International Scholars Journals

International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 9 (8), pp. 001-006, August, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Estimation of correlation coefficients among seed yield and some quantitative traits in wheat (*Triticum aestivum* L.)

Naeem Akhtar[1]*, Talat Mehmood[2], Muhammad Ahsan[3], Ahsan Aziz[1], Muhammad Ashraf[1], Salman Ahmad[1], Muhammad Asif[1] and Ehsan Safdar[1]

[1]University College of Agriculture, University of Sargodha, Sargodha- 40100, Pakistan.

[2]Department of Plant Breeding and Genetics, PMAS University of Arid Agriculture, Rawalpindi -46300, Pakistan.

[3]Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. Pakistan.

Accepted 19 April, 2019

Genetic variability of quantitative traits and their contribution towards seed yield that may be used as criteria for yield improvement in wheat was investigated. Generation means analysis technique was applied to identify correlation (phenotypic and genetic) coefficients for seven quantitative traits in two wheat crosses and their reciprocals. The estimates of genetic correlation coefficients were found greater than the phenotypic one for all studied plant traits in both crosses and their reciprocals. Seed yield per plant was found positively correlated at phenotypic and genetic levels in cross V-95199 x PARI-73 and it's reciprocal. In this cross, days to heading, peduncle length, spikelets per spike and seed yield per main spike were significantly influenced while harvest index showed negative association with seed yield per plant. The phenotypic and genetic correlation coefficients of cross Chakwal-86 x V-8060 and its reciprocal indicated that seed yield per plant had significantly positive strong association with all studied plant traits except specific flag leaf weight and days to heading. It is concluded that the inter relationship among traits both at phenotypic and genetic levels could efficiently be exploited for obtaining maximum seed yield per main spike, peduncle length, and harvest index which ultimately lead to improve crop yield.

Key words: Wheat, direct and reciprocal crosses.

INTRODUCTION

Wheat is the most important grain and a staple food for more than one third world population. It is also one of the leading cereal crops in Pakistan. It constitutes a major food staple and is a big source of protein and energy for more than 170 million peoples of Pakistan (Anonymous, 2010). It plays a significant role in food security and economic stability in Pakistan. The population of Pakistan is increasing day by day and to fulfill the demands of the rapidly increasing population we need to increase the wheat grain production per unit area by using available resources. Owing to limited land and water resources wheat production can only be increased primarily by breeding high yielding genotypes but also using improved agronomic techniques (Rajaram and Dubin, 1999). The existence of genetic variability (inter or intra-varietal) and the knowledge about the nature and extent of genetic association among different plant traits are the pre-requisite to improve the crop plants. Such knowledge tells about the inter-relationship of different plant traits with seed yield to improve the productivity of the crop. Different breeding techniques are used to improve the productivity of wheat per unit area. Among these estimation of phenotypic and genetic correlation coefficients are important in determining the degree to which various yield contributing characters are associated with one another (Singh and Singh, 2001; Zecevic et al., 2004). Keeping this in view, the phenotypic and genetic correlation coefficients were carried out in crosses of two tall and two dwarf locally adapted wheat varieties/lines along with their reciprocals to study the

*Corresponding author. E-mail: naeem.uca@gmail.com.

effect of relationship of different plant traits on seed yield.

MATERIALS AND METHODS

The experimental material comprised of four parental wheat varieties/lines. Two of them namely Chakwal-86 and V-95199 were taken as tall and the other two, that is, PARI-73 and V-8060 were as dwarf wheat varieties/lines. These genotypes were grown in the research area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during 2005 to 2007 to develop six generations for each cross. Fifty plants were selected from each tall and dwarf wheat variety/line and they were grown as parents in November, 2005. During 2006, a tall wheat line V-95199 was crossed with dwarf wheat variety PARI-73 to produce F1 and reciprocal. Similarly, wheat variety Chakwal-86 was crossed with dwarf line V-8060 to produce F1 and its reciprocal. The F1s, their reciprocals and parental seed were harvested separately at maturity. In November, 2006 a part of seed obtained from each of parents, the two hybrids and their reciprocals were sown in the field to produce F2 generation and back cross (BC1 and BC2) generations. At maturity seed from parents, F1s, BC1s BC2s and their reciprocals were harvested.

