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Correlation Coefficient and Path Coefficient Analysis for Yield Components in Wheat (*Triticum aestivum* L.)

D. L. Kamani[1*], C. A. Babariya[2] and P. B. Marviya[3]

[1]M.sc. (Agri.) student, Dept. of Agril. Statistics, JAU, Junagadh

[2]Assistant Professor, Department of Seed Science and Technology, JAU, Junagadh

[3]Ph. D Student, Dept. of Agril. Statistics, JAU, Junagadh

*Corresponding Author E-mail: cababariya@jau.in

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ABSTRACT

The study was undertaken to estimate correlation coefficients and direct and indirect effects by path analysis for grain yield per plant and its components by using 52 genotypes of wheat. The grain yield per plant has significant and positive correlations both at genotypic and phenotypic levels with biological yield per plant, number of productive tillers per plant, harvest index, plant height, days to 50% flowering, days to maturity, peduncle length and ear length. The path coefficient analysis revealed high positive direct effects of biological yield per plant, harvest index, days to 50% flowering, grain filling period, grain weight per main spike and peduncle length on grain yield per plant. Thus, these traits are to be considered as the most important yield contributors and due emphasis should be given while attempting yield improvement in wheat. Thus, these characters were identified as the most important yield components and due emphasis should be placed on these characters while selecting for high yielding genotypes in wheat.

Key words: *Character association, Path analysis, Wheat.*

INTRODUCTION

Wheat is the second most important staple food next to rice, consumed by nearly 35 per cent of the world population and providing 20 per cent of the total food calories. It is the most widely cultivated food crop of the world. It is known for its remarkable adoptation to a wide range of environments and its role in world economy. Wheat occupies about 32 per cent of the total acreage under cereals in the world. The main wheat growing countries include China, India, USA, Russia, France, Canada, Germany, Turkey, Australia and Ukrain. The concept of correlation was first elaborated by Fisher[4]. In plant breeding, correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component character on which selection can be based for genetic improvement in yield. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. The lack of correlation is also useful for the individual improvement of two traits.

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On the other hand, a negative correlation between the desirable traits impeds or make it difficult to achieve a significant improvement in the two traits. However, simple correlation does not give an insight into the true biological relationship of these traits with yield. Yield being quantitative in nature is a complex trait with low heritability and depends upon several other components with high heritability. Relationship between yield and yield contributing traits also play an important role in plant breeding. To detect traits, having an influence on final traits (*e.g.* yield), path analysis is commonly used. Path coefficient analysis was elaborated by Dewey and Lu[2]. Path analysis is simply a standardized partial regression coefficient that allows partioning of correlation coefficient into direct and indirect effects of various traits towards dependent variable and help in assessing the cause effect relationship as well as effective selection. When there is positive association of characters are negatively associated, it would be difficult to exercise simultaneous selection for them in developing a variety.

MATERIAL AND METHODS

The experimental material consisted of fifty two diverse genotypes of wheat (*Triticum aestivum* L.) representing different geographic origins. The pure seeds of these genotypes were obtained from the Research Scientist (Wheat), Wheat Research Station, Junagadh Agricultural University, Junagadh. The selected genotypes consisted of released varieties as well as breeding lines developed at different sources India. Fifty two genotypes of wheat were sown at normal condition in a Randomized Block Design with three replications during *Rabi* 2013-2014. Each entry was accommodated in a single row of 2.5 m length with a spacing of 22.5 cm. The observations were recorded on five randomly selected plants from each entry and replication for fifteen different characters. The observations were recorded on 15 characters *viz.*, days to 50% flowering, days to maturity, grain filling period (days), plant height (cm), number of productive tillers per plant, peduncle length(cm), Ear length (cm), number of grains per main spike, grain weight per main spike (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%). The recommended agronomical practices and plant protection measures were followed for the successful raising of the crop. The data recorded for various characters were statistically analyzed at the Computer Cell, Department of Genetics and Plant Breeding, College of Agriculture, Junagadh for various parameters *viz*., genetic variability, genotypic and phenotypic correlations and path coefficient analysis. The mean values were used for the statistical analysis. The phenotypic and genotypic correlation coefficients for pair of the characters were worked-out through covariance analysis as per Al-Jibouri *et al*[1]. The genotypic path coefficient analysis was done as per the method suggested by Dewey and Lu[2] by using Window Stat Ver. 7.5 software programme.

