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Estimation of Genetic Variability, Heritibility and Correlation for Some Morphological Traits in Spring Wheat

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ABSTRACT
This study was conducted to assess correlation among the six wheat genotypes and their nine crosses at cool climatic conditions of Rawalakot, Azad Jammu & Kashmir. High heritability was observed in flag leaf area, peduncle length and spike length, whereas 1000-grain weight, number of spikelets per spike and plant height showed moderate heritability. Peduncle length, grain yield and plant height, flag leaf area and days to 50% heading showed low genetic advance. Positive direct effect was observed by flag leaf area, numbers of tillers per plant, plant height and number of spikelets per spike while days to 50% heading, number of spikelets per spike and 1000-grain weight showed direct negative effects on yield. High genotypic and phenotypic variability was observed by plant height, peduncle length and grain yield per plant. Values of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the traits under study.
Key words: Spring Wheat, Heritability, Genetic Variability, Correlation and Flag leaf.

INTRODUCTION

Wheat (*Triticum aestivum* L) is the most important grain and is being used as a staple food for more than one third of the world. Developing the varieties with high yielding potential having desirable combination of characters is always the main objective of wheat breeding programme. The estimation of the genetic association and description of genetic variability between various genotypes are essential for breeders, because the artificial crosses between dissimilar parents permit a huge segregation and the grouping of various favorable alleles (Bered *et al.*, 2002).

The study of character association provides information about the estimates of interrelationship of various yield components in manifestation of yield. Efficiency of selection for higher yield depends upon the knowledge of the trait components and their interaction with grain. This requires information about nature of magnitude of variability in base population and association of yield component with grain yield (Dhaual *et al.*, 2002). Heritability is also a useful technique that estimates the performance of parents in hybrids. Highest heritability in any character shows its highest transmitting ability to next generation (Subhani *et al*., 2000). Moreover, environment may also relate with the genotypic establishment to effect heritability (Riaz *et al*., 2003). Low value of genetic advance along with high value of heritability estimates produces an appropriate state for selection. Hence, accessibility of superior knowledge of heritability and genetic advance existing in different yield parameters is a prerequisite for effective plant improvement exercise (Larik *et al*, 1989). It is also essential to know genetic variability and heritability of important agronomic characters for developing high yielding varieties. It is important to divide total variation in to heritable and non-heritable components with the aid of genetic characters e.g., genotypic and phenotypic coefficient of variation, heritability and genetic advance and genetic association among grain yield and its components for increasing selection (Paul *et al*., 2006). Association between any two traits or among various traits is of immense importance to make desired selection of combination of characters. Correlation analysis provides information about the correlated response plant characters to selection (Ahmad *et al.*, 2003). The correlation coefficient between yield and yield components generally demonstrate a compound sequence of interacting association.

The objective of the present study was to estimate genetic variability, heritability and correlation of different characters in spring wheat and also to observe the direct and indirect effect of various characters on grain yield per plant which may be helpful to identify the genotype having potential for improving yield and its components.

MATERIALS AND METHODS

A field experiment was conducted at research farms of Plant Breeding and Molecular Genetics Department, University of Azad Jammu & Kashmir, during the year 2010-11. The research material was consisting on six wheat genotypes and their nine crosses i.e 9272**,** 9381**,** 9428**,** Maraj**,** Fareed**,** LU26S, Maraj x 9272**,** Maraj x 9381**,** Maraj x 9428**,** Fareed x 9272**,** Fareed x 9381**,** Fareed x 9428**,** LU26S x 9272**,** LU26S x 9381 and LU26S x 9428.

