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Original Contribution

CORRELATION AND PATH-COEFFICIENT ANALYSIS OF QUANTITATIVE CHARACTERS IN WINTER BREAD WHEAT VARIETIES

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ABSTRACT

The present study was carried out to investigate the correlation and path coefficient analysis in 35 genotypes of winter bread wheat varieties, which were collected from different countries. Data were recorded for eight quantitative characters- number of productive tillers per plant, plant height, spike length, number of spikelets per spike, number of grains per spike, grain weight per spike, thousand grain weight and grain yield per plant. The highly significant and positive genotypic and phenotypic correlation was found between grain yield per plant and following components: number of productive tillers per plant (r_g=0.817, r_{ph}=0.843), number of grains per spike (r_g=0.448, r_{ph}=0.393), grain weight per spike (r_g=0.765, r_{ph}=0.545), thousand grain weight (r_g=0.594, r_{ph}=0.402). The number of spikelets per spike correlated positively and significantly with number of grains per spike (r_g=0.886, r_{ph}=0.487) and grain weight per spike (r_g=0.637, r_{ph}=0.370). Number of grains per spike had positive and significant phenotypic and genotypic correlations with grain weight per spike (r_g=0.748, r_{ph}=0.826). Grain weight per spike positively correlated with thousand grains weight (r_g=0.622, r_{ph}=0.688). The grain weight per spike and number of productive tillers per plant had strongest direct effect on grain yield per plant. The number of grains per spike via grain weight per spike and thousand grains weight via grain weight per spike had the highest positive indirect effect on the grain yield per plant. These relations can be used as selection criteria in breeding study to improve the high yielding cultivars for that region.

Key words: genotypic correlations, path coefficient analysis, phenotypic correlations, winter bread wheat, yield components

INTRODUCTION

The grain yield in the wheat is a complex character that can be determined by several components which reflect positive or negative effects upon this trait. It is important to examine the contribution of each of the various components in order to attract the attention to which one has the greatest influence on grain yield. Therefore, information on the relation of yield components with grain yield is of great importance to a breeder in selecting a desirable genotype (1). Correlations between traits are depending of genetic and environmental factors. Environmental conditions can cause variability, not only of some trait but interrelationships between its (2). Simple correlation analysis indicates the degree of association between traits, but it can't provide reasons of association.

Therefore, simple correlation coefficients are not always effective in determining the real relationships among traits (3). Path analyses provide a measure of relative importance of each independent variable to prediction of changes in the dependent one. 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 direct and indirect effects (4). Path coefficients show direct influence independent variable upon dependent variable. Indirect influence on independent variable through other independent variable on dependent variable is describe results between coefficient simple correlation two independent of variables and their separate direct influence (5). Path analysis was used in numerous researches with the aim of determining the effects of important

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yield components (6-17). The knowledge of genetic and phenotypic interrelationships between yield and quantitative/qualitative components of yield is giving additional information that is make possible successful work of wheat breeding.

The objective of this study was to establish the interrelationship and direct and indirect effects of some yield components among themselves and with grain yield in winter bread wheat.

MATERIALS AND METHODS

The present study was conducted in the experimental field of Institute of Plant Genetic Resources "Konstantin Malkov"-Sadovo, Bulgaria during 2011-2014 growing seasons. Thirty five wheat varieties from different countries (Bulgaria, Rumania, Serbia, Hungary, China and Ukraine) were examined. The experiment was conducted in the randomized block design in three replications and 10 m^2 plot size. Normal agronomic and cultural practices were applied to the experiment throughout the growing seasons. The agronomic characters were taken after harvesting the plants. From each variety, 20 plants were collected for biometrical measurements. Data were recorded for number of productive tillers per plant, plant height, spike length, number of spikelets per spike, number of grains per spike, grain weight per spike, thousand grain weight and grain yield per plant.

Genotypic correlations were calculated by using of genotypic variances and covariance, phenotypic correlations by using phenotypic variances and covariance. The genotypic and phenotypic correlations thus calculated were tested for significance (5). The path coefficient analysis was performed according Dewey and Lu (4), using genotypic correlations to assess direct and indirect influences of different yield components (productive tillers per plant, plant height, spike length, number of spikelets per spike, number of grains per spike, grain weight per spike and thousand grain weight) on grain yield per plant.

