International Research Journal of Agricultural Science and Soil Science (ISSN: 2251-0044) Vol. 1(8) pp. 339-343 October 2011
Available online http://www.interesjournals.org/IRJAS

Full Length Research Paper

Genotypic and phenotypic relationship among maturity and yield traits in maize hybrids (*Zea mays* L.)

[1]Taimur Malik, [2]Malak Atiq ullah Khan, [3]Sayed Jaffar Abbas*, [4]Zaheer Abbas, [5]Mehran Malik, [6]Kamil Malik

[1/2/*3/4/5/6]Biotechnology Centre, Agriculture Research Institute, Tarnab, Peshawar, Pakistan

Accepted 06 September, 2011

Ten maize hybrids were evaluated at Agriculture Research Institute, Tarnab Farm, Peshawar with the aim to estimate variation among maize hybrids during spring season 2010. Randomized complete block design with 3 replications was used for hybrids evaluation. Data were recorded on days to 50% pollen shedding, days to 50% silking, anthesis-silking interval, plant height, ear height, number of cobs ha^{-1} and grain yield. The analysis of variance showed highly significant differences among the maize hybrids for above mentioned traits. Maize hybrid population 2006 × (WD-3×6) took minimum days to pollen shedding (85.0 days) and silking (86.0 days) with desirable anthesis-silking interval of 1.0 day. The same hybrid was also short statured (155.5 cm plant height) with the desirable ear height of 75.0 cm. However, the maximum grain yield of 9.3 t ha^{-1} was produced by maize hybrid Guard BC followed by Pioneer hybrid (8.8t ha^{-1}) and NT-6621 (8.7 t ha^{-1}). Days to pollen shedding exhibited significantly positive genotypic correlation with days to silking (rG = 0.97, P = 0.01), and anthesis-silking interval (rG = 0.82, P = 0.01). Days to pollen shedding showed significantly positive phenotypic correlation with days to silking (rp = 0.92, P = 0.01), ASI (rp = 0.61, P = 0.01) and plant height (rp = 0.36, P = 0.05). Days to silking exhibited significantly positive genotypic and phenotypic correlation with anthesis-silking interval (rG = 0.94, P = 0.01 and (rp = 0.87, P = 0.01), Days to silking showed significantly positive phenotypic correlation with plant height (rp = 0.37, P = 0.05). Plant height exhibited significantly positive genotypic correlation with ear height (rG = 0.96, P = 0.01). Further evaluation at several locations of the province both in spring and kharif seasons is needed to identify desirable hybrids with specific adaptation.

Keywords: ASI (anthesis-silking interval), rp (phenotypic correlation), rG (genotypic correlation), grain yield, maize hybrids.

INTRODUCTION

The introduction of hybrids was the most important advance in the cultivation of maize. The first commercial sale of hybrid seed started in 1984. Inbred lines of maize show general deterioration in yield and vigor, but hybrid between two inbreds immediately and completely recovers. In many cases, their yield exceeds that of the varieties from which inbred were derived (Shull,1908). Increased production per unit area is the primary objective in many maize-breeding programs. Of these, grain yield is the most important and complex character with which the maize breeders work. Maize displays an orderly sequence of development of yield components namely number of cobs $plant^{-1}$, number of kernel rows cob^{-1} and kernel weight (Viola *et al*., 2003). To guarantee high yield of maize crop, farmers often grow improved varieties usually from different sources either alone or with other local varieties resulting in diversity among cultivars grown within and among farmers. Genetic variability, which is a heritable difference among cultivars, is required in an appreciable level within a population to facilitate and sustain an effective long term plant breeding programme. Progress from selection has been reported