The seeds of these genotypes along with their crosses were sown in randomized complete block design (RCBD) with three replications. Each treatment comprised of a single row of 3m length in each replication. Inter row and

inter plant distances was kept at 30 cm and 15 cm respectively. Ten guarded plants were randomly selected and data was recorded for the following characters,

50% heading days were counted from the date of sowing in each experimental unit by visual observation of plants. Plant height of the main tiller of each selected plant was measured in centimeters from ground level to the tip of the spike. Flag leaf area of the selected plants was estimated by measuring length and width with measuring scale according to the formula used by Muller *et al.* (1991). Length x Width x Correction factor where, C.F = 0.74. Number of Tillers/plant was counted from each of the tagged plants at the time of harvesting and their average was calculated. Stem of mother shoot was measured in cm from top most nodes to the base of spike of selected plants and Peduncle length was measured in centimeters. At the time of maturity spike length of main tillers of selected plants were measured in centimeters from base of the awn to its tip and values were averaged. From the main spike of guarded plants the numbers of spikelets per spike of were counted excluding the basal sterile spikelets and values were averaged. A sample of 1000 grains was taken from randomly selected plants and weight was determined in grams by weighing with the help of electric balance.

Statistical Analysis

To determine the significance of data, the variance analysis for all the characters was carried out according to the technique given by Steel *et al.* (1997). The variance was partitioned in to phenotypic and genotypic components. The heritability determination in broad sense was estimated as ratio between genotypic and phenotypic variance (Burton and Devan, 1953). Correlation analysis was performed according to Kown and Torrie (1964). Genetic advance was calculated by percentage of mean as described by Brim *et al.* (1959). Dewey & Lu (1959) method was used to calculate the path analysis for grain yield and its components maintaining grain yield as consequential variable and its components as contributory variables.

RESULTS AND DISCUSSION

The data regarding means for morphological traits of wheat genotypes is given in Table 1**.** Cross Fareed x 9428 indicated maximum days to 50% heading (159.3) followed by cross Maraj x 9272 (159.0) whereas, genotype, Fareed showed lowest (157.0) mean for days to 50% heading. The overall mean value for days to 50% heading was 154.69. Maximum plant height (85.17) was observed by cross LU26S x 9428 followed by Maraj having mean value of (83.30) while genotype Fareed showed lowest mean (16.17) for this trait. The grand mean for plant height was (78.17). Genotype Maraj showed maximum flag leaf area (25.80) which was closer to genotype Fareed (25.70). Genotype 9272 showed minimum value for flag leaf area (16.87). Maximum mean value for number of tillers per plant was observed (6.833) by the cross LU26S x 9381 proceeding by cross Maraj x 9428 (6.070. The cross Fareed x 9272 showed the lowest mean value (5.14) for number of tillers per plant. The grand mean for number of tillers per plant was 5.72. Highest mean for spikelets per spike was observed by genotype 9272 and cross Fareed x 9272 having values 17.73 and 17.70 respectively whereas cross Fareed x 9381 showed lowest mean value of 16.07 for this trait. The grand mean was for number of spikelets per spike was computed 16.69. From table of mean it was observed that for spike length cross Maraj x 9272 had highest mean value of 11.80 which is closer to the cross Fareed x 9428 having mean value of 11.43, while cross LU26S x 9272 indicated minimum mean value of 10.07. The grand mean for spike length was 11.06. Maximum mean value of 65.33 was expressed by cross LU26S x 9428 for peduncle length, while genotype 9428 had minimum mean value of 51.07. The grand mean was 58.70. Cross Fareed x 9428 had maximum mean value for 1000-grain weight 48.63 which is closer to the cross Maraj x 9381 with the mean value of 47.17. Minimum mean value was shown by the cross Fareed x 9272 that is 40.23 also shown in Graph. The grand mean for 1000-grain weight was 44.60. 1.It indicated that cross LU26S x 9428 had maximum mean value for grain yield per plant (57.430) which is closer to Maraj x 9381 with the mean value of 57.17, while minimum value was shown by cross Maraj x 9272 that is 45.83. The grand mean for grain yield per plant was observed 44.60.

Table.2 indicated highly significant differences among the wheat genotypes for all measured morphological traits.