RESULTS AND DISCUSSION

Genotypic and phenotypic correlations

Genotypic and phenotypic correlation coefficients provide a quantitative evaluation of effects of environments on particular character (18). The association of grain yield per plant with other characters was estimated by genotypic and phenotypic correlation coefficients **(Table 1).** Highly significant and positive genotypic and phenotypic correlation existed between grain yield per plant and four different traits are: number of productive tillers per plant (r_g=0.817, r_{ph}=0.843), number of grains per spike (r_g=0.448, r_{ph}=0.393), grain weight per spike (r_g=0.765, r_{ph}=0.545), thousand grain weight (r_g=0.594, r_{ph}=0.402). These results are in agreement with results obtained by Khaliq et al., Uddin et al., Narwal et al., Ashfaq et al. and Nayeem et al. (18-22). The phenotypic correlation between grain yield per plant and number of spikelets per spike was positive and significant at the 0.05 level (r_{ph}=0.292). Number of productive tillers per plant also had positive and significant phenotypic correlation with number of grain per spike (r_g=0.328), grain weight per spike (r_g=0.328) and thousand grain weight (r_g=0.218). The genotypic and phenotypic correlations between number of productive tillers per plant and spike length was negative and significant (r_g=-0.340, r_{ph}=-0.190). Plant height and spike length had significant and positive genotypic and phenotypic correlation (r_g=0.427, r_{ph}=0.368), what was confirmed by Zecevic et al. (23). Plant height and thousand grain weight was positively and significantly correlated (r_g=0.316, r_{ph}=0.179), what was in agreement with the study carried out by Khaliq et al., Zecevic et al. and Bhatt (18, 23,24). The genotypic and phenotypic correlations between plant height, number of spikelets per spike and number of grains per spike were negative and significant at the 0.05 and 0.01 levels. Spike length was in positive and significant phenotypic correlation with number of spikelets per spike (r_{ph}=0.353) and with grain weight per spike (r_{ph}=0.164). This is in agreement with the result obtained by Khaliq et al. (18). Genotypic and phenotypic correlations between spike length, number of grains per spike and thousand grain weight were also significant and positive. The number of spikelets per spike correlated positively and significantly with number of grains per spike (r_g=0.886, r_{ph}=0.487) and grain weight per spike (r_g=0.637, r_{ph}=0.370). Number of grains per spike was in positive and significant phenotypic and genotypic correlations with grain weight per spike (r_g=0.748, r_{ph}=0.826) and also in positive phenotypic correlation with thousand grains weight (r_{ph}=0.179). Grain weight per spike correlated positively and high significantly with thousand grain weight (r_g=0.622, r_{ph}=0.688). This is in agreement with results obtained by Zecevic et al. and Dolotovskiy et. al. (23, 25). Positive correlation was determined between thousand grain weight and grain yield per plant. This result confirmed the findings of Khan et al., Khaliq et al., Shachid et al. and Okuyama et al. (2, 18, 26, 27).

Table 1. *Genotypic (r_g) and phenotypic (r_{ph}) correlation coefficients of investigation yield components in winter bread wheat*

Variable		Number of productive tillers per plant	Plant height	Spike length	Number of spikelets per spike	Number of grains per spike	Grain weight per spike	Thousand grain weight	Grain yield per plant
Number of productive tillers per plant	r_g	1.000							
	r_{ph}	1.000							
Plant height	r_g	0.078	1.000						
	r_{ph}	0.080	1.000						
Spike length	r_g	-0.340*	0.427*	1.000					
	r_{ph}	-0.190**	0.368**	1.000					
Number of spikelets per spike	r_g	0.093	-0.365*	0.220	1.000				
	r_{ph}	0.145*	-0.205**	0.353**	1.000				
Number of grains per spike	r_g	0.220	-0.404*	0.503**	0.886**	1.000			
	r_{ph}	0.257**	-0.202**	0.355**	0.485**	1.000			
Grain weight per spike	r_g	0.362*	-0.145	0.154	0.637**	0.748**	1.000		
	r_{ph}	0.328**	-0.059	0.164*	0.370**	0.826**	1.000		
Thousand grain weight	r_g	0.269	0.316	0.364*	-0.055	-0.052	0.622**	1.000	
	r_{ph}	0.218**	0.179*	0.156*	0.026	0.179*	0.688**	1.000	
Grain yield per plant	r_g	0.817**	-0.060	-0.317	0.214	0.448**	0.765**	0.594**	1.000
	r_{ph}	0.843**	0.002	-0.109	0.292**	0.393**	0.545**	0.402**	1.000

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

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 (2, 18, 27).