*Corresponding author email: drbiotech05@yahoo.com

to be directly related to the magnitude of genetic variance in the population (Tabanao and Bernardo, 2005). Large amount of genetic variability has been observed to occur in the original accessions and races among sampled population representing different climatic and geographical regions (Ilarslan *et al*., 2002). Abayi *et al*. (2004), Turi *et al*. (2007) and Salami *et al*. (2007) observed significant genetic variation in important agronomic traits, especially earliness to sufficiently justify the initiation of selection programme. Breeders have developed thousands of hybrids, of which one or more can flourish in almost any combination of soil and climate found in farming areas. Better uniformity of hybrids is useful for machine harvesting. Hybrids could also incorporate favourable qualitative traits and be adapted to different habitats, especially length of growing season. Hybrids have also been developed to increase maize yield in many other areas of the world. Most of the hybrid seeds used by farmers are double crossed, or the cross product of two single cross hybrids. Hybrids are more resistant to drought than open pollinated varieties. Recently, farmers have also been using single cross hybrids because higher yielding hybrids have been developed. Hybrids do not transmit their increased vigour to their offspring, so that the parent stocks must be crossed each year to produce a new crop of hybrid seed. This is done by seed companies and by some farmers who specialize in the production of hybrid seed. Yield increases of 25 to 50% have been attributed to the use of maize hybrids. During selection on oil content it came to correlative response on other traits. Because of that one of the goals of this study was to confirm correlations between grain yield and morphological traits of plant and ear, as well as between oil content and morphological traits. Since yield components are interrelated and develop sequentially at different growth stages, correlations may not provide a clear picture of the importance of each component in determining grain yield. Path coefficient analysis provides more information among variables than do correlation coefficients since this analysis provides the direct effects of specific yield components on yield and indirect effects via other yield components (Garcia del Moral et al., 2003, Arshad *et al.,* 2004, 2006; Aycicek and Yildirim, 2006). Because of that goal of this study also was founding the direct and indirect effects of morphological traits on grain yield.

The present study was intended to:

- Test the genetic variability for maturity and yield traits in different maize hybrids.
- Determine genotypic and phenotypic correlations among important traits of maize hybrids.

MATERIALS AND METHODS

The experiment was conducted during spring crop season (February-June) 2010 at Agriculture Research Institute, Tarnab Farm, Peshawar. The experimental material comprised 10 hybrids i.e. Psev-246×FRHW-20, Psev-246×FRHW-22(F_2), FRHW 22(F_2)×FRHW22(F_2), FRHW-20×FRHW-22(F_2), Baber Improved, Pop.2006×(WD-3x6), Pioneer hybrids, Ghauri-3×Tam-1, Guard BC (Chinese hybrid), NT-6621(Syngenta hybrid). The experiment was laid out in Randomized Complete Block Design with three replications and sown on February 20, 2010. Each plot comprised four rows of 5 m length. Plant spacing between rows was 0.75 m; while plant to plant distance was 0.25 m. Standard cultural (sealing, irrigation etc) practices were applied uniformly at experimental site. Data were recorded on days to 50% pollen shedding, days to 50% silking, anthesis-silking interval (ASI), plant height, ear height, number of cob ha^{-1} and grain yield.

Data were subjected to analysis of variance by Statistical Analytical System (SAS, 1999). Means were compared using least significant difference at 50% level of probability. Genetic variance was calculated using variance command of SAS/STAT (SAS Institute Inc., 1999). Genotypic and phenotypic correlations were also worked out among yield traits following the method proposed by Singh and Chaudhary (1997).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences for all the traits among the maize hybrids. The values of coefficient of variation and R^2 for days to pollen shedding, days to silking, ASI, plant height, ear height, number of cobs ha^{-1} and grain yield ha^{-1} were (0.89, 90.89%), (1.40, 90.66%), (42.28, 67.39%), (5.57, 81.52%), (13.06, 68.38%), (6.29, 97.31%), (14.44, 88.90%), respectively (Table 1). These results are in agreement with the earlier reports of Mehdi *et al*. (2001) who found lower CV for various traits in maize hybrids. According to Singh and Chaudhry (1997), 10% or less CV is desirable for selection of traits in breeding populations. Days to pollen shedding for maize hybrids ranged from 85.0 to 90.3 (Table 1). The maximum days to pollen shedding (90.3) were taken by Pioneer maize hybrid and the minimum days to pollen shedding (85.0 days) were observed for maize hybrid Pop.2006×(WD-3×6) which was statistically at par with hybrid FRHW-22(F2)×FRHW22 (F_2) and Baber Improved (each taking 85.6 days to pollen shedding). Our results are in conformity to the earlier findings of Ihsan *et al.* (2005) and Sener *et al*. (2004). Days to pollen shedding exhibited significant positive genotypic correlation with days to silking (rG = 0.97) and ASI (rG = 0.82,) (Table 2). However, the genotypic correlation of days to pollen shedding with plant height, ear height, cobs ha^{-1} and yield was non-significant. Days to pollen shedding showed significantly positive phenotypic correlation with days to silking (rp = 0.92), ASI (rp = 0.61) and plant height (rp =

Table 1. Data on yield and yield components of 10 Maize Hybrids Evaluated at CCRI, Pirsabak During Spring 2010.

