JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
1813–2235/2005/01–3–262–265
http://www.ijabjass.org

Genetic Correlation among Various Quantitative Characters in Maize (*Zea mays* L.) Hybrids

HAQ NAWAZ MALIK[1], SAAD IMRAN MALIK†, MOZAMIL HUSSAIN, SAJJAD UR REHMAN CHUGHTAI AND HABIB IQBAL JAVED
Maize, Sorghum and Millet Programme, NARC, Islamabad,
†*University of Arid Agriculture, Rawalpindi*
[1]Corresponding author's e-mail: malik_narc@yahoo.com

ABSTRACT

Thirty six maize (*Zea mays* L.) hybrids along with their parental lines were grown in a randomized complete block design with two replications to assess the genetic correlation among 16 quantitative traits. A positive genetic correlation with grain yield was recorded for plant and ear heights, leaves plant^{-1}, leaf length, width and area, ear weight and kernels row^{-1}. Days to silking and tasselling, and grain moisture at harvest were negatively and correlated with grain yield, while ears plant^{-1}, grain moisture at harvest, kernel rows ear^{-1} and 100-kernel weight exhibited positive but no genetic correlation existed with grain yield. Kernels row^{-1} was marked as the most contributing character towards high grain yield (r_A = 0.76) followed by leaf area (r_A = 0.69), plant height (r_A = 0.67) and leaves plant^{-1} (r_A = 0.43). A strong positive genetic correlation was observed among plant height, leaf area, leaves plant^{-1}, ear weight, kernels row^{-1}, and grain yield indicating that selection for these characters can help improve maize grain yield.

Key Words: *Zea mays*; Genetic correlation; Yield; Yield components

INTRODUCTION

Maize (*Zea mays* L.) is the most widely grown cereal in the world. It is also the leading world cereal in terms of productivity. In Pakistan, it is the third most important cereal after wheat and rice. However, with its highest yield potential and the scope of increasing its yield in the country, its improvement deserves special attention. In countries like Pakistan, where rapid growth in population outstrips our gains in cereal production, maize offers the best opportunity for increasing cereal production. Increased production of maize and its alternate utilization in food channel can reduce the pressure on wheat and its imports.

Genetic correlation analysis is a handy technique which elaborates the degree of association among important quantitative traits. The studies on correlation are quite old and extensive but, unfortunately, there is hardly any rule set on how much a character contributes towards the expression of other character(s) in a plant population. Grain yield is positively genetically correlated with days to silking and tasselling (Altenbas & Algan, 1993; Ahmad, 1997; Rather *et al.*, 1999). Some other published results are contrary to this (Umakanth *et al.*, 2000). Plant and ear heights are strongly associated with grain yield (Martin & Russell, 1984; Burak & Magoja, 1991; Singh & Dash, 2000; Umakanth *et al*., 2000), but Rather *et al.* (1999) reported the association of plant height with grain yield as non-significant. Similarly, strong genetic correlation exists between grain yield and leaf area (Khakim *et al.*, 1998; Lee *et al.*, 2001). Number of ears plant^{-1} and ear weight are also strongly associated with grain yield (Martin & Russell, 1984; Khakim *et al.*, 1998). Ear height, ear length and ear diameter have also positive genetic correlation with grain yield (Burak & Magoja, 1991; Malvar *et al.*, 1994; Khatun *et al.*, 1999; Singha & Prodhan, 2000) but negatively with kernel weight (Martin & Russell, 1984). Number of kernels row^{-1} and kernel rows ear^{-1} have also a positive genetic correlation with grain yield (Shalygina, 1990; Altenbas & Algan, 1993; Gyanendra & Singh, 1993; Khakim *et al.*, 1998; Khatun *et al.*, 1999).

Keeping in view many other factors, the genetic base of the material under study and the effects of environment are very important while studying genetic correlation among various quantitative characters in crop species. Such studies could lead plant breeders in the selection of traits contributing towards the character(s) of concern, and ultimately their improvement through hybridization.