RESULTS AND DISCUSSIONS

The analysis of variance revealed the presence of sufficient amount of genetic variability among the genotypes for all the 13 characters studied (Table I). The values of phenotypic coefficient of variation were higher than genotypic coefficient of variation for all the characters indicating the influence of environmental factors on the expression of characters. The highest genotypic coefficient of variation was observed for number of productive tillers per plant followed by grain yield per plant, biological yield per plant, grain weight per main spike and number of grains per main spike suggesting the presence of wide variation for these characters. The days to 50% flowering, plant height, days to maturity, grain filling period and harvest index had low genotypic coefficient of variation. The characters like 100-grain weight, ear length

and peduncle length showed moderate genotypic coefficient of variation.

The highest phenotypic coefficient of variation was observed for number of productive tillers per plant followed by grain yield per plant, biological yield per plant, grain weight per main spike and number of grains per main spike. The 100 grain weight, ear length and peduncle length had moderate value, while plant height, days to 50% flowering, harvest index, days to maturity and grain filling period exhibited very low phenotypic coefficient of variation.

High heritability estimates were observed for days to 50% flowering, ear length, days to maturity, number of grains per main spike, grain weight per main spike, grain filling period, 100 grain weight, number of productive tillers per plant, plant height, grain yield per plant, biological yield per plant and peduncle length. Low heritability estimates were expressed by harvest index.

The estimates of genetic advance expressed as percentage of mean were found high for number productive tillers per plant, grain yield per plant and biological yield per plant. The values were moderate for grain weight per main spike, number of grains per main spike, 100 grain weight, ear length and peduncle length. The values were low for days to 50% flowering, plant height, days to maturity, grain filling period and harvest index.

In general, the values of genotypic correlation were higher than their corresponding phenotypic correlations in the present study (Table 2). This indicated that though there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. The phenotypic correlation coefficient of grain filling period with plant height, grain filling period with peduncle length, grain filling period with grain weight per main spike, grain filling period with 100 grain weight, grain filling period with grain yield per plant, number of productive tillers per plant with grain yield per plant and grain weight per main spike with 100 grain weight was higher than the genotypic correlation coefficient which might be due to the non-genetic causes probably environment inflated the value of phenotypic correlation.

The study of genotypic correlation gives an idea of the extent of relationship between different variables. This relationship among yield contributing characters as well as their association with yield provides information for exercising selection pressure for bringing genetic improvement in grain yield. In the present investigation, grain yield per plant was found to be significantly and positively correlated with biological yield per plant, number of productive tillers per plant, harvest index, plant height, days to maturity, days to 50% flowering, peduncle length and ear length at both the genotypic and phenotypic levels. Such positive interrelationship between grain yield and these attributes has also been reported in wheat by several researchers. The positive genotypic association has been reported between grain yield per plant and biological yield per plant, number of productive tillers per plant, harvest index, plant height, days to maturity, days to 50% flowering, peduncle length, ear length, grain weight per main spike and number of grain per main spike. Yadav *et al*[13]., and Singh *et al*[11]., also found significant positive correlations between grain yield per plant with yield attributing characters. The 100 grain weight was positively correlated with grain yield per plant which confirms the earlier findings of Sharma *et al*[9]., and Monpara[7]. The days to 50% flowering had significant and positive association with days to maturity, ear length, grain weight, biological yield and 100 grain weight at genotypic and phenotypic levels. Days to 50% flowering exhibited