The parents, F1, F2 and backcross (BC1 and BC2) generations and their reciprocals were sown in the field by using randomized complete block design with three replications during November, 2007. A single row of parental and F1 generations, two of each backcross and three of each F2 generations were planted. Ten plants were selected at random from each parent and each F1, 20 from each backcross (BC1 and BC2) and 30 from each F2 generation from each replication to record the data on individual plant basis for the plant traits, that is, specific flag leaf weight, days to heading, peduncle length, spikelets per spike, seed yield per main spike, seed yield per plant and harvest index in April, 2008.

Phenotypic correlation

The phenotypic (r_P) correlations between two x and y traits were calculated in F2 using the formula of Kwon and Torrie (1964).

$$r_P = \frac{COV_p\,(X\,,Y)}{\sqrt{V_p\,(X).\,V_p\,(Y)}}$$

Where:

CovP(x, y) = Mean product of xyth traits in F2 generation.
VP(x) and VP(y) = Mean squares for xth and yth traits, respectively in F2 generation

Genetic correlation

The genetic correlations (r_G) between two characters x and y were calculated by the formula:

$$r_G = \frac{COV_g\,(X\,,Y)}{\sqrt{V_g\,(X).\,V_g\,(Y)}}$$

Where:

Covg (x, y) = Cov (x, y) F2 - Cov (x,y) E
Cov (x,y) E = (1/4) [Cov (x,y)P1 + Cov (x,y)P2 + 2 Cov(x,y)F1]
Covg (x,y), Cov (x,y) E, Cov (x,y)P1, Cov (x,y)P2, Cov(x,y)F1 and Cov(x,y)F2 are covariance's of x and y associated with genetic effects, non-significant effects, P1, P2, F1 and F2 generations, respectively.
Vg(x) = V(x) F2 - V(x) E
Vg(y) = V(y) F2 - V(y) E
V(x) E = (1/4) [V(x) P1 + V(x) P2 + 2 V(x) F1]
V(y) E = (1/4) [V(y) P1 + V(y) P2 + 2 V(y) F1]
Vg(x) and Vg(y) are genetic variances of x and y, respectively.

RESULTS AND DISCUSSION

Phenotypic correlation coefficients

Specific flag leaf weight exhibited highly significant correlation with seed yield per main spike of cross V-95199 x PARI-73 (Table1) while its association with the remaining plant traits was non-significant. In the reciprocal cross (PARI-73 x V-95199), specific flag leaf weight showed non-significant correlation with all studied plant traits (Table 2). So it has less importance in selection of high yielding plants on the basis of specific flag leaf weight. The results are contrary with the findings of Bhullar et al. (1985) who reported that grain yield per plant was positively correlated with specific leaf weight. In case of Chakwal-86 x V-8060 (Table 3) correlation coefficients of specific flag leaf weight was found positive or negative but non-significant for all traits except with days to heading and peduncle length where it was significant and negative. In the reciprocal cross (V-8060 x Chakwal-86) (Table 4) specific flag leaf weight revealed significantly positive association with spikelets per spike, peduncle length, seed yield per plant and harvest index. The results are contrary to the finding of Bhuller et al. (1985). Days to heading of the cross V-95199 x PARI-73 as well as its reciprocal cross (PARI-73 x V-95199) exhibited highly significant positive correlation coefficients with almost all traits studied (Khan and Mohammad, 1999).

In the cross Chakwal-86 x V-8060 days to heading was highly significantly correlated with peduncle length and seed yield per main spike while non significant with spikelets per spike,, seed yield per plant and harvest index. In reciprocal cross (V-8060 x Chakwal-86) it was highly significantly correlated with all indicated plant traits except spikelets per spike with which it had non significant correlation. The results are in agreement with the findings of Nirala and Jha (1997), Khan and Mohammad (1999) and Mohsin et al. (2009) who reported that day's to heading had direct positive effects on grain yield. The results are, however, contrary to the findings of Rana and Sharma (1997) and Narwal et al. (1999) who reported negative correlation for days to heading with harvest index. Peduncle length of the cross V-95199 x PARI-73 showed highly significant and positive correlation coefficients with seed yield per main

Table 1. Phenotypic (rp) and genetic (rg) correlation coefficients among various quantitative traits of the cross V-95199 x PARI-73 of wheat.