Table-1:- Means for studied traits in wheat genotypes

Genotypes	Days to 50% heading	Flag leaf area	Plant height	No. of tiller per plant	Spike length	No of spikelet/spike	1000-grain weight	Grain yield /plant	Peduncle length
LU26S x 9381	156.3abcd	21.73ab	76.47abc	6.833	10.60bc	16.23b	46.57ab	48.60abc	64.13ab
Maraj x 9428	154.7abcd	24.57a	82.00ab	6.067	10.93ab	16.27b	44.80abcd	47.77bc	53.50cd
LU26S x 9272	157.0abcd	25.00a	82.10a	6.067	10.07c	16.40b	40.70cd	48.50abc	57.30abc
9272	152.0cd	16.87c	75.70abc	6.033	11.27ab	17.73a	45.73abc	46.33c	53.30cd
Fareed x 9428	159.3a	22.13ab	79.73ab	5.900	11.43ab	16.17b	48.63a	56.43ab	61.63abc
9381	151.3cd	21.93ab	75.33abc	5.867	10.70bc	16.53b	44.93 abcd	46.63c	57.13abcd
Maraj	152.7bcd	25.80a	83.30a	5.867	11.27ab	16.23b	44.30abcd	47.87bc	61.43abc
Fareed x 9381	155.7abcd	23.97a	78.73ab	5.767	11.37ab	16.07ab	44.90abcd	54.57abc	56.43abcd
LU26S x 9428	157.7abc	23.20ab	85.17a	5.633	10.87bc	16.53b	42.97bcd	57.43a	65.33a
LU26S	152.3cd	24.80a	72.07abc	5.567	11.00ab	16.87ab	45.27abcd	50.07abc	53.80cd
Fareed	150.7d	25.70a	68.17c	5.533	11.03a	16.50b	43.97abcd	54.17abc	61.77abc
Maraj x 9272	159.0ab	21.57ab	76.60abc	5.467	11.80a	17.23ab	42.03bcd	45.83c	58.17abcd
9428	152.3cd	19.87bc	76.27ab	5.433	11.40ab	17.03ab	46.83ab	53.23abc	51.97d
Maraj x 9381	153.7abcd	22.53ab	83.17a	5.400	10.90bc	16.97b	47.17ab	57.17a	61.27abc
Fareed x 9272	155.7abcd	24.23a	77.80ab	5.133	11.30ab	17.70a	40.23d	49.03abc	64.23ab

Table-2:- Analysis of variance for studied traits in wheat genotypes

SOV	DF	Days to 50% heading	Flag leaf area	Plant height	No. of tiller per plant	Spike length	No of spikelet/spike	1000-grain weight	Grain yield /plant	Peduncle length
Replication	2	7.356	6.291	6.398	0.294	0.075	0.098	2.3321	1.350	6.611
Genotypes	14	23.546**	18.414**	62.936**	0.488**	0.525**	0.869**	16.654**	51.666**	58.187**
Error	28	11.189	6.049	26.382	0.214	0.204	0.355	7.263	22.331	19.364
Total	44									