With increased industrial demand it is necessary to maximize maize production at a much faster pace than the current. Cultivar with desirable traits is a major contributing factor in grain yield per unit area. In order to develop promising genotypes, it is essential to know the associations among different traits, especially with grain yield, which is the most important ultimate objective in any breeding programme. The purpose of this study was to establish an association among 16 different quantitative characters in maize hybrids and, consequently with the grain yield.

MATERIALS AND METHODS

The experiment was conducted in the experimental field area of Maize, Sorghum and Millet Programme at the

National Agricultural Research Centre (NARC). Thirty-six single cross maize hybrids along with their parental lines were grown in the summer of 2002 in a randomized complete block design with two replications. Each row in main plot (5 m long) consisted of 21 plants. Hills were over planted and thinned to a normal plant stand of 56,000 plants ha^{-1}. Rows were spaced 0.75 m apart with plant to plant distance of 0.25 m.

Uniform cultural practices were carried out in all the plots in both replicates. Due to insufficient rainfall, all the plots were grown under irrigation. Data for 16 traits were recorded before harvest: days to tasseling and silking, number of tassel branches, plant height (from soil to the lowest tassel branch), ear height (from soil to the leaf subtending the ear), leaves $plant^{-1}$, leaf length, width and area (according to Payne *et al*., 1991), and ears $plant^{-1.}$ After the attainment of physiological maturity, the plants in the plots were harvested manually. The ears were husked and data for remaining traits i.e. ear weight, grain moisture at harvest (through a portable moisture tester), number of kernels row^{-1}, kernel row ear^{-1}, 100-kernel weight (at a constant moisture level of 15%) and grain yield $plot^{-1}$ were recorded. The genetic correlation was estimated by the covariance values for all the traits according to the formulae described by Falconer and Mackay (1996).

RESULTS AND DISCUSSION

Days to 50% tasselling were positively and ($P \leq 0.05$) correlated with days to silking, leaf length and grain moisture at harvest (Table I).The results are in agreement with Chase and Nanda (1967). This trait showed negative and significant genetic correlations with number of tassel branches, ear height, leaf width, and 100-kernel weight while no correlations with plant height, leaf number, leaf area, ears $plant^{-1}$, ear weight, kernel row ear^{-1} and grain yield were noted in this study (Table I).

Days to mid-silking were positively correlated with leaf length and grain moisture at harvest, negatively with number of tassel branches, ear height, leaf width, 100-kernel weight and grain yield but had no correlation with plant height, number of leaves $plant^{-1}$, leaf area, ears $plant^{-1}$, ear weight, kernel rows ear^{-1} and kernels row^{-1} (Table I). Altenbas and Algan (1993) reported kernels row^{-1} to be partially correlated with days to silking, Tiwari and Verma (1999) found cob yield while Umakanth *et al.* (2000) reported grain yield to be negatively correlated with days to silking. Number of tassel branches was positively correlated with plant height, ear height, leaves $plant^{-1}$, leaf width and area, 100-kernel weight and grain yield. This trait was negatively correlated with days to tasselling, but not with leaf length, ear $plant^{-1}$, ear weight, grain moisture at harvest, kernel rows ear^{-1} and kernels row^{-1} (Table I).

Plant height was positively correlated with number of tassel branches, ear height, leaf length, width and area, ears $plant^{-1}$, ear weight, kernels row^{-1} and grain yield. It was not correlated with days to tasselling and silking, grain moisture at harvest, kernel rows ear^{-1} and 100-kernel weight (Table I). Singha and Prodhan (2000) also reported grain yield to be positively associated with plant height. Burak and Magoja (1991), and Umakanth *et al.* (2000) found maximum correlation between plant height and grain yield.

Ear height was found to have a positive relationship with number of tassel branches, plant height, leaves $plant^{-1}$, leaf length, width and area, ear weight, kernels row^{-1}, 100-kernel weight and grain yield (Table I). It was negatively correlated with days to tasselling and silking but not with rest of the traits under study (Table I). Number of leaves $plant^{-1}$ was found to be positively correlated with number of tassel branches, plant height, ear height, leaf length, width and area, ear weight, number of kernels row^{-1} and grain yield, while no correlation was noted with days to tasselling and silking, ear $plant^{-1}$, grain moisture at harvest, kernel rows ear^{-1} and 100-kernel weight (Table I). Allen *et al*. (1973) also found leaves $plant^{-1}$ to be positively correlated with grain yield. Chase and Nanda (1967) found significant positive correlation between number of leaves and days to anthesis. Lee *et al*. (2001) reported plant and ear heights and leaf area to be positively correlated with each others.

