Correlation and Path Coefficient Analysis for Yield and its Attributing Traits in Wheat (*Triticum aestivum* L.) Genotypes

ABSTRACT

The present investigation conducted on 80 accessions of wheat during 2018-19 at Main Experiment Station (MES) of A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) to evaluate character association and genetic divergence for the identification of most diverse and promising genotypes. The experiment was laid out in Augmented Block Design. The observations were recorded on various morphological and physiological characters. The traits thousand-grain weight, biological yield per plant, peduncle length, spike length and harvest index revealed direct effect and positive correlation therefore, these traits should be selected in future for yield improvement of wheat.

Keywords- wheat, correlation, Path coefficient, yield components

Introduction

Grain production is a complex phenomenon, entailing several contributing factors. These factors influence grain production both directly and indirectly and the breeder is naturally interested in investigating the extent and type of association of such traits. Towards a clear understanding of the type of plant traits, correlation and path coefficient analysis are logical steps. Phenotypic and genotypic correlations within varieties are of value to indicate the degree to which various characters are associated with economic productivity. Path coefficient analysis is a reliable statistical technique which provides means not to quantify the interrelationships of different yield components but also indicates whether the influence is directly reflected in the yield or takes some other path way for ultimate effects.

Correlation coefficient analysis looks to be quiet powerful tool to understand the inter-relationship of various yield attributes. This parameter also gives the estimates of the inter relationship in between grain yield and other attributes and between themselves. This would facilitate breeders in choosing effective selection schemes to improve the yield. Path coefficient analysis dealing with the extent of direct and indirect contribution of the independent variables on a dependent variable by splitting the correlation coefficient of grain yield and the concerned trait. Consequently, path coefficient analysis was considered as the most common and useful statistical method used for this purpose and it can also be used to estimate the quantitative impact of direct and indirect effects caused by one or other components of grain yield and their relationship b/w these components.

Grain yield is a dynamic feature, determined by a variety of characters that contribute. The estimation of the interrelation between grain yield and other yield attributes, and between them, will encourage successful selection schemes to boost yield. Assuming yield is a contribution of many characters associated with each other, and to yield, co-efficient path analysis has been established (Wright, 1921; Dewey and Lu, 1959).The correlation coefficient measures the degree of the relationship, while the path coefficient analysis measures the magnitude of direct and indirect involvement of the specific component characters on the complex character and is defined as a standardized regression coefficient dividing the coefficient of correlation into direct and indirect effects.

Since yield is a complex end product of multiplicative interactions between different yield components, the genetic architecture of grain yield in wheat can be better solved through components rather than yield per se. (Grafius, 1959) Therefore yield is often selected as a supercharacter. Therefore, Donald (1968) put forward the idea of plant ideotype considering "an optimum combination of all yield components and other essential plant characteristics, so that maximum economic yield can be reproduced in the environment for which it is intended. Thus, selection for yield per se does not matter as such unless followed by selection for important characters responsible for conditioning it. "The correlation and path-coefficients allow us to understand the relative significance of different characters affecting yield such that the most significant yield components can be identified. For the preparation of an effective selection strategy, the identification of essential yield components is important because practice selection for a large number of characters along with grain yield is almost impossible and impracticable.

MATERIALS AND METHODS

The present investigation conducted on 80 accessions of wheat during 2018-19 of wheat Main Experiment Station (MES) of A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) to evaluate character association and genetic divergence for the identification of most diverse and promising genotypes. The experiment was laid out in Augmented Block Design. The observations done on 5 plants that were randomly selected and data were recorded for plant height (cm), flag leaf area (cm^2), number of fertile tillers per plant, spike length (cm), number of spikelets per spike, number of grains per spike, 1000-grain weight (g), peduncle length (cm), biological yield per plant (g), harvest index (g) and grain yield per plant (g).

Genotypic and phenotypic correlations were worked out according to the method given by Searle (1961). The direct and indirect effects of each trait were assessed by path analysis using the method of Dewey and Lu (1959).

RESULT AND DISCUSSION

Correlation Analysis

Genotypic and phenotypic correlations for all possible combinations for traits under study are presented in Table 1 and 2. In almost all the cases genotypic correlations were higher as compared to phenotypic ones.