The values of variance, Coefficient of variability, heritability and genetic advance among various quantitative traits are presented in Table 3. Higher values of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) show the magnitude of variation for that character. Highest value (12.850) for genotypic variance was observed by peduncle length followed by plant height (12.184) and grain yield per plant (9.778) while it remained low (0.091) for number of tillers per plant. Maximum value for genotypic coefficient of variability was observed by flag leaf area (8.88) whereas it remained lowest for the character days to 50% heading (1.31). High phenotypic variance was observed for plant height and peduncle length (20.97) and (19.39) respectively, while number of tillers per plant showed lowest value (0.16) for this trait. The highest phenotypic coefficient of variation (10.83) was shown by flag leaf area followed by grain yield per plant (8.15) and least by days to 50% heading. Grain yield per plant expressed highest environmental variation (7.44) however spike length was the trait which showed the minimum variation due to environmental factors. Environmental coefficient of variability was high (6.21) for flag leaf area (table. 3). Values of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the traits under consideration. The results are agreed with Aharizad et al. (2012) who reported the similar results in wheat. Heritability estimates were higher in flag leaf area (67.2) while it was estimated minimum in days to 50% heading (52.5). High heritability with low genetic advance was reported by Salem *et al.* (2003). High heritability with low genetic advance as observed in flag leaf area and spike length indicating the non-additive gene effects. It showed that these characters are largely influenced by environmental effects so selection for improvement of those characters may not be useful. Moderate heritability with low value of genetic advance was indicated by days to 50% heading. Moderate heritability with low genetic advance was also observed by Bilgin *et al.* (2008) and Muhammad *et al.* (2006). Estimation of genetic advance is useful in knowing the type of gene action in expression of different characters, low values of genetic advance showed non-additive gene effects so selection of characters with low genetic advance might be ineffective. Highest genetic advance was observed by plant height and grain yield per plant which was 3.72 and 3.29 respectively.

Table 3:-Components of variance, Coefficient of variability, heritability and genetic advance among various quantitative traits in wheat genotypes

Traits	GV	GCV	PV	PCV	EV	ECV	SE	h^2	GA
DH	4.119	1.31	7.84	1.81	3.72	1.25	0.08	52.5	2.05
FLA	4.121	8.88	6.13	10.83	2.01	6.21	0.08	67.2	2.32
PH	12.184	4.47	20.97	5.86	8.79	3.79	0.04	58.1	3.72
N/P	0.091	5.23	0.16	6.99	0.07	4.63	0.56	56.1	0.31
N.S/S	0.171	2.48	0.28	3.22	0.11	2.06	0.41	59.1	0.44
SL	0.1069	2.96	0.17	3.78	0.06	2.36	0.53	61.1	0.35
PL	12.850	6.10	19.39	7.49	6.54	4.35	0.05	66.3	4.08
1000-GW	3.130	3.97	5.55	5.28	2.42	3.49	0.09	56.4	1.86
GY/P	9.778	6.14	17.22	8.15	7.44	5.36	0.05	56.8	3.29

Direct positive effect on grain yield of some characters indicated that selection of these traits is directly helpful for the improvement of yield. Negative indirect effects of some characters on grain yield showed that effects of such traits are indirectly effecting the grain yield. Number of spiklets per spike (-0.335), peduncle length (-0.119) and 1000 grain weight (-0.377) showed negative direct effect on grain yield per plant which shows that these traits have no true relation with grain yield and hence not effective for the improvement of grain yield. Similar conclusions were observed by Singh *et al*. (2010). Plant height (0.449), number of tillers per plant (0.169) and spike length (0.325) showed positive direct effect on grain yield (Table.4).

Days to 50%heading exerted negative direct effect on grain yield (-0.470), Indirect effect via spikelets per spike and peduncle length on grain yield was also negative but it was positive through flag leaf area, plant height, number of tillers per plant and spike length with the values of (0.026), (0.075), (0.035) and (0.006) respectively. Flag leaf area showed positive direct effect on grain yield (0.108) but its indirect effects were negative for days to 50% heading, number of tillers per plant, spike length, peduncle length with the values (-0.470), (-0.039), (-0.004), (-0.059.) respectively. Positive indirect effect on grain yield was observed for flag leaf area by plant height (0.116), number of spikelets per spike (0.306) and 1000-grain weight (0.317).

