Forage Res., **42** (3) : pp. 204-207 (2016) **http://forageresearch.in**
SHORT COMMUNICATION

ASSOCIATION ANALYSIS OF YIELD AND QUALITY ATTRIBUTES IN MAIZE

PREETI SHARMA*, M. S. PUNIA AND M. C. KAMBOJ

Department of Genetics & Plant Breeding
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India
**(e-mail : sharmapreeti.genetics@gmail.com)*

(Received : 13 November 2016; Accepted : 25 December 2016)

SUMMARY

The experiment was conducted to evaluate the relationship among 17 quantitative traits. The 63 single cross hybrids developed from crossing nine productive maize inbred lines with seven quality protein maize inbred lines in line x tester mating design along with their parents and standard checks were evaluated through correlation studies at experimental area of CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal during 2013-14. Correlation is important in estimating the relative importance of various characters on grain yield. From the association analysis, it was found that grain yield per plant showed significant positive correlation with days to 50 per cent tesselling, days to 50 per cent silking, days to maturity, plant height, ear height, cob length, cob diameter, number of grains per cob, 100-grain weight, shelling percentage and lysine content, whereas it was found significant negative with protein content and starch content. Among yield and quality characters, grain yield per plant had significant negative correlation with protein content and starch content. Protein content had significant negative correlation with tryptophan content and tryptophan was significantly positively correlated with lysine content. While oil content and lysine content exhibited positive and significant association with grain yield per plant but with tryptophan content, grain yield per plant showed positive but non-significant association. Strong positive and significant association was established between lysine content and tryptophan content. Hence, days to 50 per cent tesselling, days to 50 per cent silking, days to maturity, plant height, ear height, cob length, cob diameter, number of grains per cob, 100-grain weight, shelling percentage, oil content, lysine content and tryptophan content should be given more importance while formulating selection indices for grain yield improvement in maize.

Key words : Character association, yield, quality, maize

The production areas of maize are increasing day by day due to increase in poultry and dairy farms in the country and the farmers are also interested to grow it in their crop diversification programme in India. As maize has been the source of nutrient for human as cereal crop and animals as fodder, the improvement of maize in terms of its protein quality mainly lysine and tryptophan is very important (Sharma *et al.*, 2015). The significant improvement in the efficiency of crop breeding programmes can be achieved through the use of proper selection indices, where interrelationships between yield and its contributing components exist. Breeding for high yield and improved quality is one of the major objectives to increase productivity in maize. However, yield is a complex quantitative character generally having low heritability and is influenced by many components or contributing traits both in positive and negative directions. Consequently, a rational approach towards improvement of yield necessitates the selection of the important yield components and to study their extent and nature of association with yield, which would provide effective basis of selection. Correlation coefficient is one of the important biometrical tools for formulating a selection index as it reveals the strength of relationship among the group of characters. This also helps to decide the dependability of the characters that have little or no importance. The relationship of a character with yield and other component characters could also be useful for the proper choice of parents for hybridization programme. In breeding programmes designed to increase the yield potential of a crop plant, an understanding of the mode of inheritance of the yield components, the correlations among them and the relationship between the components and yield is necessary for a better selection of breeding procedures for developing high-yielding varieties. Grain yield is also

one of such dependent traits, which is influenced by many independent characters. The knowledge of correlation between different yield attributes helps the maize breeder to find out the nature and magnitude of the association between these traits which are mostly used to attain better yield of the crop. Therefore, it is useful in the selection of several traits simultaneously influencing yield. The present study was, therefore, conducted to assess the genetic relationships among yield components and quality characters, through association analysis for enhancing the usefulness of selection for grain yield improvement along with other quality characters in maize.