Leaf length was positively correlated with days to tasselling and silking, plant height, ear height, leaves $plant^{-1}$, leaf area, ear weight, kernels row^{-1} and grain yield (Table I). Leaf width had a positive relationship with number of tassel branches, plant height, ear height, leaves $plant^{-1}$, leaf area, ear weight, kernels row^{-1}, and grain yield (Table I). The genetic correlation of leaf width with days to tasselling and silking, and grain moisture at harvest was negative and significant (Table I). A positive correlation of leaf area with number of tassel branches, plant height, ear height, leaves $plant^{-1}$, leaf length and width, ear weight, kernels row^{-1} and grain yield was observed. Number of ears $plant^{-1}$ was positively correlated with plant height only, while its correlations with all other traits were not established (Table I). Martin and Russel (1984) found grain yield to be positively correlated with ears $plant^{-1}$. Ear weight was positively correlated with plant and ear heights, leaf length, width and area, kernels row^{-1} and grain yield but non-significantly with days to tasselling and silking, number of tassel branches, grain moisture, kernel rows ear^{-1} and 100-kernel weight (Table I).

Grain moisture at harvest exhibited positive correlation with days to tasselling and silking, a negative one with leaf width and 100-kernel weight but none with remaining traits under study (Table I). Sotchenco (2000) found non-significant but positive genetic correlation between grain moisture at harvest and grain yield, while Chase and Nanda (1967) found grain moisture to be positively correlated with days to anthesis.

Table I. Genetic correlation among various characters of maize hybrids. (DT=days to 50% tasselling, DS=days to 50% silking, TB=tassel branches, PH= plant height, EH=ear height, LC= leaves plant^{-1}, LL=leaf length, LW=leaf width, LA=leaf area, $E_{wt.}$=ear weight, M%=grain moisture %age, RE^{-1}=kernel rows ear^{-1}, KR^{-1}=kernels row^{-1}, HKW=100-kernel weight, GY=grain yield).

Variables	DT	DS	TB	PH	EH	LC	LL	LW	LA	EP^{-1}	$E_{wt.}$	M%	RE^{-1}	KR^{-1}	HKW
DT															
DS	0.98**														
TB	-0.45*	-0.49**													
PH	-0.14	-0.25	0.35*												
EH	-0.28*	-0.37**	0.62**	0.84**											
LC	0.02	-0.06	0.45**	0.53**	0.60**										
LL	0.33*	0.25*	0.10	0.53**	0.40**	0.48**									
LW	-0.30*	-0.35**	0.47**	0.32*	0.47**	0.27*	0.01								
LA	-0.01	-0.10	0.43**	0.56**	0.60**	0.51**	0.64**	0.77**							
EP^{-1}	-0.07	-0.11	-0.17	0.33*	0.10	-0.01	0.07	-0.10	-0.04						
$E_{wt.}$	0.24	0.17	0.04	0.55**	0.44**	0.34**	0.53**	0.43**	0.67**	0.19					
M%	0.73**	0.75**	-0.26	-0.07	-0.19	-0.20	0.16	-0.37**	-0.18	-0.06	0.09				
RE^{-1}	0.30	0.28	-0.19	0.08	-0.01	0.16	0.23	-0.19	0.01	0.04	0.16	0.08			
KR^{-1}	-0.15	-0.22	0.24	0.56**	0.53**	0.43**	0.37**	0.53**	0.65**	0.12	0.63**	-0.23	0.00		
HKW	-0.62**	-0.63**	0.51**	0.22	0.28*	0.17	0.03	0.27	0.23	-0.08	0.10	-0.53**	-0.28	0.19	
GY	-0.14	-0.24*	0.28*	0.67**	0.60**	0.43**	0.48**	0.49**	0.69**	0.23	0.66**	-0.23	0.05	0.76**	0.25

* Significant at 5% and, ** Significant at 1% probability levels.

