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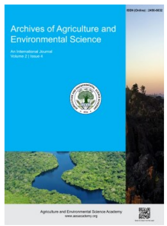

ORIGINAL RESEARCH ARTICLE

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Correlation and path coefficient analysis among yield and yield attributing traits of wheat (*Triticum aestivum* L.) genotypes

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ABSTRACT

To assess correlation and to find out the direct and indirect effect of yield attributing traits on grain yield, thirty wheat (*Triticum aestivum* L.) genotypes were experimented at Kamalamai-04, Phant, of Sindhuli district, Nepal. The experiment was laid out in alpha-lattice design with three replications. Thirteen quantitative traits including grain yield of wheat were studied during this study. The grain yield of wheat has significant (*P≤0.01*) and positive genotypic and phenotypic correlation with number of spikes per meter (0.6**, 0.47**), grains per spike (0.69**, 0.65**), weight of grains per spike (0.69**, 0.61**), thousand kernel weight (0.87**, 0.74**), maturity days (0.5*, 0.47**), above ground mass yield (0.96**, 0.83**) and harvest index (0.93**, 0.64**) of wheat. The genotypic correlation is higher in magnitude than the phenotypic correlation for almost all the studied traits. Path analysis of genotypic correlation showed a high positive direct effect of plant height (0.75), above ground biomass (0.6), spike length (0.43), and harvest index (0.29) on grain yield of wheat. Hence, for increasing yield of wheat in the breeding program, selection and hybridization can be made more effective and accurate by using those traits that have a significant positive correlation coefficient and direct effect on the grain yield of wheat.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world. It provides staple food to 40% of the world's population with more calories and 20% of daily dietary protein than any other cereal (LACC/IGW, 2018). It is directly linked to food security, nutrition, and rural livelihood of resource poor farmers of developing and developed countries. To fulfill the diverse needs of farmers, to solve the problem of food security and to make food available for increasing population, production and productivity of wheat must have to increase (FAO, 2017) (World and Group, 2018).

Since, domestication wheat is continuously improving until now through different plant breeding techniques like selection, hybridization (Kiszonas and Morris, 2018). In many developing countries like Nepal, conventional breeding is still prevalent for improving yield and yield related traits (Joshi *et al*., 2008). The availability of diverse wheat genotypes (wild relatives and introduced genotypes) of various climatic conditions having higher genetic variability is helpful for the effective breeding programs (Sabit *et al*., 2017). Most of the agronomic characters in crop plants are quantitative. Yield is one such character that results due to the actions and interactions of various component characters (Grafious, 1960). Grain yield is an economically important trait of wheat. Yield being quantitative trait is complex in nature, which is the product of several directly or indirectly affecting factors. Effective Selection has a significant impact on crop improvement programs therefore selection can play a substantial role in achieving breeding goals (Al-Tabbal, 2016).

Correlation is very important in plant breeding because of its reflection in dependence degree between two or more traits

(Zecevic *et al*., 2004). Genetically correlated traits can be improved by improving any one of the traits by direct selection. Correlations between traits are dependent on genetic and environmental factors (Falconer, 1962). Correlation expresses the degree of interrelationship between various traits while path analysis provides a better understanding of the type of effect (Sabit *et al*., 2017). The existing interrelationship between components is expressed through correlations coefficients and those coefficients can be separated on direct and indirect influence by path analysis (Saif-ur-rasheed *et al*. 2014). If there are genetic correlations among the traits, selection for a trait can result in modification of another trait i.e. correlation response to selection would be obtained (Sheridan and Barker, 1974). This paper aims to compare results of genotypic and phenotypic correlations and path coefficient analysis of wheat and helps in the effective selection of genotypes for improving yield in a wheat breeding program.

MATERIALS AND METHODS

The trial was conducted in the farmer's field of Kamalamai-04, Phant, Sindhuli district, Nepal from November 2017 to April 2018. It has 26 advanced wheat lines and four-released wheat cultivars as treatments. The experiment was executed in Alpha lattice design with three replications, each replication consisting of 6 blocks with 5 plots in each block. The individual plot size was 3 m × 2 m (6 m^2). Row to row spacing was 25 cm where 8 rows of 3 m length in each plot were maintained. Standard agronomical practices were followed during the crop growing period. Thirteen economically important quantitative traits namely flag leaf area, plant height, spike per meter, spike length, peduncle length, grains per spike, grain weight per spike, thousand kernel weight, heading days, maturity days, above ground biomass, harvest index and grain yield were measured from 30 wheat genotypes. Based on those replicated data, phenotypic and genotypic correlation coefficients were calculated among the quantitative traits. Genotypic and phenotypic correlation coefficients were analyzed in Meta R software developed by CIMMYT. The genetic path coefficient was obtained using Excel, following the procedure describe by Akintunde (2012).

RESULTS AND DISCUSSION

Association of characters

From the Table 1 it is clear that the genotypic correlation coefficients were more in magnitude than the phenotypic correlation coefficients that revealed the presence of inherent genetic relationships among various characters and are less dependent on environment. Similar results is also reported by (Dab *et al*., 2016).