Direct effect of plant height on grain yield was positive (0.45). Indirect effects of plant height were negative via days to 50% heading, spike length and peduncle length with the values (-0.07), (-0.04) and (-0.01). Positive indirect effect was indicated by flag leaf area, number of tillers, number of spikelets per spike and 1000-grain weight with the values (0.02), (0.02), (0.06) and (0.07) respectively. Positive direct effect was also observed by Ashraf *et al*. (2002) for plant height on grain yield. The direct effect of plant height on grain yield showed that there is true relation between them and selection for this trait is helpful in increasing yield. Negative indirect effects of some characters on grain yield showed that there is not true relation of such characters on grain yield as negative effects were showed by days to heading, spike length and peduncle length on grain yield. Positive indirect effects mean that flag leaf area, number of tillers, number of spikelets per spike and 1000-grain weight had no direct effects on grain yield but it is effective on yield via other characters. Number of tillers per plant indicated direct positive effects on grain yield (0.16) as shown in Table 4. Singh *et al*. (2010) also estimated positive association of grain yield with number of tillers per plant. Negative indirect effect was indicated by days to 50% heading, flag leaf area, spike length, peduncle length and 1000-grain weight on grain yield with the values (-0.09), (-0.02), (-0.26), (-0.04), (-0.26). Positive and indirect effects were indicated by plant height and number of spikelets per spike with the values (0.06) and (0.29) on grain yield. Direct effects of one character on grain yield showed that this character is directly effected grain yield and might be helpful in selection for improvement of yield. Indirect effects on grain yield indicated that such traits are effected on yield via other component characters. Negative indirect effects showed that these characters are not effective on grain yield, hence selection of such traits for improvement of yield could be less reliable. Negative indirect effects were indicated by days to 50% heading, flag leaf area, plant height and number of tillers per plant with the values (-0.01), (-0.09), (-0.08) and (- 0.14). Positive indirect effects were observed by spike length, peduncle length and 1000-grain weight with the values (0.15), (0.03), and (0.24) on grain yield per plant. Positive direct effect of spikelets per spike on grain yield was indicated by Majumder *et al*. (2008). Negative indirect effects of flag leaf area, plant height and number of tillers per plant showed that these characters are not influence on grain yield. Positive indirect effect of spike length, peduncle length and 1000-grain weight showed that these characters are effective on grain yield but through other characters. Number of spikelets per spike showed negative direct effects on grain yield. It showed that grain yield is not directly effective on number of spikelets per spike. Positive direct effects of spike length on grain yield were revealed (Table.4). Spike length indicated negative indirect effect of days to 50% heading, flag leaf area, plant height, number of tillers per plant, number of spikelets per spike, and 1000-grain weight with the values (-0.01), (-0.04), (-0.06), (-0.14), (-0.16), (-0.13) respectivly. Its mean that these characters had no strong relationship with grain yield so selection of these traits

may not be useful. Positive indirect effect was shown by peduncle length on grain yield with the value 0.03. Positive direct effect of spike length on grain yield was also estimated by Ali *et al*. (2008). Positive direct effects of spike length on grain yield showed that strong relation between them and direct selection for this character for improvement of grain yield could be useful. Positive indirect effects showed that these characters influenced grain yield through other component traits. Negative direct effect was shown by 1000-grain weight on grain yield (Table.4) with the value (-0.37). Days to 50% heading, number of tillers per plant, number of spikelets per spike, spike length and peduncle length showed positive indirect effect on grain yield with the values (0.13), (0.11), (0.21), 0.11), (0.01) which showed that these effected on grain yield through other characters. Negative indirect effect was indicated by flag leaf area and plant height with the values of (-0.09) and (-0.09) on grain yield. Negative but direct effect was shown by 1000-grain weight on grain yield. Number of tillers, spike length, and peduncle length indirectly effected grain yield. Flag leaf area and plant height had not directly effected grain yield so selection of such traits for improvement of yield may not be much helpful. Evaluation of direct and indirect effects of different characters on grain yield indicated that highest positive direct effects on grain yield were shown by plant height followed by number of tiller, spike length and flag leaf area. Direct negative effects on grain yield were observed by days to 50% heading, number of spikelets per spike and peduncle length. Direct positive effects shows that these characters are major contributors for improvement of grain yield and are main components for selection in breeding for higher grain yield. On the other hand indirect effects on grain yield indicated that these characters could not effected yield directly.