positive correlation with number of grains per main spike, biological yield per plant, number of productive tillers per plant similar result found Dwivedi *et al*[3]., and Sharma *et al*[10]. The days to maturity had positive and significant genotypic and phenotypic associations with grain filling period, plant height, ear length, grain weight per main spike, biological yield per plant, harvest index and 100-grain weight similar record observed by Dwivedi *et al*[3]. The grain filling period had positive and moderate significant genotypic and phenotypic associations with plant height, peduncle length and harvest index had highly significant at genotypic level and moderate phenotypic level. Plant height exhibited positive and significant association at genotypic and phenotypic levels with number of productive tillers per plant, ear length, number grain per main spike, grain weight per main spike and biological yield per plant similar result found by Yadav *et al*[13]. Plant height showed positive and significant association with peduncle length phenotypic level only. Harvest index had positive and significant genotypic level only. 100-grain weight showed negative association with plant height. Number of productive tillers per plant was found to be positively correlated with biological yield per plant and Harvest index similar record observed by Munir *et al*[8]. The number of tillers per plant exhibited negative correlation at genotypic and phenotypic level with number of grain per main spike, grain weight per main spike and 100-garin weight. Peduncle length exhibited positive and significant association at genotypic and phenotypic levels with ear length, number of grains per main spike, grain weight per main spike and biological yield per plant similar result found by Sharma *et al*[9]., and Khan *et al*[5]. 100-grain weight showed negative association with peduncle length. Ear length was found to be positively correlated with number of grains per main spike, grain weight per main spike and biological yield per plant. Number of grains per main spike exhibited significant and positive correlation with grain weight per main spike and biological yield per plant at both genotypic and phenotypic levels. Harvest index positive correlated only genotypic level. Number of grains per spike were found to be negatively associated with 100 grain weight. Grain weight per main spike showed significant and positive correlation with biological yield per plant and 100 grain. Harvest index has positive only genotypic level. The biological yield per plant had significant and positive genotypic and phenotypic associations with harvest index[13]. The interrelationship between harvest index and 100 grain weight was showed negative correlation at both genotypic and phenotypic levels.

The present results on correlation coefficients thus, revealed that the biological yield per plant, number of productive tillers per plant, harvest index, plant height, days to maturity, days to 50% flowering, peduncle length and ear length were the most important traits and may contribute considerably towards higher grain yield. The interrelationship among yield components would help in increasing the yield levels and therefore, more emphasis should be given to these components while selecting better types in wheat.

The magnitude of genotypic correlation was higher as compared to the corresponding phenotypic correlation indicating that there was an inherent association between the characters at genotypic level. The grain yield per plant had significant and positive correlations both at genotypic and phenotypic levels with biological yield per plant, number of productive tillers per plant, harvest index, plant height, days to 50% flowering, days to maturity, peduncle length and ear length. The grain yield per plant had positive and highly

significant correlation only at genotypic level as well as moderate significant at phenotypic level with grain weight per main spike and number of grain per main spike.

In the present study (Table 3), the path coefficient analysis revealed that the biological yield per plant, days to 50% flowering, harvest index, grain filling period, grain weight per main spike and peduncle length exhibited high and positive direct effects on grain yield per plant. Thus, these characters turned-out to be the major components of grain yield. The characters like ear length, number productive tillers per plant, 100-garin weight, plant height, number of grain per main spike and days to maturity exerted low and negative direct effects on grain yield per plant. Santosh *et al.*, (2013) reported high and positive direct effect of biological yield per plant and harvest index on grain yield per plant in wheat. High positive direct effect on yield was found for grain weight per plant as reported by Mollasadeghi *et al*[6]. The negative direct effect of days to maturity on grain yield has been reported earlier by Singh *et al*[11]. The number of tillers per plant and 100 grain weight showed negative direct effect on grain yield as reported earlier by Singh *et al*[11]. The number of grains per main spike also exhibited negative direct effect on grain yield per plant has as reported by Talebi and Fayyaz[12].

The direct effect of biological yield per plant on grain yield was high and positive. This character also contributed indirectly by exhibiting positive effect *via* days to 50% flowering, days to maturity, grain filling period, plant height, number of productive tillers per plant, peduncle length, ear length, number of grains per spike, grain weight per main spike, harvest index and 100-grain weight. The character days to 50% flowering showed positive direct effect and also contributed indirectly by days to maturity, grain filling period, plant height, number of productive tillers per plant, peduncle length, ear length, number of grains per spike, grain weight per main spike, biological yield per plant harvest index and 100-grain weight. The character harvest index showed positive direct effect and also contributed indirectly by days to 50% flowering, days to maturity, grain filling period, plant height, number of productive tillers per plant, peduncle length, ear length, number of grains per spike, grain weight per main spike and biological yield per plant. The character grain filling period showed positive direct effect and also contributed indirectly by days to 50% flowering, days to maturity, plant height, number of productive tillers per plant, peduncle length, ear length, number of grains per spike, grain weight per main spike, biological yield per plant, harvest index and 100-grain weight. The character grain weight per main spike showed positive direct effect and also contributed indirectly by days to 50% flowering, days to maturity, grain filling period, plant height, peduncle length, ear length, number of grains per spike, biological yield per plant, harvest index and 100-grain weight. The character peduncle length showed positive direct effect and also contributed indirectly by days to 50% flowering, days to maturity, grain filling period, plant height, number of productive tillers per plant, ear length, number of grains per spike, grain weight per main spike, biological yield per plant and harvest index.