Phenotypic and genotypic correlation

Phenotypic and genotypic correlations among the 30 wheat genotypes were presented in Table 1. Flag leaf area has positive genetic and phenotypic correlation with all the studied traits except heading days and spike per meter. Plant height has positive correlation with all studied traits except spikes per meter, maturity days, grain yield and harvest index for both genetic and phenotypic levels. It shows significant positive relation with peduncle length while significant negative relation with harvest index for both genotypic and phenotypic levels. For plant height, Joshi *et al.* (2008) had also found similar types of results. Spike per meter has significant positive relation with spike length, thousand kernel weight, maturity days, above ground mass yield, and grain yield in both genotypic and phenotypic level while it has negative significant correlation with peduncle length. It has negative relationship with flag leaf are and plan height. Spike length has positive correlation with all studied traits except heading days in both genotypic and phenotypic levels. It has significant relation with flag leaf area, spike length, number of grains per spike, weight of grains per spike, thousand kernel weight , maturity days, above ground mass, grain yield, harvest index in genetic correlation but only with spike per meter, weight of grains per spike, thousand kernel weight and yield has significant correlation in phenotypic level. Assefa (2017) also found significant positive correlation of spike length with thousand kernel weight, grain yield and positive correlation with maturity days, number of grains per spike in contrast they found harvest index negatively correlated.

Number of grains per spike and Weight of grains per spike has positive correlation with all the studied traits except heading days. Maturity days is positively correlated with all the studied traits except plant height and peduncle length. Heading days has negative correlation with all the studied traits except plant height, spike per meter and maturity days in both levels while it has significant negative correlation with harvest index. Above ground mass has positive correlation with all the studied traits except peduncle length and heading days in both levels. It has significant positive correlation with spike per meter, grains per spike, weight of grains per spike, thousand kernel weight, maturity days and yield. While genotypic has also significant positive correlation with flag leaf area, spike length, yield, harvest index of wheat.

Harvest index has significant negative correlation with plant height, peduncle length and heading days and significant positive correlation with thousand kernel weight and grain yield in both genotypic and phenotypic levels. In addition, harvest index also has positive significant genotypic correlation with spike length, weight of grains per spike, biological yield. Grain yield has positive correlation with all the studied traits except plant height, peduncle length and heading days. Grain yield has significant positive correlation with number of spikes per meter, spike length, grains per spike, weight of grains per spike, thousands kernel weight, above ground mass and harvest index for both genetic and phenotypic levels. Assefa (2017) also had found significant positive correlation of grain yield with spike length, grains per spike, thousand kernel weight, above ground mass and harvest index in both genetic and phenotypic levels. He had showed negative correlation with plant height and heading days. Baranwal *et al.* (2012) had also reported significant positive genotypic and phenotypic correlation of grain yield with grains per spike, thousand kernel weight, number of spikes per meter and negative correlation with peduncle length. They also found spike length negatively correlated with grain yield which is in contrast with my result. Joshi *et al.* (2008) also found similar results. They also found positive genotypic and phenotypic correlation with maturity days, number of spikes per meter, grains per spike, weight of grains per spike, thousand kernel weight and negative correlation with plant height. Khan *et al.* (2010) also found thousand kernel weight, grans per spike, spike length and maturity days positively correlated as similar to the result of this paper in contrast they found leaf area negatively correlated with grain yield. Dabi *et al.* (2016) also reported significant positive correlation with thousand kernel weight, above ground mass, harvest index, kernel per spike, positive correlation with spike length and negative correlative with heading days whereas significant positive correlation with plant height.

Genotypic direct and indirect effects of various traits on grain yield

Path coefficient analysis is an important tool for partitioning the correlation coefficients into the direct and indirect effects of independent variables on a dependent variable. It is also important to understand the relative importance of different parameters as selection criteria. It helps to better understand the interrelationship among the traits. Grain yield is complex character for its improvement multiple traits to be considered. The direct and indirect effect of various parameters on grain yield is shown in Table 2. The table shows plant height (0.75), above ground biomass (0.6) and spike length (0.42) had high direct effect on grain yield indicating the relationship between these traits as good contributors to grain yield. Flag leaf area, spike per meter, grain weight per spike, maturity days and harvest index have positive direct effect on grain yield. While peduncle length, thousand kernel weight, heading days and grains per spike has negative direct effect on yield. These characters could be considered as main components of selection in a breeding program for obtaining higher grain yield. According to Joshi *et al.* (2008) plant height, maturity days, spike grain weight has positive direct effect, heading days and spike grain number has negative direct effect on grain yield which are similar with this result presented in Table 2. In contrast they reported positive direct effect of thousand kernel weight. Kumar *et al.* (2014) reported plant height, harvest index, above ground mass, spike length, number of grains per spike has positive direct effect and in contrast they reported thousand kernel weight has positive direct effect.