Table-4: Direct and indirect effect of different characters on grain yield per plant among various quantitative traits

	DIRECT EFFECT	INDIRECT EFFECT							
		DH	**FLA**	**PH**	**NT**	**NS**	**SL**	**PL**	**1000-GW**
DH	-0.470	1	0.026	0.075	0.057	-0.004	0.006	-0.059	0.109
FLA	0.108	-0.115	1	0.116	-0.039	0.304	-0.124	-0.010	0.317
PH	0.449	-0.078	0.028	1	0.024	0.065	-0.045	-0.014	0.079
NT	0.169	-0.099	-0.025	0.062	1	0.297	-0.269	-0.040	-0.265
NS	-0.335	-0.006	-0.098	-0.087	-0.149	1	0.156	0.039	0.245
SL	0.325	-0.009	-0.041	-0.063	-0.140	-0.161	1	0.035	-0.136
PL	-0.119	-0.232	0.092	0.556	0.057	0.109	-0.095	1	0.031
1000-GW	-0.377	0.137	-0.091	-0.094	0.119	0.021	0.117	0.009	1

Path coefficient analysis helps to estimate the influence of each variable upon the resultant variable directly as well as indirectly by partitioning the genetic correlation coefficients. .Data presented in Table. 5 revealed that days to 50% heading showed positive and non-significant correlation with flag leaf area, plant height, number of tillers per plant and spike length at phenotypic level. Negative and non-significant phenotypic correlation of days to 50% heading was observed with number of spikelets per spike, 1000-grain weight and grain yield per plant. The results are partially agreed with Sakin *et.al* (2011) who reported the negative correlation between days to headings and grain yield. Peduncle length was observed to be associated positively and significantly with days to 50% heading phenotypically. At genotypic level positive and significant genotypic association of days to 50% heading was observed with flag leaf area, plant height and peduncle length while it was non-significantly and positively correlated with number of tillers per plant, spikelets per spike and spike length. Genotypic association of days to 50% heading with 1000 grain weight was non-significant and negative whereas it was negative and significant with grain yield per plant.

Flag leaf area revealed positive and non-significant correlation with plant height at genotypic and phenotypic levels. Negative and non- significant association was observed between flag leaf area, number of tillers per plant and spike length both genotypically and phenotypically. Correlation between flag leaf area and number of spikelets per spike was negative and non-significant at both levels. The coefficient of genotypic correlation showed negative and non-significant association of flag leaf area with number of spikelets per spike and 1000 grain weight where as positive and significant association was observed by peduncle length and grain yield per plant with flag leaf area. Phenotypically positive and highly significant correlation was observed between flag leaf area and peduncle length whereas it was negative and highly non-significant with number of spikelets per spike and 1000 grain weight. Grain yield per plant showed positive and non-significant phenotypic association with flag leaf area.

Negative and non-significant genotypic and phenotypic correlation was observed by number of spikelets per spike and 1000 grain weight with plant height. Phenotypic and genotypic association of plant height with number of tillers per plant was non-significant and positive while grain yield per plant expressed positive and significant correlation at both levels. Genotypic relationship of peduncle length with plant height was positive and significant whereas its phenotypic association was non-significant positive.

Phenotypic association of number of tillers per plant with spike length and number of spikelets per spike was negative and highly significant whereas genotypically these traits were correlated non-significantly and negatively. Peduncle length revealed positive and non-significant correlation with number of tillers per plant at both genotypic and phenotypic levels. Correlation between 1000 grain weight and number of tillers per plant was positive and significant at both levels. Grain yield per plot expressed negative relationship with number of tillers per plant.