Observations revealed that the genotypic correlations of grain yield were higher with almost all the characters than phenotypic correlations. Grain yield per plant was highly significant and positively correlated with, harvest index, thousand grain weight and tiller per plant where as it showed non-significant positive correlation with spike length, days to maturity, peduncle length and plant height. Similar observations were also reported by Baloch *et* al., (2014), Rehman *et* al. (2015) and Muhammad *et* al. (2011). Whereas it shows negative significant correlation with number of flag leaf area. These results were in accordance with the findings of Muhammad and Ihsan (2004) for plant height, spike length and grains yield. Whereas non-significant negative correlation with biological yield per plant and days to 50% flowering. Observations revealed that the genotypic correlation of grain yield per plant were higher with almost all the characters than phenotypic correlations but in the same direction. Chaitali and Bini (2007) and Anwar *et* al. (2009) also found similar observation. High magnitude of genetic association may be due to pleiotropic rather than linkage. By improving the characters which are directly and positively associated with grain yield and by elimination the negative correlated characters with grain yield will ultimately improve yield.

Days to 50% flowering has shown positive significant correlation with days to maturity whereas it shows non-significant but positive correlation with tiller per plant**,**1000 grain weight and harvest index. It shows highly significant negative correlation with spike length while non-significant negative correlation with flag leaf area, plant height, spike length, peduncle length and grain yield per plant. Ayer *et* al., 2017 also found similar pattern of negative correlation.

Flag leaf area has shown highly positive significant correlation with plant height, spike length, peduncle length and biological yield per plant. While it shows highly significant negative correlation with harvest index, tiller per plant and grain yield per plant. Flag leaf area has shown highly non-significant negative correlation with thousand grain weight, days to 50% flowering and days to maturity.

Plant height has shown significant positive correlation with biological yield per plant, peduncle length, spike length and flag leaf area. Whereas significant negative correlation with harvest index. Plant height has shown non-significant positive correlation with tiller per plant and days to maturity, whereas non-significant negative correlation with thousand grain weight and days to 50% flowering. These findings are similar to the results recorded by Joshi *et* al. (2008). Kumar *et* al., (2018) and Zare *et* al., (2017).

Days to maturity has shown significant and positive correlation with tiller per plant and days to flowering. The character days to maturity has shown non-significant negative correlation with spike length and flag leaf area, positive non-significant correlation with plant height, pod length, biological yield per plant, grain yield per plant, thousand grain weight and harvest index. Upadhyay (2020) also found the similar results.

Tiller per plant has shown highly significant positive correlation with days to maturity and with grain yield per plant, whereas non-significant negative correlation with flag leaf area. Tillers per plant has shown highly non-significant positive correlation, harvest index, biological yield per plant, days to 50% flowering and plant height whereas non-significant negative correlation with spike length and thousand grain weight.

Spike length has shown significant negative correlation with days to 50% flowering whereas significant positive correlation with peduncle length, plant height, biological yield per plant and flag leaf area. Spike length has shown non-significant negative correlation with harvest index, days to maturity and tillers per plant, whereas non-significant positive correlation with grain yield per plant. Earlier Assefa (2017), Kumar *et* al., (2018) and Sharma *et* al., (2018) have recorded the similar pattern of association.

Peduncle length has shown significant negative correlation with harvest index whereas significant positive correlation with biological yield per plant, plant height, spike length and flag leaf area. Peduncle length has shown non-significant negative correlation with thousand grain weight and days to 50% flowering whereas non-significant positive correlation with days to maturity, grain yield per plant and tiller per plant. Earlier supported by Sharma *et* al., (2018) for positive correlation.

Biological yield per plant has shown highly significant negative correlation with harvest index, thousand grain weight, whereas significant positive correlation with plant height, peduncle length, spike length and flag leaf area. Biological yield per plant has shown highly non-significant negative correlation grain yield per plant and days to 50% flowering, whereas non-significant positive correlation with plant height with days to maturity and tiller per plant.

Thousand grain weight has shown highly significant positive correlation with harvest index and grain yield per plant (similar as Akram *et* al., 2008), whereas significant negative correlation with biological yield per plant. Thousand grain weight has shown non-significant positive correlation with days to maturity and days to 50% flowering, whereas non-significant negative correlation with spike length, tiller per plant, flag leaf area, peduncle length and plant height.