Hybrids	Pollen shedding(days)	Silking(days)	ASI(days)	Plant height (cm)	Ear height (cm)	Cobs ha^1 (no.)	Grain yield (t ha^{-1})
Psev-246xFRHW-20	87.3 C	91.0 CDE	3.7 AB	194.4 A	95.0 AB	54222 A	8.2 ABC
Psev-246xFRHW-22(F_2)	87.3 C	89.6 E	2.3 BCD	194.4 A	100.5 A	53778 AB	7.5 BCD
FRHW-22(F_2)xFRHW22(F_2)	85.6 D	86.6 F	1.0 CD	150.0 E	58.8 E	49556 AB	6.3 D
FRHW-20xFRHW-22(F_2)	87.6 D	90.6 DE	3.0 AB	173.3 BC	83.3 ABCD	48667 B	6.5 CD
Baber Improved	85.6 BC	86.3 F	0.7 D	170.0 CD	78.8 BCD	54444 A	7.9 ABCD
Pop.2006x(WD-3x6)	85.0 D	86.0 F	1.0 CD	155.5 ED	75.0 CDE	54444 A	6.8 CD
Pioneer hybrid	90.3 A	93.0 ABC	2.7 BC	189.4 AB	92.7 ABC	54222 A	8.8 AB
Ghauri-3xTam-1	89.0 AB	92.3 BCD	3.3 AB	154.9 ED	68.3 DE	6222 C	1.0 E
Guard BC (Chinese hybrid)	90.0 A	94.6 A	4.7 A	167.7 CD	83.3 ABCD	51778 AB	9.3 A
NT-6621(Syngenta hybrid)	90.0 A	93.6 AB	3.7 AB	179.4 ABC	90.0 ABC	497728 AB	8.7 AB
LSD (0.05)	1.3	2.2	2.0	16.5	18.5	5149.2	1.7
CV (%)	0.89	1.40	42.28	5.57	13.06	6.29	14.44
R^2 (%)	90.89	90.66	67.39	81.52	68.38	97.31	88.90

Means sharing similar letter in a column are not significantly different from each other at 5% probability level.

Table 2. Genotypic (Above Diagonal) and Phenotypic (Below Diagonal) Correlation, With P-Value in Parentheses, Among Various Traits of 10 Maize Hybrids.

	Pollen Shedding	Silking	Anthesis-silking interval	Plant height	Ear height	Cobs ha^{-1}	Grain yield
Pollen shedding		0.97 (0.01)	0.82 (0.01)	0.37 (0.29)	0.41 (0.24)	0.40 (0.24)	0.13 (0.72)
Silking	0.92 (0.01)		0.94 (0.01)	0.38 (0.27)	0.43 (0.21)	-0.24 (0.50)	0.12 (0.73)
Anthesis-silking interval	0.61 (0.01)	0.87 (0.01)		0.36 (0.30)	0.42 (0.22)	-0.22 (0.53)	0.09 (0.78)
Plant height	0.36 (0.05)	0.37 (0.05)	0.30 (0.01)		0.96 (0.01)	0.43 (0.21)	0.54 (0.10)
Ear height	0.35 (0.06)	0.33 (0.07)	0.24 (0.20)	0.81 (0.01)		0.44 (0.20)	0.57 (0.08)
Cobs ha^{-1}	-0.22 (0.23)	-0.24 (0.20)	-0.20 (0.28)	0.40 (0.02)	0.37 (0.04)		0.91 (0.01)
Grain yield	0.10 (0.60)	0.10 (0.60)	0.10 (0.61)	0.53 (0.01)	0.48 (0.01)	0.90 (0.01)	

Genetic and phenotypic correlation separated by diagonal

0.36). Phenotypic correlations of days to pollen shedding with remaining traits were non-significant. El-Nagouli *et al*. (1983) found that yield was directly influenced by ear height and indirectly by days to 50% silking via ear height. Positive and non-significant genotypic and phenotypic correlation between number of days taken to tasseling and grain yield per plant have also been reported by Troyer (1990) and Stojsin and Kannenberg (1994). The maximum days to silking (94.6) were taken by maize hybrid Guard BC (Chinese hybrid) while the minimum days to silking were observed for maize hybrid Pop.2006× (WD-3×6) (86.0 days). Nazir *et al*. (2003) have reported that maize varieties differed significantly for days to 50% silking, plant height and grain yield. Saleh *et al*. (2002) and El-Nagouli *et al.* (1983) observed that yield was directly influenced by ear height and indirectly by days to 50% silking via ear height. Days to silking exhibited significant positive genotypic (rG = 0.94) and phenotypic (rp = 0.87) correlation with ASI and significant positive phenotypic correlation with plant height (rp = 0.37) (Table 2). ASI for maize hybrids ranged from 0.7 to 4.7 days (Table 1). Brakke *et al.* (1983) have reported significant interaction for environmental effects for flowering traits in maize hybrids. ASI exhibited significantly positive genotypic correlation with days to pollen shedding (rG = 0.82) and days to silking (rG = 0.94) (Table 2). However, the genotypic correlation of ASI with plant height, ear height, cobs ha^{-1} and yield was non-significant. ASI showed significant positive phenotypic correlation with plant height (rp = 0.30). Phenotypic correlation of anthesis-silking interval with remaining traits was non-significant.