There was observed negative and non-significant genotypic and phenotypic correlation of flag leaf area, 1000 grain weight and grain yield per plant with number of spikelets per spike. The association of number of spikelets per spike with spike length was positively significant phenotypically and positively non-significant genotypically.

Spike length showed negative and non-significant association with peduncle length and grain yield per plant the results are partially agreed with Sakin *et.al* (2011) who observed the similar results for spike length and yield per plant. Genotypic and phenotypic correlation of Spike length was positive and non-significant with 1000 grain weight. Genotypic correlation of peduncle length was negative and non-significant with 1000 grain weight and grain yield per plant while phenotypically its association was negative, non-significant with 1000 grain weight and positive non-significant with grain yield per plant. Grain yield per plot revealed positive and non-significant relationship with 1000 grain weight at both genotypic and phenotypic levels. Positive association between grain yield and 1000-grain weight was also reported by, Bahari and Sabzi (2005) and Moral *et al*.2003.

Table 5:- Genotypic (G) and Phenotypic (P) correlation among 6 wheat genotypes and their crosses

Character	Correlation	Days to 50 % heading	Flag leaf area	Plant height	No of tillers per plant	No of spikelets per spike	Spike length	Peduncle length	1000 Grain weight	Grain yield/pl
Days to 50% heading	G	1.00	0.24*	0.16 *	0.21	0.01	0.02	0.49*	-0.29	- 0.28*
	P	1.00	0.04	0.09	0.13	- 0.17	0.10	0.18*	-0.18	- 0.09
Flag leaf area	G		1.00	0.25	- 0.23	- 0.90	-0.38	0.85*	-0.84	0.46*
	P		1.00	0.12	- 0.12	- 0.51**	-0.28	0.45**	-0.41**	0.26
Plant height	G			1.00	0.13	- 0.19	-0.14	0.12*	-0.21	0.50*
	P			1.00	0.08	- 0.24	-0.17	0.09	-0.10	0.30*
No of tiller/plant	G				1.00	-0.88	-0.83	0.33	0.70*	-0.17*
	P				1.00	-0.50**	-0.47**	0.21	0.29*	-0.24
No of spikelets per spike	G					1.00	0.48	-0.32	-0.65	-0.23
	P					1.00	0.34*	-0.25	-0.26	-0.25
Spike length	G						1.00	-0.29	0.36	-0.19
	P						1.00	-0.80	0.16	-0.12
Peduncle length	G							1.00	-0.08	-0.10
	P							1.00	-0.04	0.02
1000-grain weight	G								1.00	0..03
	P								1.00	0.13

* = **Signifcant**
** = **Highly significant**

DH= Days to 50% heading
FLA= Flag leaf area
PH= Plant height
NT= No of tiller per plant
SL= Spike length
NS= No of spikelet per spike
PL= Peduncle length
1000-GW= 1000-Grain weight
GY/P= Grain yield per plant.

Reference

Ahmad, M., F. Mohammad, K. Maqbool A. Azam and S. Iqbal. 2003. Genetic variability and trait correlation in wheat. Sarhad J. Agric., 19(3): 347-351.

Ali, Y., B. Manzoor, J. Akhter, P. Monneveux and Z. Latif. 2008. Genetic variability, association and diversity studies in wheat (*Triticum aestivum* L.) germplasm. Pak. J. Bot., 40(5):2 087-2097.

Ashraf, M., A Ghafoor, N. A. Khan and M.Yousaf. 2002. Path coefficient in wheat under rainfad conditions. Pak. J. Agric. Res., 17(1):244-246.

Aharizad, S., Mohsin.S. S. A. Mohammadi, and E. Khudadi (2012) Multivariative analyses of genetic diversity in wheat (Triticum aestivum L.) recombinant inbred line using agronomic traits. Annals of Biological Res. 3(5):2118-2126.

Burton, G. W. and E. H. Devan.1953. Estimating heritability in tall fescue (*Fstuca ruandinacea)* from replicated clonal material. Argon . J., 45: 478-481.