Traits		Days to heading	Peduncle length	Spikelets per spike	Seed yield per main spike	Seed yield per plant	Harvest index
Specific flag leaf weight	rp	0.0322NS	0.0984NS	0.1166NS	0.2084**	0.1207NS	0.0545NS
	rg	0.1346	0.0486	0.4187	0.3901	0.2859	0.0492
Days to heading	rp		0.7554**	0.1333*	0.1791**	0.4365**	0.2137**
	rg		0.8483	0.2037	0.2141	1.0622	0.2432
Peduncle length	rp			0.1195NS	0.1639**	0.4828**	-0.1141NS
	rg			0.1621	0.1614	1.0204	-0.1650
Spikelets per spike	rp				0.3357**	0.2649**	0.0625NS
	rg			0.1621	0.1614	1.0204	-0.1650
Seed yield per main spike	rp					0.4684**	0.0487NS
	rg					0.6193	0.0251
Seed yield per plant	rp						-0.0195NS
	rg						-0.1594

NS = Non-significant. * = P ≤0.05. ** = P ≤ 0.01.

Table 2. Phenotypic (rp) and genetic (rg) correlation coefficients among various quantitative traits of the cross PARI-73 x V-95199 of wheat.

Traits		Days to heading	Peduncle length	Spikelets per spike	Seed yield per main spike	Seed yield per plant	Harvest index
Specific flag leaf weight	rp	-0.0379NS	-0.0227NS	0.0357NS	0.0077NS	0.0689NS	0.0024NS
	rg	-0.0457	-0.0681	-0.0196	0.0372	0.0451	-0.0561
Days to heading	rp		0.6997**	0.1294*	0.2909**	0.3751**	0.3837**
	rg		0.7548	0.2445	0.3677	0.4050	0.4577
Peduncle length	rp			0.1179NS	0.3217**	0.3624**	-0.3011**
	rg			0.0555	0.3278	0.3913	-0.4853
Spikelets per spike	rp				0.4690**	0.2964**	-0.0336NS
	rg				0.5772	0.4264	-0.2068
Seed yield per main spike	rp					0.4202**	0.0973NS
	rg					0.4766	-0.0419
Seed yield per plant	rp						-0.0623NS
	rg						-0.3983

NS = Non-significant. * = P ≤0.05. ** = P ≤ 0.01.

spike and seed yield per plant while non significant with spikelets per spike and negatively correlated with harvest index. In reciprocal cross (PARI-73 x V-95199) peduncle length also exhibited highly significant and positive phenotypic correlation coefficients with seed yield per main spike and seed yield per plant. A negative and highly significant correlation coefficient between peduncle length and harvest index was also observed. The results are in agreement with Berwal et al. (1997) and Khaliq et al. (2004) who reported that grain yield was positively associated with peduncle length.

In cross Chakwal-86 x V-8060, peduncle length was found significantly correlated with seed yield per main spike and seed yield per plant while it had negative significant correlation with harvest index. There was non-significant negative correlation coefficient with spikelets per spike. In reciprocal cross (V-8060 x Chakwal-86) peduncle length revealed highly significant positive correlation coefficients with seed yield per main spike and seed yield per plant. The non-significantly positive

Table 3. Phenotypic (rp) and genetic (rg) correlation coefficients among various quantitative traits of the cross Chakwal-86 x V-8060 of wheat.

Traits		Days to heading	Peduncle length	Spikelets per spike	Seed yield per main spike	Seed yield per plant	Harvest index
Specific flag leaf weight	rp	-0.1795**	-0.1331*	-0.0160NS	0.0415NS	0.0836NS	0.0720NS
	rg	-0.2456	-0.1871	-0.2356	-0.0863	-0.0944	0.0196
Days to heading	rp		0.6253**	0.0125NS	0.2002**	0.0685NS	0.0732NS
	rg		0.6982	-0.0909	0.2263	0.0776	0.047
Peduncle length	rp			-0.0477NS	0.2835**	0.1344*	-0.2461**
	rg			-0.0499	0.3948	0.4706	-0.3461
Spikelets per spike	rp				0.4962**	0.2894**	0.1684**
	rg				0.5952	0.0296	0.2245
Seed yield per main spike	rp					0.6078**	0.1643**
	rg					1.6026	0.1290
Seed yield per plant	rp						0.3165**
	rg						0.5899

NS = Non-significant. * = P ≤0.05. ** = P ≤ 0.01.