Number of kernels row^{-1} was positively correlated with plant and ear heights, leaves plant^{-1}, leaf length, width and area, ear weight and grain yield, and non-significantly with days to tasselling and silking, tassel branches, ear plant^{-1}, grain moisture at harvest and 100-kernel weight (Table I). Rehman *et al*. (1995), however, found kernels row^{-1} to be positively correlated with grain yield. In this study, kernel rows ear^{-1} indicated no genetic correlation with all of the traits under study (Table I). Likewise, hundred kernel weight was positively correlated with number of tassel branches and ear height, negatively with days to tasselling and silking and grain moisture at harvest, but not with plant height, leaves plant^{-1}, leaf length, width and area, ears plant^{-1}, ear weight, kernel rows ear^{-1}, kernels row^{-1} and grain yield (Table I). Shalygina (1990) reported 100-kernel weight as very closely correlated with grain yield. Similar findings are reported by Iqbal and Chuhan (2003).

Grain yield was positively correlated with most of the traits under study, i.e., number of tassel branches, plant and ear heights, leaves plant^{-1}, leaf length, width and area, ear weight, and kernels row^{-1} (Table I). The findings are in agreement with those of Iqbal (1990) and Afzal *et al*., (1997). Grain yield was negatively correlated with days to silking only. No correlation of grain yield with days to tasselling, ears plant^{-1}, grain moisture at harvest, kernel rows ear^{-1} and 100-kernel weight was evident (Table I). Similar findings have also been reported by Rehman *et al*. (1995). Kumar and Mishra (1995), while Iqbal and Chuhan (2003) reported a positive correlation of grain yield with kernels row^{-1} and 100-kernel weight.

Results of this study indicated that for corn, grain yield was positively correlated with plant and ear heights (for agronomic values; however, short ears may be desirable), leaf area, ear weight and kernel rows ear^{-1}. So selection for these traits can help improve maize grain yield per unit area. Negative correlation of grain yield with days to tasselling and silking was noteworthy in this study. It is plausible that in late maturing hybrids, poor grain filling was due to less favorable photoperiod and low temperature induced by changing season. It is also likely that in late maturing hybrids, the seed setting was reduced because of limited moisture especially towards the end of the season. These results clearly indicate that for the rainfed areas like that of Islamabad, the hybrids have to be early maturing and high yielding. Of course, for any short duration environment, early maturity is the most important character.

Since maturity and yield in maize are positively correlated, the early maturing varieties will be low yielding. In hybrid maize, however, this relationship could be broken making it possible to combine early maturity with high yield (Chughtai *et al*., 1994). These findings explicitly indicate that hybrid maize offers an effective way of boosting productivity in the short season environments such as the rainfed areas and the highland areas in the north of Pakistan. The genetic correlations in hybrid maize differed when hybrids were tested in different environments and locations (Chughtai *et al*., 1994). For instance, the correlations between days to flowering and grain yield were negative and highly significant at high altitudes (-0.363), positive and significant at mid-altitude (0.138), and but non-significant at low altitude (0.067). These differences can explain the discrepancies among various studies on correlations on maize hybrids. The correlations among various characters of maize hybrids may be different from those of open pollinated varieties of maize. For any given environment, the genetic correlations among various characters of maize can be very helpful in devising a breeding strategy for improving maize productivity.

REFERENCES

Afzal, M., M. Sharif and M.H. Chaudhry, 1997. Genetic and path coefficient analysis studies in maize. *Pakistan J. Agric. Res.,* 35: 360–8

Ahmad, S., 1997. Response to selection for grain yield and its components in a maize population. *M.Sc. Thesis,* Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

Altenbas, M. and N. Algan, 1993. Correlation among earliness, yield, yield components and quality traits in hybrid maize. *Anadolu.,* 3: 40–62

Allen, J.R., G.W. McKee and J.M. McGahen, 1973. Leaf number and maturity in hybrid corn. *Agron. J.,* 65: 233–5

Burak, R. and J.L. Magoja, 1991. Yield and yield components of full–sib and half–sib families derived from a perennial teosinte introgression population. *Maize Genet. Corp Newslett.,* 67–76