The path coefficient analysis revealed high positive direct effects of biological yield per plant, harvest index, days to 50% flowering, grain filling period, grain weight per main spike and peduncle length on grain yield per plant. The direct effects of days to maturity, number of grains per main spike, number of productive tillers per plant, 100-grain weight and plant height were negative. Most of the characters contributed indirectly through biological yield per plant towards grain yield per plant. Thus, biological yield per plant was identified as the most important yield component followed by days to maturity, harvest index and grain weight per main spike.

Table 1: Range, mean and components of variance, genotypic and phenotypic coefficients of variation, heritability and genetic advance as per of mean for thirteen characters in fifty two genotypes of wheat

Characters	Phenotypic Range	General mean	$\sigma^2(G)$	$\sigma^2(P)$	$\sigma^2(E)$	GCV%	PCV%	Heritability (%)	GA (% of mean)
Days to 50% flowering	47.33-67.67	57.97	26.44	26.93	0.49	8.87	8.96	98.17	18.12
Days to maturity	97-119.67	109.66	36.11	37.02	0.91	5.48	5.55	97.54	11.15
Grain Filling Period (Days)	41.33-53.00	48.24	6.43	6.89	0.46	5.26	5.44	93.36	10.47
Plant height (cm)	55.57-83.066	71.02	37.91	41.57	3.66	8.67	9.08	91.21	17.06
Number of productive tillers per plant	4.1-19.23	9.08	9.73	10.59	0.86	34.36	35.84	91.89	67.86
Peduncle length (cm)	23.00-36.67	30.28	10.28	11.55	1.27	10.59	11.22	88.98	20.57
Ear length (cm)	7.65-12.45	9.92	1.43	1.46	0.03	12.03	12.16	97.91	24.52
Number of grains per main spike	32.66-74.00	50.43	106.04	108.75	2.71	20.42	20.68	97.51	41.53
Grain weight per main spike (g)	1.20-2.83	1.82	0.15	0.16	0.01	20.95	21.29	96.89	42.50
Grain yield per plant (g)	6.93-26.58	16.16	24.32	27.13	2.81	30.52	32.24	89.63	59.52
Biological yield per plant (g)	17.40-56.32	34.46	97.47	109.17	11.70	28.65	30.32	89.29	55.78
Harvest index (%)	38.78-54.01	46.66	3.52	14.43	10.91	4.02	8.14	24.44	4.10
100-grain weight (g)	2.32-4.92	3.65	0.29	0.32	0.03	14.80	15.42	92.08	29.27

Table 2: Genotypic and phenotypic correlation of grain yield with other characters in fifty two genotypes of wheat

Character		Days to Maturity	Grain filling period	Plant height	Number of productive tillers per plant	Peduncle length	Ear length	Number of grain per main spike	Grain weight per main spike	Biological yield per plant	Harvest index (%)	100-grain weight	Grain yield per plant
Days to 50% flowering	r_g	0.9003**	0.1078	0.1557	0.0706	0.0427	0.2690**	0.0997	0.3240**	0.3136**	0.2773**	0.3613**	0.3175**
	r_p	0.8879**	0.0822	0.1438	0.0674	0.0390	0.2687**	0.0973	0.3163**	0.2973**	0.1103	0.3447**	0.2976**
Days to Maturity	r_g		0.5215**	0.2242**	0.1122	0.1166	0.2726**	0.0964	0.2969**	0.3118**	0.4095**	0.3238**	0.3328**
	r_p		0.5097**	0.2104**	0.1055	0.1135	0.2715**	0.0884	0.2938**	0.3001**	0.1772*	0.3205**	0.3139**
Grain filling period	r_g			0.1874*	0.1200	0.1604*	0.0999	0.0170	0.0517	0.1177	0.3308**	0.0518	0.1503
	r_p			0.1917*	0.1122	0.1647*	0.0924	0.0076	0.0531	0.1082	0.1930*	0.0626	0.4130
Plant height	r_g				0.2675**	0.9634	0.5834**	0.4137**	0.2365**	0.4207**	0.3119**	-0.2592**	0.4169**
	r_p				0.2371**	0.9448**	0.5501**	0.3837**	0.2117**	0.3713**	0.1485	-0.2391**	0.3655**
Number of productive tillers per plant	r_g					0.1736*	-0.1587*	-0.2418**	-0.3864**	0.7711**	0.5965**	-0.1764*	0.7869**
	r_p					0.1495	-0.1452	-0.2331**	-0.3769**	0.7591**	0.3780**	-0.1736*	0.7956**
Peduncle length	r_g						0.5610**	0.4281**	0.2271**	0.3225**	0.2145**	-0.2973**	0.3174**
	r_p						0.5275**	0.3885**	0.2106**	0.2855**	0.0972	-0.2594**	0.2764**
Ear length	r_g							0.8192**	0.7135**	0.2849**	0.2405**	-0.1857*	0.2810**
	r_p							0.7981**	0.6939**	0.2689**	0.1129	-0.1746*	0.2664**
Number of grain per main spike	r_g								0.7503**	0.2238**	0.2448**	-0.3941**	0.2291**
	r_p								0.7320**	0.2015*	0.1281	-0.3999**	0.2096*
Grain weight per main spike	r_g									0.2264**	0.1589*	0.3010**	0.2235**
	r_p									0.2197**	0.0656	0.3165**	0.2133*
Biological yield per plant	r_g										0.5988**	0.0136	0.9941**
	r_p										0.2061*	0.0305	0.9705**
Harvest index (%)	r_g											-0.0988	0.6774**
	r_p											-0.0875	0.4251**
100-grain weight	r_g												0.0032
	r_p												0.0098