The plant height for maize hybrids ranged from 150.0 to 194.4 cm (Table 2). Plant height exhibited significant positive genotypic correlation with ear height (rG = 0.96) (Table 2). However, the genetic correlation of plant height with the remaining traits was non-significant. Plant height showed significant positive phenotypic correlation with ear height (rp = 0.81), cob ha^{-1} (rp = 0.40) and grain yield (rp = 0.53) (Table 2). Phenotypic correlation of plant height with the remaining traits was non-significant. Rahman *et al*. (1995) studied correlations and path coefficients in maize composites. The ear height for maize hybrids ranged from 58.8 to 100.5 cm (Table 1). Our results get support from the findings of Widdicomb and Thelen (2002) who reported significant variation for maturity and plant height. Significant genetic variance for plant height and ear height was also reported by El-Hosary and Sattar (1997) in maize. The genotypic correlation of ear height with plant height (rG = 0.96) was positive (Table 2). The genotypic correlation of ear height with the remaining traits was non-significant. Ear height showed significantly positive phenotypic correlation with cob ha^{-1} (rp = 0.37) and grain yield (rp = 0.48) (Table 2). However, phenotypic correlation of ear height with the remaining traits was non-significant. The maximum cobs ha^{-1} of 54444 were recorded for maize hybrid Baber Improved and Pop.2006×(WD-3x6) and the minimum cobs ha^{-1} were observed for maize hybrid Ghauri-3xTam-1 (6222).Cobs ha^{-1} exhibited significant positive genotypic correlation with grain yield (rG = 0.91) (Table 2). Genotypic correlation of cobs ha^{-1} with days to pollen shedding, days to silking, ASI, plant height and ear height was non-significant. Cobs ha^{-1} also showed significant positive phenotypic correlation with grain yield (rp = 0.90). Phenotypic correlation of cobs ha^{-1} with remaining traits was non-significant. Juma *et al*. (1999) revealed highly significant genotypic positive association between yield and yield components, whereas the phenotypic association of yield components with yield was positive and significant except number of cobs $plant^{-1}$, where it was positive but non-significant. The yield per hectare for maize hybrids ranged from 1.0 to 9.3 tons (Table 1). Aziz *et al*. (1992) and Khan *et al*. (1999) reported that varieties having diverse genetic background significantly differed in their grain yield performance. Grain yield exhibited significant positive genotypic correlation with cobs ha^{-1} (rG = 0.91) (Table 2). However, it was non-significant with other traits. Grain yield showed significantly positive phenotypic correlation with cobs ha^{-1} (rp = 0.90) (Table 2). However, it was non-significant with other traits. The present results are supported by the findings of Rahman *et al*. (1985) who concluded that grain yield was significantly and positively correlated with plant height, ear height. Ahmad and Mehdi (2001) found significant and positive estimates of genetic correlations of grain yield and plant height (rG = 0.78).

CONCLUSION

In the light of the present research, it can be concluded that selection for genotypes having high yield potential may be based on days to flowering and cobs $plant^{-1}$. Both of these characters are easily measurable and could be used directly to increase yield.

REFERENCES

Abayi IK, Ojo AA, Kalu BA, Adeyemo MO (2004). Genetic variability, heritability and genetic variance in S1 progenies of extra-early and early maize (*Zea mays* L.) population. J. Sustainable Agric. and the Environ. 6:179-184.

Ahmad N, Mehdi SS (2001). Genetic comparison of S1 families for various grain yield and quality traits in a popcorn population. Pak. J. Sci. 53(1-2): 23-25.

Arshad M, Bakhsah A, Abdul Ghafoor (2004). Path coefficientanalysis in chickpea (Cicer arietinum L.) under rainfed conditions. Pak. J. Bot. 36(1): 75-81.