Chase, S.S. and D.K. Nanda, 1967. Number of leaves and maturity classification in *Zea mays* L. *Crop Sci.,* 7: 431–3

Chughtai, S.R., J. Crossa, H.I. Javed, M. Aslam, H.N. Malik and M. Hussain, 1994. Looking for Breakthrough: Combining high yield and early maturity in maize. *TAMNET Newslett.,* 1: 6–7

Falconer, D.S. and T.F.C. Mackay, 1996. *Introduction to Quantitative Genetics.* p. 315. 4th ed. Longman Inc., New York.

Gyanendra, S. and M. Singh, 1993. Correlation and path analysis in maize under mid–hills of Sikkim. *Crop Improv.,* 20: 222–5

Iqbal, R.M. and H.Q.I. Chauhan, 2003. Relationship between different growth and yield parameters in maize under varying levels of phosphorus. *J. Biol. Sci.,* 3: 921–5

Iqbal, M., 1990. Genotypic and phenotypic correlation for grain yield and yield components in maize (*Zea mays* L.) single crosses. *M.Sc. Thesis,* Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

Khakim, A., S. Stoyanova and S. Tsankova, 1998. Establishing the correlation between yield and some morphological, reproductive and biochemical characteristics in maize. *Rasteniev"dni Nauki,* 35: 419–22Khatun, F., S. Begum, A. Motin, S. Yasmin and M.R. Islam, 1999. Correlation coefficient and path analysis of some maize (*Z. mays* L.) hybrids. *Bangladesh J. Bot.,* 28: 9–15

Kumar, S. and N. Mishra, 1995. Genetic performance of S_1 lines derived after modified ear–to–row selection in maize. *Ann. Agric. Res.,* 16: 64–71

Lee, H., S.F. Jauh, T.W. Long and L.H. Shung, 2001. Studies on the agronomic traits and forage yield of three–way cross forage maize hybrids. *J. Agric. Res. China,* 50: 25–32

Malvar, R.A., P. Revilla and A. Ordas, 1994. Additive correlation between days to flowering and agronomic traits in low land races of maize. *Annales de la Estacition Experimental de Aula Dei.*, 20: 59–64

Martin, M.J. and A.W. Russel, 1984. Correlation response of yield and other agronomic traits to recurrent selection for stalk quality in maize synthetics. *Crop Sci.,* 24: 746–50

Payne, W.A, C.W. Wendt, L.R. Hossner and C.E. Gates, 1991. Estimating pearl millet leaf area and specific leaf area. *Agron. J.,* 83: 937–41

Rather, A.G., F.A. Sheikh and S.A. Wani, 1999. Variability and correlation studies in maize (*Zea mays* L.) under rainfed conditions. *Adv. Plant Sci.,* 12: 539–42

Rehman, M.M., M.R. Ali, M.S. Sultan and M.K. Mitra, 1995. Correlation and path coefficient studies in maize (*Zea mays* L.) composites. *Bangladesh J. Sci. Ind. Res.,* 30: 87–92

Shalygina, O.M., 1990. Correlation of yield in maize plants with its yield components and biological characters under irrigation in the lower Volga area. *Genetike–i–Selektsii,* 134: 10–4

Singh, J.M. and B. Dash, 2000. Analysis of genetic variability and character association in maize. *African Crop Sci. J.,* 5: 1–8

Singha, N. and S.H. Prodhan, 2000. Character association in green maize. *Env. Eco.,* 18: 962–5

Sotchenco, Y.V., 2000. Analysis of the traits "grain yield" and "grain moisture at harvest" in the selection of maize hybrids for earliness. *Kukuruza–i–Sorgo.,* 14: 17–8

Tiwari, V.K. and S.S. Verma, 1999. Correlation and path coefficient analysis in baby corn. *Agric. Sci. Digest,* 19: 230–4

Umakanth, A.V., E. Satyanarayana and M.V. Kumar, 2000. Correlation and heritability studies in Ashwini maize composite. *Ann. Agric. Res.,* 21: 228–30

(Received 28 January 2005; Accepted 05 May 2005)