The direct effect of grain weight per spike on grain yield were found to be important in the numerous studies (9; 28-37). Our results showed that grain weight per spike had the greatest positive effect (1.692) on yield grain per plant, followed by number of productive tillers per plant (0.610) **(Table 2).** The effect of the others traits were negative direction towards reducing the yield. Especially number of grains per spike had a prominent effect on yield grain per plant in negative direction with (-0.939), what is in agreement with result reported by Yagdi (13).

The direct effect of thousand grains weight on yield grain per plant was also negative and high (-0.670), while plant height and number of spikelets per spike had minimum negative direct effect on the yield (-0.096 and -0.021), respectively. Plant height had positive indirect effect via number of grains per spike (0.304), while negative effects through grain weight per spike and thousand grain weight on grain yield per plant. Spike length affected the grain yield negatively via number of grains per spike (-0.429). The indirect effect of number of spikelets per spike through number of grains per spike was negative (-0.687), while it was positive through grain weight per spike (0.860). Number of grains per spike had the highest positive indirect effect (1.316) via grain weight per spike. Thousand grain weight also had an appreciable indirect effect (1.104) via grain weight per spike **(Table 2).**

The path coefficient analysis gave a somewhat different picture from what the simple correlation analysis did. The genotypic correlation analysis indicated that number of grains per spike and thousand grain weight as important positive influences on grain yield per plant, but path coefficient analysis suggested that they had direct negative influence on grain yield per plant. The direct negative effects of number of grains per spike and thousand grain weight on the grain yield were masked from the positive indirect effect of these characters through grain weight per spike.

Table 2. *Direct (Bold and Underline) and indirect effect of 7 characters (independent variables) on grain yield per plant (dependent variable) in 35 wheat genotypes. The last column shows genotypic correlations of independent variables with grain yield plant*

Variable	Direct and indirect effect							Total indirect effect	r_g
	Number of productive tillers per plant	Plant height	Spike length	Number of spikelets per spike	Number of grains per spike	Grain weight per spike	Thousand grain weight		
Number of productive tillers / plant	**0.610**	-0.009	0.042	-0.003	-0.222	0.573	-0.174	0.207	0.817**
Plant height	0.043	**-0.096**	0.052	0.006	0.304	-0.186	-0.184	0.035	-0.061
Spike length	-0.191	0.032	**-0.151**	-0.011	-0.429	0.243	0.190	-0.166	-0.317
Number of spikelets per spike	0.063	0.026	-0.039	**-0.021**	-0.687	0.860	0.012	0.235	0.214
Number of grains per spike	0.146	0.031	-0.058	-0.013	**-0.939**	1.316	-0.035	1.387	0.448**
Grain weight per spike	0.231	0.021	-0.014	-0.008	-0.725	**1.692**	-0.432	-0.927	0.765**
Thousand grain weight	0.166	-0.016	0.050	0.002	-0.042	1.104	**-0.670**	1.264	0.594**

CONCLUSION

The results obtained from 35 bread wheat genotypes showed that grain yield per plant was significantly and positively correlated with number of productive tillers per plant, number of grains per spike, grain weight per spike and thousand grain weight both at genotypic and phenotypic levels. Path coefficient analysis indicated that the direct effects of plant height, spike length and number of spikelets per spike on grain yield were weakly negative. The direct effects of grain weight per spike and number of productive tillers per plant were strongly positive, while number of grains per spike and thousand grain weight had strongly negative effect. Therefore, the characters of grain weight per spike, number of productive tillers per plant, number of grains per spike and thousand grain weight can be used as selection criteria to increase grain yield in bread wheat in the region.

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