The field experiment was conducted in experimental area of CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal during the growing seasons of 2013 and 2014. Karnal is located at 29.43º N latitude and 76.58º E longitude and is about 250 m above mean sea level. The average annual rainfall was about 354.5 mm, in which around 29 per cent of the total rainfall was received during the months from July to September which was distributed evenly during the cropping period and the soil type was clay loam. The monthly maximum and minimum temperatures during hot months ranged from 39.5ºC to 19ºC and during cold months ranged from 4ºC to 32ºC. The 63 crosses (experimental hybrids) were generated by Line x Tester mating design among nine productive inbred lines [used as females and denoted as Lines (L)] and seven QPM (Quality protein miaze) inbred lines (used as males and denoted as Testers (T)] during **rabi** 2013-14. The hybrid seeds were utilized for raising the F_1's along with the parents and two standard check varieties (HQPM 1 and HM 5) were raised in a randomized block design (RBD) with three replications during **kharif** 2014. These 63 crosses along with 16 parents and two standard checks viz., HQPM 1 and HM 5 were grown in a randomized block design with three replications during **kharif** 2014. Each genotype was planted in a single row of 3 m length and the distance between rows and plants was kept at 75 and 20 cm, respectively. All the recommended agronomic practices were followed throughout the cropping period. From each replication and from each genotype, five competitive plants were randomly selected from each row of parents and their F_1's and observations were recorded on 17 quantitative traits including yield, its component traits and quality characters viz., days 50 per cent taselling, days to 50 per cent silking, days to maturity, plant height (cm), ear height (cm), number of cobs per plant, cob length (cm), cob diameter (cm), number of grains per cob, 100-grain weight (g), grain yield per plant (g), shelling percentage, protein content (%), lysine content, tryptophan content (%), oil content (%) and starch content (%). The data were averaged of these randomly selected plants for these traits, taken as the mean of the treatment. Quality characters were determined at quality laboratory using Near Infrared Spectrophotometer (NIRS), (Rosales *et al*., 2011). The correlation coefficient was worked out to find out the relationship between yield and its components in the parents and their hybrids. Genotypic coefficient of correlation between pairs of traits was determined by using the variance and covariance components as suggested by Al-Jibouri *et al.* (1958).

Results regarding correlation studies in 81 genotypes (including parental inbreds, experimental hybrids and standard checks) for 17 characters have been presented in Table 1. The results presented in this study are exploratory in nature and could be useful in suggesting associations and variances that could be exploited in quality protein maize breeding programmes, to facilitate its genetic improvement. The results from correlation study indicate that some traits could be selected and improved simultaneously. Highly significant and positive association was exhibited between days to 50 per cent taselling and days to 50 per cent silking as well as with days to maturity. Similar results were obtained by Shakoor *et al*. (2007), Saleem *et al.* (2008), Nastasic *et al*. (2010), Yusuf (2010), Ravi *et al.* (2012) and Reddy *et al*, (2013). Days to 50 per cent taselling and days to 50 per cent silking also showed positive significant association with cob length, cob diameter, number of grains per cob and grain yield. Similarly, maturity exhibited positive and significant association with plant height, ear height, number of cobs per plant, cob length, cob diameter, number of grains per cob and grain yield. The results are in agreement with the findings of El-Shouny *et al.* (2005), Shakoor *et al*. (2007) and Sumalini and Manjulatha (2012), which showed that grain yield per plant was correlated positively and significantly with ear diameter, ear length, number of kernels per row, 100-kernel weight, number of rows per ear, ear height, plant height and days to silking under normal planting date and with number of kernels per row, ear diameter, 100-kernel weight, ear length, number of rows per ear, ear height under late planting date. The results are contradictory where Netaji *et al.* (2000) and Sumalini and Manjulatha (2012) found negative correlation of grain yield with days to tasselling and silking. Positive and significant association was established between plant height and grain yield per

TABLE 1
Genotypic correlation coefficients in respect of 17 characters in maize genotypes including parental inbred lines, experimental hybrids and standard checks

	50% T	50% S	Mat	PH	EH	C/P	CL	CD	NGPC	100 GW	Shelling (%)	PC	LC	TRP	OC	SC
50% T																
50% S	0.88**															
Mat	0.77**	0.73**														
PH	0.08	0.16*	0.26**													
EH	0.26**	0.16*	0.37**	0.55**												
C/P	0.16	0.11	0.29**	-0.13*	0.07											
CL	0.28**	0.20**	0.33**	0.53**	0.68**	0.12										
CD	0.38**	0.36**	0.52**	0.44**	0.66**	0.08	0.66**									
NGPC	0.44**	0.34**	0.48**	0.45**	0.73**	-0.13	0.79**	0.62**								
100 G	0.12	0.07	0.15*	0.32**	0.39**	0.47**	0.45**	0.44**	0.50**							
Shelling (%)	0.25**	0.32**	0.34**	0.47**	0.31**	0.17**	0.45**	0.12	0.60**	0.31**						
PC	-0.12	-0.1	-0.34**	-0.07	-0.07	-0.06	0.12	0.11	-0.20*	-0.01	-0.06					
LC	0.12	0.14*	0.23**	0.39**	0.1	0.07	0.12	0.08	0.05	0.08	0.1	-0.23**				
TRP	0.08	0.04	0.02	0.19*	0.01	0.03	0.01	0.12	0.02	0.05	0.05	-0.45**	0.80**			
OC	0.04	0.09	0.21*	0.16*	0.04	0.08	0.14*	0.04	0.26**	0.06	0.11	-0.31**	0.09	0.1		
SC	-0.11	-0.07	-0.08	-0.24**	-0.57**	-0.1	-0.05	-0.38**	-0.57**	-0.44**	-0.14*	-0.16**	0.03	-0.06	-0.04	-0.02
GYPP	0.45**	0.39**	0.47**	0.41**	0.66**	0.26**	0.70**	0.50**	0.93**	0.58**	0.66**	-0.20**	0.29**	0.1	0.24**	-0.41**