Harvest index has shown highly significant negative correlation with biological yield per plant, plant height, flag leaf area and peduncle length, where as significant positive correlation with thousand grain weight. Harvest index has shown non-significant negative correlation spike length, whereas non-significant positive correlation with tiller per plant, days to maturity and days to 50% flowering. These findings are similar to Upadhyay (2020) and Khan *et* al. (2010).

Path Coefficient Analysis

The direct and indirect effects of different characters on grain yield per plant were worked out using path coefficient analysis at genotypic level presented in Table 3.

Analysis of the path coefficient is a method for partitioning the observed correlation coefficient into the direct and indirect effects on grain yield from yield components. Review of the direction gives a good picture of the character interactions to formulate an appropriate selection strategy. Evaluation of the route coefficient varies from simple correlation in that it points out the causes and their relative value, while the latter tests merely the reciprocal relationship that lacks the causation. Sewal wright (1921) introduced the idea of a path coefficient and Dewey and Lu (1959) first used the technique for plant selection. Path analysis has emerged as an effective and commonly used technique for understanding the direct and indirect contribution of different characteristics to the economic production of crops, so that the relative value of different yield contributing characteristics can be evaluated.

Correlation provides relationship between two characters but in path analysis direct and indirect effect of independent trait on dependent trait will be known. Path coefficient analysis was done to determine direct and indirect influence of days to 50% flowering, flag leaf area, days to maturity, plant height, spike length, tillers per plant, peduncle length, biological yield per plant, harvest index, test weight on grain yield per plant.

Path analysis revealed that thousand-grain weight showed highest and positive direct effect on grain yield per plant followed by biological yield per plant, peduncle length, spike length and harvest index. Highest negative direct effect on grain yield per plant revealed by plant height followed by flag leaf area, tillers per plant, days to flowering and days to maturity. Earlier study of Joshi et al. (2008)found similar results for thousand-grain weight, Kumar *et* al. (2014) for thousand-grain weight, biological yield per plant, harvest index and spike length, Bhushan *et* al. (2013) for biological yield per plant and plant height, Baye *et* al., (2020) for days to maturity.

Days to flowering revealed positive and indirect effect via flag leaf area, plant height, harvest index and thousand-grain weight while it shows negative indirect effect with days to maturity, tillers per plant, spike length, peduncle length and biological yield per plant.

Flag leaf area shows positive and indirect effect via tillers per plant, spike length, peduncle length and biological yield per plant while negative indirect effect through plant height, harvest index and thousand-grain weight. Suleiman *et* al. (2014) and Ayer *et* al. (2017) also found similar result and revealed that leaf area index had negative direct effect on yield.

Plant height revealed positive and indirect effect via spike length, peduncle length and biological yield per plant while negative indirect effect through days to maturity, tillers per plant and harvest index. Similar observation was recorded by Tarkeshwar *et* al. (2020).

Days to maturity shows positive and indirect effect via peduncle length, harvest index and thousand-grain weight while negative indirect effect via tillers per plant and spike length. Similar observation was recorded by Tarkeshwar *et* al. (2020).

Tillers per plant shows positive and indirect effect via peduncle length, biological yield per plant and thousand-grain weight while negative indirect effect via spike length and harvest index. These findings are supported by Tarkeshwar *et* al. (2020).

Spike length showed high and positive indirect effect towards grain yield per plant via peduncle length and biological yield per plant while negative indirect effect via harvest index and thousand-grain weight. Findings were supported by Upadhyay (2020) for peduncle length and Ayer *et* al. (2013) for biological yield per plant.

Low residual effects of (0.0253) path indicated that the yield traits chosen in the present study were sufficient to explain the grain yield per plant.

CONCLUSION:

For improvement of yield, effective selection is very important. Information of associations among yield contributing traits clarifies their relative importance for selection in yield improvement. Grain yield of wheat is determined by several yield attributing traits. These yield attributing traits revealed both positive as well as negative correlation with grain yield. During selection of genotypes of wheat there is necessity to know about performance of different characters and relation among these characters. The direct effecting traits and positively correlated traits *viz.*, thousand-grain weight, biological yield per plant, peduncle length, spike length and harvest index should be selected in future for yield improvement of wheat.