Table 4. Phenotypic (rp) and genetic (rg) correlation coefficients among various quantitative traits of the cross V-8060 x Chakwal-86 of wheat.

Traits		Days to heading	Peduncle length	Spikelets per spike	Seed yield per main spike	Seed yield per plant	Harvest index
Specific flag leaf weight	rp	0.0662NS	-0.1374*	0.1676**	0.1360*	-0.2045**	-0.3096**
	rg	0.0442	-0.3164	0.2102	0.1068	-0.4832	-1.1474
Days to heading	rp		0.7874**	0.1027NS	0.3652**	0.2201**	0.3294**
	rg		0.8933	-0.2437	0.3663	0.2485	0.5591
Peduncle length	rp			0.0347NS	0.3727**	0.2154**	-0.0606NS
	rg			-0.0955	0.4879	0.3198	-0.2755
Spikelets per spike	rp				0.2471**	0.2409**	0.0389NS
	rg				-0.3127	0.3395	0.0017
Seed yield per main spike	rp					0.0056NS	-0.1673**
	rg					-0.3843	-0.7757
Seed yield per plant	rp						0.3127**
	rg						0.8096

NS = Non-significant. * = P ≤0.05 ** = P ≤ 0.01

correlation coefficient of peduncle length was also evident with spikelets per spike and negative with harvest index. The results are in accordance with the findings of Berwal et al. (1997). Spikelets per spike of the cross V-95199 x PARI-73 as well as its reciprocal cross showed highly significant and positive correlation with seed yield per main spike and seed yield per plant. The correlation coefficients between spikelets per spike and harvest index was positive and non significant in cross V-95199 x PARI-73 while negative in reciprocal cross (PARI-73 x V-95199). In cross Chakwal-86 x V-8060 spikelets per spike was highly significantly correlated with seed yield per main spike, seed yield per plant and harvest index. In reciprocal cross (V-8060 x Chakwal-86) it showed highly significant correlation coefficients with seed yield per main spike and seed yield per plant while non-significant with harvest index. The results get support from Deswal et al. (1997), Martincic et al. (1998), Akram et al. (2008) and Mohsin et al. (2009).

Seed yield per main spike showed highly significant positive correlation coefficients with seed yield per plant while non-significant with harvest index of the cross V-95199 x PARI-73 . Similar results were obtained in its reciprocal cross. The results get conformity with the findings of Rana and Sharma (1997), Ioan (1998) and Zecevic et al. (2004). Seed yield per main spike of the cross Chakwal-86 x V-8060 exhibited highly significant correlation coefficients with seed yield per plant and harvest index. However, in reciprocal cross (V-8060 x Chakwal-86) the situation was different in which seed yield per main spike showed non-significant positive correlation coefficient with seed yield per plant but negative and highly significant correlation coefficient with harvest index. The results of reciprocal cross are contrary to Martincic et al. (1998) and Zecevic et al. (2004) who reported positive association among these traits. Seed yield per plant showed negative and non-significant phenotypic correlation coefficient with harvest index of the cross V-95199 x PARI-73 as well as the reciprocal cross. Singh and Singh (1999) found negative association between grain yield per plant and harvest index. Seed yield per plant exhibited highly significant positive correlation coefficient with harvest index in the cross Chakwal-86 x V-8060 as well as the reciprocal cross. The results are in agreement with Dhanda and Sethi (1996), Iqbal and Ridhu (1997) and Zecevic et al. (2004) who reported positive association between grain yield per plant and harvest index.

Genetic correlation coefficients

Specific flag leaf weight of cross V-95199 x PARI-73 exhibited positive genetic correlation coefficients with all indicated plant traits. In case of the reciprocal cross (PARI-73 x V-95199) the situation was different in which the genetic correlation coefficient estimates of specific flag leaf weight were found positive with seed yield per plant and seed yield per main spike while negative with the remaining plant traits. The results are supported by the findings of Bhullar et al. (1985) who reported that grain yield per plant was positively correlated with specific leaf weight.

The magnitude of genetic correlation coefficient estimates of specific flag leaf weight of the cross Chakwal-86 x V-8060 were found negative with all studied plant traits except harvest index where this estimate was positive with specific flag leaf weight. In reciprocal cross (V-8060 x Chakwal-86) the association of specific flag leaf weight was positive with spikelets per spike seed yield per main spike and days to heading while its association was negative with the remaining plant traits. The results are contrary with the findings of Bhullar et al. (1985). They reported positive association between specific flag leaf weight and grain yield per plant.