DT–Days to 50% taselling, DS–Days to 50% silking, DM–Days to maturity, PH–Plant height (cm), EH–Ear height (cm), C/P–Number of cobs per plant, CL–Cob length (cm), CD–Cob diameter (cm), NGPC–Number of grains/cob, 100 GW–100-grain weight (g), GYPP–Grain yield per plant (g), Shelling (%)–Shelling percentage, PC–Protein content (%), LC–Lysine content, TRP–Tryptophan content (%), OC–Oil content (%) and SC–Starch content (%).
*,**Significant at P=0.05 and P=0.01 levels, respectively.

plant, ear height, cob length, cob diameter, and number of grains per cob. Ear height exhibited positive and significant association with plant height, cob length, cob diameter, number of grains per cob, 100-grain weight and grain yield. The strong correlation between ear height and plant height with grain yield suggested that tall plants with high ear placement gave better yields compared to the shorter plants with lower ear placement. This could be attributed to the high dry matter accumulation function carried out by the high number of leaves possessed in the case of tall plants. Cob length established positive and significant association with cob diameter, number of grains per cob, 100-grain weight and grain yield per plant. Correlation studies revealed that significant positive association between grain yield per plant with cob diameter, number of grains per plant, 100-grain weight and shelling percentage. The results are in agreement with previous findings of Rafiq *et al.* (2010), Yusuf (2010), Sumalini and Manjulatha (2012) and Tengan *et al*. (2012).

Among yield and quality characters, grain yield per plant had significant negative correlation with protein content and starch content. It is difficult to exercise simultaneous selection of negatively associated traits to develop a variety. Under such situations, judicious selection programme must be formulated for simultaneous improvement of such traits. Earlier Aliu *et al.* (2012) found negative correlation between yield and protein content but positive and significant correlation was found with starch content and positive but non-significant with oil content. While oil content and lysine content exhibited positive and significant association with grain yield per plant but with tryptophan content, grain yield per plant showed positive but non-significant association. This is in partial agreement with Medici *et al.* (2009) who observed positive correlation between lysine and oil content, and protein and starch content in 81 maize inbreds. Sreckov *et al*. (2011) studied the correlation between grain yield and oil content in two testcross populations of maize. The relationship was negative with the first population, while in the second population grain yield was positively associated with kernel oil content. For protein content significant negative association was found for lysine content, tryptophan content, oil content and starch content. Abou-Deif *et al*. (2012) observed significant negative association between protein and oil content. Strong positive and significant association was established between lysine content and tryptophan content.

The results provide a measure of association between the characters and reveal the character that might be useful as an index for selection. Therefore, it could be concluded that positive significant correlations between grain yield and other yield contributing characters indicated the possibility of achieving higher yield. Also the positive correlations among quality

characters (lysine and tryptophan, oil content and lysine, grain yield and starch content) indicated that more than one quality character could be improved simultaneously. This study concluded that ear girth, number of rows, number of grains per row, 100-grain weight, cob length, shelling percentage and starch content had significant positive association with grain yield. These findings suggested that improvement of grain yield in maize was linked with the development of these traits that might have good impact on grain yield. Hence, these characters can be used as a selection index for improving grain yield in maize. These findings would be of great help to the breeders for improving the inbreds of maize, which can further be used in synthesizing the high yielding single cross hybrids. Generally for the positive correlation of grain yield with other yield related traits indicated that plant breeders could use these traits as indicators in predicting yield. This is because when two traits are correlated, selecting for one would ensure selection for the other trait, thus selecting for the best of the above traits would result in improved yields. It is anticipated that these findings will be useful in future breeding programmes involving this very important crop.

ACKNOWLEDGEMENT

The first author is indebted to the Department of Genetics & Plant Breeding and CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal, for providing technical assistance, planting materials and valuable information used for the study and to Department of Science & Technology for providing financial support with INSPIRE Fellowship.