Arshad M, Naazar Ali, Abdul Ghafoor (2006). Character correlation and path coefficient in soybean (Glycine max (L.) Merrill). Pak. J. Bot. 38(1): 121-130.

Aycicek M, Telat Yildirim (2006). Path coefficient analysis of yield and yield components in bread wheat (Triticum aestivum L.) genotypes. Pak. J. Bot. 38(2): 417-424.

Aziz A, Saleem M, Rahman H, Mohammad F (1992). Genetic variability for yield and disease resistance in full and short season varieties of

maize. Sarhad J. Agric. 8(2): 195-198.
Brakke JP, Francis CA, Nelson LA, Garnder CO (1983). Genotype × cropping system interactions in maize. Crop Sci. 23(5): 868-870.
El-Hosary AA, Sattar AA (1997). Components of genetic variance in synthetic variety of maize “Moshtohor 2” with reference to expected gain from selection. Annals of Agri. Sci. Moshtohor. 35:1,171-180.
El-Nagouli OO, Fadi MA, Ismail AA, Khamis M (1983). Genotypic and phenotypic correlation and path analysis in maize and their implications in selection. Agron. Am. Soc. Agron. P. 62-63.
Ihsan H, Khalil IH, Rehman H, Iqbal M (2005). Genotypic variability for morphological and reproductive traits among exotic maize hybrids. Sarhad. J. Agric. 21(4):599-602.
Ilarslan R, Kaya Z, Kandemir I, Bretting PK (2002). Genetic variability among Turkish populations, Flint and dent corn (*Zea mays* spp Mays) races; morphological and agronomic traits. Euphytica, 128: 173-182
Juma K, Shafiullah, Baithullah (1999). Correlation and path-coefficient analysis in diallel crosses for yield components of maize (Zea mays L.). Pak. J. Biol. Sci. 2(4): 1419-1422.
Khan MA, Akbar S, Ahmad K, baloch MS (1999). Evaluation of corn hybrids for grain yield. Pak. J. Biol. Sci. 2(2): 413-414.
Mehdi SS, Nadeem A, Ahsan M (2001). Evaluation of S1 maize (Zea mays L.) families at seedling stage under drought conditions. J. Biol. Sci. 1: 4-6.
Nazir H, Hayat K, Khan FU, Aziz A, Zaman QU (2003). Evaluation of different maize varieties under agro ecological conditions of D.I. Khan. Sarhad J. Agric. 19(4), 539-542.
Rahman MM, Ali MR, Sultan MS, Mitra MK (1995). Correlation and path coefficient studies in maize (Zea mays L.) composites. Bangladesh J. Sci. and Ind. Res. 30 (1):87-92.
Salami AE, Adegoke SAO, Adegbite OA (2007). Genetic variability among maize cultivars grown in Ekiti-State, Nigeria Middle-East. J. Sci. Res. 2(1): 09-13.
Saleh GB, Alawi SAS, Panjaitan K (2002). Performance, correlation and hereability studies on selected sweet corn synthetic populations. Pak. J. Biol. Sci. 5(3): 251-254.
SAS Institute Inc., (1999). SAS/STAT user’s guide version 8. SAS Institute Inc. Cary, NC.
Sener O, Gozubenli H, Kunuskan O, Kilinc M (2004). The effect of entra-row spacing on the grain yield and some agronomic characters of maize (Zea mays L.) hybrids. Asian J. Plant Sci. (4): 429-432.
Shull GH (1908). The composition of a field of maize. Am. Breeders Assoc. Rep. 4: 296-301. MINFAL. 2009. Govt of Pakistan. Ministry of Food Agriculture and Livestock. Economics Wing, Islamabad.
Stojsin D, Kannenberg LW (1994). Genetic changes associated with different methods of recurrent selection in five maize populations.II. Indirectly selected traits. Crop Sci. 1466-72.
Tabanao DA, Bernardo R (2005). Genetic variation in maize breeding population with different numbers of parents. Crop Sci., 45: 2301-2306.
Troyer F (1990). Selection for early flowering in corn three adapted synthetics. Crop Sci. 30:896-900.
Turi NA, Shah SS, Ali S, Rahman H, Ali T, Sajjad M (2007). Genetic variability for yield parameters in maize (Zea mays .L) Genotypes. J. Agric. Biol. Sci. 2(4): 1-3.
Viola G, Ganesh M, Reddy SS, Kumar CVS (2003). Study on heritability and genetic advances in elite baby corn (Zea mays) lines. Progr. Agric. 3(2): 127-128.