***Significant at P = 0.05 **Significant at P = 0.01**

Table 3: Direct and Indirect effect of thirteen causal variables on grain yield in fifty two genotypes of wheat

Character	Days to 50% flowering	Days to Maturity	Grain filling period	Plant height	Number of productive tillers per plant	Peduncle length	Ear length	Number of grain per main spike	Grain weight per main spike	Biological yield per plant	Harvest index (%)	100-grain weight	Grain yield per plant
Days to 50% flowering	**0.1646**	0.1482	0.0177	0.0256	0.0116	0.0070	0.0443	0.0164	0.0533	0.0516	0.0456	0.0595	0.3175**
Days to Maturity	-0.1738	**-0.1930**	-0.1006	-0.0433	-0.0217	-0.0225	-0.0526	-0.0186	-0.0573	-0.0602	-0.0790	-0.0625	0.3328**
Grain filling period	0.0085	0.0410	**0.0786**	0.0147	0.0094	0.0126	0.0078	0.0013	0.0041	0.0093	0.0260	0.0041	0.1503
Plant height	-0.0091	-0.0131	-0.0110	**-0.0585**	-0.0156	-0.0563	-0.0341	-0.0242	-0.0138	-0.0246	-0.0182	0.0152	0.4169**
Number of productive tillers per plant	-0.0026	-0.0041	-0.0044	-0.0098	**-0.0364**	-0.0063	0.0058	0.0088	0.0141	-0.0281	-0.0217	0.0064	0.7869**
Peduncle length	0.0025	0.0070	0.0096	0.0575	0.0104	**0.0597**	0.0335	0.0255	0.0136	0.0192	0.0128	-0.0177	0.3174**
Ear length	-0.0037	-0.0037	-0.0014	-0.0080	0.0022	-0.0077	**-0.0137**	-0.0112	-0.0098	-0.0039	-0.0033	0.0025	0.2810**
Number of grain per main spike	-0.0088	-0.0085	-0.0015	-0.0364	0.0213	-0.0377	-0.0722	**-0.0881**	-0.0661	-0.0197	-0.0216	0.0347	0.2291**
Grain weight per main spike	0.0207	0.0189	0.0033	0.0151	-0.0246	0.0145	0.0455	0.0479	**0.0638**	0.0144	0.0101	0.0192	0.2235**
Biological yield per plant	0.2958	0.2941	0.1111	0.3967	0.7273	0.3041	0.2687	0.2111	0.2136	**0.9431**	0.5647	0.0128	0.9941**
Harvest index (%)	0.0434	0.0641	0.0518	0.0488	0.0933	0.0336	0.0376	0.0383	0.0249	0.0937	**0.1565**	-0.0155	0.6774**
100-grain weight	-0.0201	-0.0180	-0.0029	0.0144	0.0098	0.0165	0.0103	0.0219	-0.0167	-0.0008	0.0055	**-0.0555**	0.0032

**** Significant at P = 0.01**

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