REFERENCES

Abou-Deif, M. H., B. B., Mekki, E. A. H. Mostafa, R. M. Esmail, and S. A. M. Khattab, 2012 : The genetic relationship between proteins, oil and grain yield in some maize hybrids. *World J. Agric. Sci.* **8** : 43-50.

Al-Jibouri, H. A., P. A. Miller, and H. F. Robinson. 1958 : Genotypic and environment variances and covariances in upland cotton cross of inter-specific origin. *Agron. J.*, **50** : 633-637.

Aliu, S., I. Rusinovci, S. Fetahu, and E. Simeonovska, 2012 : Genetic diversity and correlation estimates for grain yield and quality traits in Kosovo local maize (*Zea mays* L.) populations. *Acta Agriculturae Slovenica*, **99** : 121-128.

El-Shouny, K. A., O. H. El-Baguory, K. I. M. Ibrahim, and S. A. Al-Ahmad. 2005 : Correlation and path coefficient analysis in four yellow maize crosses under two planting dates. *Arab Univ. J. Sci.* **13** : 327-339.

Medici, L. O., S. A. Gaziola, V. A. Varisi, J. A. C. Paula, R. R. Ferreira, and R. A. Azevedo. 2009 : Diallelic analysis for lysine and oil contents in maize grains. *Scientia Agricola*, **66** : 204-209.

Nastasic, A., D. Jockovic, M. Ivanovic, M. Stojakovic, J. Bocanski, I. Dalovic, and Z. Sreckov, 2010 : Genetic relationship between yield and yield components of maize. *Genetika*, **42** : 529 -534.

Netaji, S. V. S. R. K., E. Satyanarayana, and V. Suneetha, 2000 : Heterosis studies for yield and yield component characters in maize (*Zea mays* L.). *The Andhra Agric. J.*, **47** : 39-42.

Rafiq, C. M., M. Rafique, A. Hussain, and M. Altaf 2010 : Studies on heritability, correlation and path analysis in maize (*Zea mays* L.). *Agric. Res.*, **48** : 35-38.

Ravi, V. M., Chikkalingaiah, and H. Shailaja. 2012 : Correlation study for protein content, grain yield and yield contributing traits in quality protein maize (*Zea mays* L.). *Electronic J. Plant Breed*. **3** : 649-651.

Reddy, V. R., J. Farzana, M. R. Sudarshan, and A. Seshagiri Rao, 2013 : Studies on genetic variability, heritability, correlation and path analysis in maize (*Zea mays* L.) over locations. *Intern. J. Appl. Biol. and Pharmaceutical Technol.*, **4** : 195-199.

Rosales, A., L. Galicia, E. Oviedo, C. Islas, and N. P. Rojas. 2011 : Near-infrared reflectance spectroscopy (NIRS) for protein, tryptophan and lysine evaluation in quality protein maize (QPM) breeding programmes. *J. Agric. Food Chem.*, **59** : 10781-10786.

Saleem, M., M. Ahsan, M. Aslam, and A. Majeed, 2008 : Comparative evaluation and correlation estimates for grain yield and quality attributes in maize. *Pak. J. Bot.*, **40** : 2361-2367.

Shakoor, M. S., M. Akbar, and A. Hussain. 2007 : Correlation and path coefficient studies of some morpho-physiological traits in maize double crosses. *Pak. J. Agric. Sci.*, **44** : 213-216.

Sharma, P., M. S. Punia, and M. C. Kamboj. 2015 : Estimates of heritability, heterosis and inbreeding depression for yield and quality traits in maize. *Forage Res.*, **41** : 139-146.

Sreckov, Z., A. J., Nastastic, I., Bocanski, M., Djalovic, Vukosavljev, and B., Jockovic. 2011 : Correlation and path analysis of grain yield and morphological traits in test-cross populations of maize. *Pak. J. Bot.*, **43** : 1729-1731

Sumalini, K., and G. Manjulatha. 2012 : Heritability, correlation and path coefficient analysis in maize. *Maize J.* **1** : 97-101.

Tengan, K. M. L., K. Obeng-Antwi and R. Akromah. 2012 : Genetic variances, heritability and correlation studies on selected phenotypic traits in a backcross breeding programme involving normal and opaque-2 maize. *Agric. Biol. J. N. Am.*, **3** : 287-291.

Yusuf., M. 2010 : Genetic variability and correlation in single cross hybrids of quality protein maize (Zea *mays* L.). *Af. J. Agric. Food Nutri. & Develop*., **10** : 2167-2175.