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Table:1 Phenotypic correlation of eleven agro-morphological traits

Traits	DFF	FLA	PH	DM	TP	SL	PL	BYP	GYP	TW	HI
DFF	1.000										
FLA	-0.053	1.000									
PH	-0.128	0.422	1.000								
DM	0.461	-0.003	0.074	1.000							
TP	0.101	-0.343	0.095	0.226	1.000						
SL	-0.252	0.385	0.551	-0.133	-0.16	1.000					
PL	-0.081	0.487	0.881	0.104	0.016	0.576	1.000				
BYP	-0.12	0.457	0.907	0.066	0.117	0.502	0.845	1.000			
GYP	-0.058	-0.231	0.012	0.049	0.212	0.072	0.054	-0.124	1.000		
TW	0.1	-0.122	-0.198	0.201	-0.116	-0.02	-0.149	-0.21	0.325	1.000	
HI	0.022	-0.381	-0.4	0.027	0.137	-0.186	-0.345	-0.564	0.878	0.355	1.00

***, **Significant at 1% & 5% level of significance respectively**

Table 2- Genotypic correlation of eleven agro-morphological traits

Traits	DFF	FLA	PH	DM	TP	SL	PL	BYP	GYP	TW	HI
DFF	1.000										
FLA	-0.053	1.000									
PH	-0.128	0.422**	1.000								
DM	0.461**	-0.003	0.074	1.000							
TP	0.101	-0.343**	0.095	0.226*	1.000						
SL	-0.252*	0.385**	0.551**	-0.133	-0.16	1.000					
PL	-0.081	0.487**	0.881**	0.104	0.016	0.576**	1.000				
BYP	-0.12	0.457**	0.907**	0.066	0.117	0.502**	0.845**	1.000			
GYP	-0.058	-0.231*	0.023	0.049	0.212*	0.072	0.054	-0.124	1.000		
TW	0.1	-0.122	-0.198	0.201	-0.116	-0.02	-0.149	-0.210*	0.325**	1.00	
HI	0.022	-0.381**	-0.40**	0.027	0.137	-0.186	-0.345**	-0.564**	0.878**	0.355**	1.00

***, **Significant at 1% & 5% level of significance respectively**

DFF (Days to 50% flowering),FLA (Flag leaf area),PH (Plant height),DM (Days to maturity),TP (Tillers per plant), SL (Spike length), PL (Peduncle length),BYP (Biological yield per plant),GYP (Grain yield per plant), TW (Thousand grain weight), HI (Harvest index)

Table: 3-Genotypic path coefficient direct and indirect effect of all other characters on grain yield

Traits	DFF	FLA	PH	DM	TP	SL	PL	BYP	HI	TW
DFF	-0.0219	0.00367	0.03019	-0.00048	-0.00382	-0.0116	-0.00647	-0.08671	0.00076	0.01637
FLA	0.00107	-0.07487	-0.12003	0	0.01281	0.01832	0.05742	0.3878	-0.00082	-0.5917
PH	0.00276	-0.03751	-0.23958	-0.00008	-0.00407	0.0245	0.08927	0.73385	-0.00104	-0.6131
DM	-0.00983	-0.00007	-0.01749	-0.00107	-0.01056	-0.00704	0.01112	0.05379	0.0012	0.02896
TP	-0.00197	0.02261	-0.023	-0.00027	-0.04241	-0.00623	0.00303	0.11883	-0.00052	0.16492
SL	0.00563	-0.0304	-0.13009	0.00017	0.00585	0.04513	0.05722	0.39342	-0.0002	-0.34873
PL	0.0014	-0.04253	-0.21155	-0.00012	-0.00127	0.02554	0.1011	0.67845	-0.00082	-0.5212
BYP	0.00237	-0.03616	-0.21898	-0.00007	-0.00628	0.02211	0.08543	0.8029	-0.00115	-0.79817
HI	-0.003	0.01116	0.04504	-0.00023	0.00399	-0.00162	-0.01506	-0.167	0.00551	0.56023
TW	-0.00028	0.03519	0.11668	-0.00002	-0.00556	-0.0125	-0.04185	-0.50904	0.00245	1.25894