Table 1. Genotypic (below diagonal) and phenotypic (above diagonal) correlation coefficients of the 13 quantitative traits of wheat genotypes at Sindhuli Nepal.

	FLA	PH	SPM	SL	PL	NGPS	GWPS	TKW	MD	HD	AGM	HI	Y
FLA	1	0.52	-0.14	0.33	0.78**	0.40*	0.33	0.36	0.05	-0.13	0.23	0.01	0.18
PH	0.55**	1	-0.3	0.12	0.83**	0.06	0.11	0.19	-0.05	0.26	0.03	-0.26*	-0.12
SPM	-0.14	-0.39	1	0.3*	-0.39	0.21	0.22	0.68**	0.54*	0.11	0.96*	0.13	0.47**
SL	0.52**	0.2	0.65**	1	0.15	0.22	0.41*	0.61*	0.35	-0.03	0.35	0.22	0.41*
PL	0.82**	0.88**	-0.47*	0.2	1	0.09	0.08	0.16	-0.2	-0.03	-0.07	-0.21	-0.17
NGPS	0.47**	0.08	0.25	0.47**	0.11	1	0.57**	0.36	0.42*	-0.03	0.6**	0.26	0.65**
GWPS	0.37*	0.11	0.27	0.74**	0.07	0.73**	1	0.58**	0.36*	-0.003	0.52**	0.34	0.61**
TKW	0.43*	0.24	0.79**	0.99**	0.20	0.40*	0.71**	1	0.53**	-0.06	0.57**	0.51**	0.74**
MD	0.06	-0.05	0.55*	0.80**	-0.21	0.47**	0.41*	0.56**	1	0.5**	0.41*	0.24	0.47**
HD	-0.15	0.29	0.14	-0.01	-0.04	-0.06	-0.004	-0.11	0.54**	1	-0.01	-0.46*	-0.24
AGM	0.39*	0.05	0.99**	0.65**	-0.1	0.78**	0.67**	0.81**	0.54**	-0.03	1	0.10	0.83**
HI	-0.03	-0.41*	0.23	0.66**	-0.36*	0.34	0.62**	0.85**	0.35	-0.78**	0.78**	1	0.64**
Y	0.23	-0.14	0.6**	0.7**	-0.21	0.69**	0.69**	0.87**	0.5*	-0.31	0.96**	0.93**	1

**Significance at *P<0.01*, *Significance at p<0.05 FLA= flag leaf area, PH= plant height, SPM = Spikes per meter, SL= spike length, PL= peduncle length, GPS= number of grains per spike, GWPS= grains weight per spike, TKW= thousand kernel weight, MD= maturity days, HD= heading days, AGM= above ground mass, HI= harvest index.

Table 2. Estimate of direct effect (bold face and diagonal) and indirect effects (off diagonal) at phenotypic level in 30 wheat genotypes at Sindhuli Nepal.

	FLA	PH	SPM	SL	PL	GPS	GWPS	TKW	MD	HD	AGM	HI
FLA	0.24	0.13	-0.03	0.12	0.19	0.11	0.09	0.1	0.01	-0.04	0.09	-0.01
PH	0.42	0.75	-0.29	0.15	0.66	0.06	0.09	0.18	-0.04	0.22	0.04	-0.31
SPM	-0.01	-0.03	0.08	0.05	-0.04	0.02	0.02	0.06	0.04	0.01	0.08	0.02
SL	0.22	0.09	0.28	0.43	0.09	0.2	0.32	0.43	0.34	-0.01	0.28	0.28
PL	-0.65	-0.7	0.38	-0.16	-0.8	-0.09	-0.06	-0.16	0.17	0.03	0.08	0.29
GPS	-0.06	-0.01	-0.03	-0.06	-0.01	-0.12	-0.09	-0.05	-0.06	0.01	-0.1	-0.04
GWPS	0.05	0.02	0.04	0.11	0.01	0.11	0.14	0.1	0.06	-0.01	0.1	0.09
TKW	-0.28	-0.15	-0.51	-0.65	-0.13	-0.26	-0.46	-0.65	-0.37	0.07	-0.53	-0.55
MD	0.01	-0.01	0.09	0.13	-0.03	0.08	0.07	0.09	0.16	0.09	0.09	0.06
HD	0.07	-0.13	-0.06	0.01	0.02	0.03	0.01	0.05	-0.24	-0.44	0.01	0.34
AGM	0.23	0.03	0.6	0.39	-0.06	0.47	0.4	0.49	0.32	-0.02	0.6	0.47
HI	-0.01	-0.12	0.07	0.19	-0.11	0.1	0.18	0.25	0.1	-0.23	0.23	0.29

Conclusion

The correlation coefficient of above ground biomass, spike length of wheat was significant and positive with grain yield of wheat whereas plant height has a negative correlation. Therefore, significant positive correlated traits having a positive direct effect on grain yield like spike length, above ground biomass, weight of grains per spike, harvest index, spikes per meter and maturity days of wheat should be given much attention while selecting genotypes as these characters are helpful for indirect selection.

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