Brim,C. A., H.W. Johnson and C.C. Cockerham. 1959. Multiple selection criteria in wheat. Crop Sci., 1:187-190.

Bahari, M. and H. Sabzi, 2005. Study of morphological, traits correlation with grain yield of durum wheats.The 8 Iranian Congress of Agronomy and Plant, Gilan.

Bered F., J. Barbosa and F. Carvalho. 2002. Genetic variability in common wheat germplasm on coefficient of percentage. Genetics & Mol. Biol., 25(2):211-215.

Bilgin, O., K. Z. Korkut, I. Baser, O. Daglioglu, I. Ozturk, T. Kahraman and A.A.Balkan. 2011. Genetic variation and inter-relationship of some morpho-physiological traits in durum wheat (*Triticum durum* L.). Pak. J .Bot., 43(1):253-260.

Dewey, J.R. and K.H. Lu.1959. A correlation and path coefficient analysis components of crested wheat grass seed production. Agron. J., 51:515-518.

Kown, S.H. and J.H Torrie. 1964. Heritability and inter-relationship among traits of two soyabean populations. Crop .Sci., 4: 196-8.

Larik, A. S., H. M. I. Hafiz and A. M. Khush. 1989. Estimation of genetic parameters in wheat populations derived from intercultivaral hybridization. Pakphyton, 1:51-56.

Muller J.1991.Determining leaf surface area by means of linear measurements in wheat and triticale. (A brief report) Arch. Funhtung Frachung , 21(2):121-123.

Majumder, D. A. N., A. K. M. Shamsuddin, M. A. Kabirand and L. Hassan.2008.Genetic variability correlated response and path analysis of yield and yield contributing traits of spring wheat. J. Bangladesh Agri. Univ., 6(2):224-227.

Moral, G.L., Y. Rharrabit, D. Villegas and C. Roya, 2003. Evaluation of grain yield and its Components in. Durum Wheat under Mediterranean Conditions. An Ontogenic Approach. Agron. J., 95: 266-274.

Muhammad.T., S. Haider, M. J. Qureshi, G. S. Shah and R. Zamir. 2006. Path coefficient and correlation of yield and yield assosiation traits in candidate bread wheat (*Triticum aestivum* L.) lines. Pak. J. Agric. Res., 19(4): 211-224.

Paul, A. K., M. A. Islam, M. J. Hassan, M. M. H. Chowdhury. 2006. Genetic variation of some morpho-physiological characters in wheat (*Triticum durum* L.).Int. J. Sustain. Agric. Tech., 2(8):11-14.

Riaz, R., and M.A. Chowdhry. 2003. Estimation of variation and heritability of some physio-morpic traits of wheat under drought condition. Asian . J. Plant. Sci ., 2(10):748-755.

Sakin, M.A., C. Akinci, O. Duzdemir and E. Donmez. 2011. Assessment of genotype x environment interaction on yield and yield components of durum wheat genotypes by multivariate analyses. A. J. Biotech., 10(15) :2875-2885.

Salem, I.,A. S. Khan and A. Ali. 2003. Estimation of heritability and genetic advance for grain yield traits in wheat (*Triticum aestivum* L.). J. Anim. Pl. Sci.,13(1):52-54.

Steel, R. D. G.,J. H. Torrie and D. A. Deekey. 1997. Principles and procedures of statistics. A biometrical approach. 3rd Ed. McGraw Hill: New York.

Subhani, G. M., and M . A. Chowdhry. 2000. Correlation and path coefficient analysis in bread wheat under drought stress and normal conditions. Pak . J. Biol. Sci., 3:72-77.

Singh, B, N., S. R. Vishwakarma and V. K Singh. 2010. Character association and path analysis in elite lines of wheat (*Triticum aestivum* L.).Department of Genetics and Plant Breeding Faisalabad., 10(2):845-847.