The positive genetic association of days to heading with all indicated plant traits was found in the cross V-95199 x PARI-73 as well as its reciprocal cross (PARI-73 x V-95199). Similar results were also observed in cross Chakwal-86 and V-8060 and its reciprocal, where days to heading showed positive genetic correlation coefficient with peduncle length, seed yield per main spike, seed yield per plant and harvest index except spikelets per spike which revealed negative association at genotypic level. The results are in agreement with Nirala and Jha (1997), Khan and Mohammad (1999) and Mohsin et al. (2009) who reported that positive association was found between grain yield and days to heading.

Peduncle length exhibited positive genetic association with all indicated plant traits except with harvest index where it showed negative genetic correlation coefficient in the cross V-95199 x PARI-73 as well as the reciprocal cross (PARI-73 x V-95199). The results are in agreement with Berwal et al. (1997) and Khaliq et al. (2004) who reported that grain yield was positively associated with peduncle length. Peduncle length of the cross Chakwal-86 x V-8060 was found to be positively correlated at genotypic level with seed yield per main spike whereas the genetic correlation coefficients were negative with spikelets per spike and harvest index. In reciprocal cross (V-8060 x Chakwal-86) the positive genetic association of peduncle length was evident with seed yield per main spike and seed yield per plant while the association was changed to negative with spikelets per spike and harvest index. The results get support from the findings of Berwal et al. (1997). Spikelets per spike of the cross V-95199 x PARI-73 showed positive genetic association with all indicated plant traits. In the reciprocal cross (PARI-73 x V-95199) spikelets per spike showed positive association with seed yield per main spike and seed yield per plant while negative association with harvest index. The results are in conformity with the findings of Deswal et al. (1997), Martincic et al. (1998), Khaliq et al. (2004) and Akram et al. (2008) who reported that grain yield was significantly associated with spikelets per spike.

In cross Chakwal-86 x V-8060 spikelets per spike revealed positive genetic correlation coefficient with all indicated plant traits. In reciprocal cross (V-8060 x Chakwal-86) positive genetic correlation coefficients of spikelets per spike were also observed with all indicated plant traits except seed yield per main spike which showed negative genetic correlation coefficient. The results get support from Deswal et al. (1997) and Martincic et al. (1998), Khaliq et al. (2004) and Mohsin et al. (2009). Seed yield per main spike exhibited positive genetic association with seed yield per plant and harvest index in the cross V-95199 x PARI-73. In case of the reciprocal cross (PARI-73 x V-95199) seed yield per main spike also showed positive genetic association with seed yield per plant while this association was changed to negative with harvest index. The results get conformity with the findings of Rana and Sharma (1997), Ioan (1998) and Martincic et al. (1998). Seed yield per main spike of the cross Chakwal-86 x V-8060 showed positive genetic correlation coefficient with seed yield per plant and harvest index while in the reciprocal cross its genetic relationship was negative with above said plant traits. The results of cross Chakwal-86 x V-8060 are in agreement with Rana and Sharma (1997), Martincic et al. (1998) and Zecevic et al. (2004) who reported that seed yield per main spike had direct effect on seed yield.

A negative genetic association between seed yield per plant and harvest index was observed in cross V-95199 x PARI-73 as well as the reciprocal cross. Similar results were also observed by Singh and Singh (1999). They revealed negative genetic association between seed yield per plant and harvest index. However, the results of Dhanda and Sethi (1996) and Iqbal and Redhu (1997) are contrary to the present findings, who reported positive association between seed yield per plant and harvest index. In case of the cross Chakwal-86 x V-8060 as well as the reciprocal cross positive genetic correlation coefficient was observed between seed yield per plant and harvest index. The results are in agreement with Iqbal and Redhu (1997), Budak and Yildirim (1999) and Mohsin et al. (2009) who reported positive association between seed yield per plant and harvest index.

Conclusion

According to the present findings it is concluded that the association among plant traits studied are under genetic control and could efficiently be exploited for obtaining maximum expression of peduncle length, seed yield per main spike and harvest index which ultimately lead to improve wheat yield.

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