# GENETIC VARIABILITY OF YIELD AND ITS CONTRIBUTING CHARACTERS ON CIMMYT MAIZE INBREDS UNDER DROUGHT STRESS

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## Abstract

This experiment was conducted in a randomized block design with three replications at Bangladesh Agricultural Research Institute, Gazipur-1701 during the rabi season of 2010 with 25 maize inbred lines. Correlation and path coefficient analysis were done for yield and some other traits. Genotypic variations were observed for ear height and grains/row. The highest broad sense heritability ($h^2_b$) was observed for yield/plant followed by ear height and 1000-grain weight. Maximum genetic advance in percentage of mean (GA) was recorded for yield/plant (92.652) and ear height (75.87). The yield/plant showed significant positive genotypic correlation ($r_g$) with cob diameter (0.440) and grains/row (0.265). Significant negative correlation was observed between ear height and yield and also for days to 50% tasseling. The highest direct positive effect was obtained for rows/cob. These studies suggest that cob diameter, row per cob, grains/row and ear height were the most important yield contributing factors and an attempt should, therefore, be made for an effective selection of these traits.

Keywords: Maize (*Zea mays* L.), variability, correlation, path analysis, Bangladesh.

## Introduction

Maize (*Zea mays* L.) is the third leading important cereal crop after rice and wheat. Hybrid varieties of maize have been commercially exploited in different cereal loading countries of the world because it has a greater genetic potentiality compared to synthetic and composite varieties. The area and production of maize is increasing day by day in Bangladesh and it continues to expand rapidly at an average rate of 20% per year (BBS 2008).

Hybrid varieties are also becoming popular among the maize growers in Bangladesh. At present, some NGOs and seed companies have imported hybrid maize seed and distributed to the maize growing farmers.

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Bangladesh faces a serious problem of water shortage for crop production. The water resources are becoming limiting and it has been estimated that water for irrigation purposes may be reduced. Abiotic stresses limit maize productivity (Bahl *et al.,* 1977 and Mohammadia *et al.,* 2003). Among various abiotic stresses, drought is undoubtedly one of the most terrible natural enemy in plant lifecycle. Western part of Bangladesh is drought prone and called Barendra area.

But an understanding of genetic basis of drought tolerance in crop plants based on various morpho-physiological traits is also a pre-requisite for a geneticist to evolve superior genotype through either conventional breeding methodology or genetic engineering (Falconer, 1989 and Singh, 1978). It is, therefore, effective maize breeding programme would be launched to evolve high yielding and well adapted hybrids/varieties for water deficit conditions. Inbred lines are prerequisite in the production of commercial hybrid varieties of maize. So, a study of genetic variability in inbred lines is essential before designing an efficient hybridization programme aiming to develop high yielding hybrid varieties. Seed or grain yield is a complex character, which is affected by a large number of yield contributing characters. For this reason, careful selection of desirable individual may lead to discover lines with higher yield than the original variety. Coefficient measures the degree and strength of relationship between the yield and other yield contributing characters which is helpful for selection of desirable characters under a breeding programme (Falconer, 1989). The measurement correlation of coefficient between the characters is matter of considerable importance in selection practices which help in the construction of selection indicates and also permit the prediction of correlated response (Lerner, 1985). Many workers have reported wide area of work about correlation coefficient (Sandhu *et al*., 1972; Bahl *et al*., 1977; Khoskhoi and Niknesad, 1972; Islam *et al*., 1984; Shahi *et al.,* 1984).

The estimates of path coefficient analysis are important for better understanding of the crop. It gives specific measures of direct and indirect effect of each component character under seed yield (Singh and Singh, 1974). Therefore, present study was undertaken to find out selection for identifying parents for hybridization programme in order to develop hybrid varieties through the study of heritability, genetic variability and relationship between yield and yield components traits in maize inbred lines.

## Materials and Method

The experiment consisting of 25 inbred maize genotypes received from CIMMYT, India. The experiment was conducted at Bangladesh Agricultural Research Institute (BARI), Gazipur during rabi 2010-2011. The inbred lines were grown in a randomized complete block design with three replications. The

seeds of each inbred lines were sown in a single row of 5 m long plot. Spacing adopted was 75cm $\times$ 20cm between rows and hills, respectively. One healthy seedling/hill was kept after proper thinning. Fertilizers were applied @ 120, 80, 80, 20, 5, and 1 kg/ha of N, $P_2O_5$, $K_2O$, S, Zn, and B, respectively. Standard agronomic practices were followed (Quayyum, 1993) and plant protection measures were taken when required. No irrigation was given during experimental period. Data on days to 50% tasseling and silking were recorded on whole plot basis. Ten randomly selected plants were used for recording ten characters viz., days to 50% silking (DS), days to 50% tasseling (DT), plant height (PH), ear height (EH), cob length (CL), cob diameter (CD), rows/cob (R/C), grains/row (G/R), 1000-grain weight (GW), and grain yield/plant (Y/P). Genotypic and phenotypic coefficients of variation were estimated as per Singh and Chaudhary (1979). The broad sense heritability and genetic advance in percentage of mean were calculated as suggested by Jonson *et al.* (1955). Genotypic and phenotypic correlation coefficients were calculated according Miller *et al.* (1958). Path coefficient analysis was estimated according to method suggested by Dewey and Lu (1959).

**Results and Discussion**

The estimates of $\sigma^2g$, $\sigma^2p$, genotypic (GCV) and phenotypic coefficient of variation (PCV), $h^2_b$, CV and genetic advance in percentage of mean (GA) for different characters have been presented in Table 1. The highest $\sigma^2g$ and $\sigma^2p$ were found for yield/plant (639.28 and 639.65) and 1000-grain weight (217.27 and 217.74). This is in line with the previous results of Mutisya (1987). Lowest amount of $\sigma^2g$ and $\sigma^2p$ was observed in cob diameter (1.043 and 1.703).

The GCV and PCV were the highest for yield/plant followed by ear height and grains/row. High GCV for grain yield and 1000-grain weight were also observed in maize (Malhotra and Khehra, 1986). High GCV and PCV for grain yield/plant, ear height and grains/row indicated that selection of these traits would be effective. Days to 50% silking and days to 50% tasseling had moderate $h^2_b$ but low GCV; therefore, there is a limited scope of selection. Park *et al.* (1990) in an earlier study with maize reported similar results.

The heritability ($h^2_b$) ranged from 61.250 to 99.942. High heritability was observed for grain yield/plant (99.942) followed by 1000-grain weight (99.784) and ear height (98.796) which suggested that selection for improvement of these characters would be effective through phenotypic selection. High heritability estimates is indicating to preponderance of additive gene action. In the present study, high GA with high $h^2_b$ was observed for yield/plant, ear height, grains/row Higher genetic advance for grain yield/plant, ear height, plant height, and grains/row depicts additive gene effects.

In addition, the lowest CV was determined for 1000-grain weight as 0.83%, the highest CV was determined for the rows/cob (7.48%). Similar results were obtained by previous researches of Burhan (2007).

**Table 1. Estimation of genetic parameters of variation for ten characters of the 25 maize genotypes.**

| Characters | Grand mean | $\sigma^2 g$ | $\sigma^2 p$ | GCV (%) | PCV (%) | $h^2_b$ (%) | GA | CV% |
|---|---|---|---|---|---|---|---|---|
| DT | 94.48 | 18.544 | 21.691 | 4.558 | 4.929 | 85.493 | 8.682 | 1.88 |
| DS | 97.39 | 21.630 | 25.203 | 4.776 | 5.155 | 85.822 | 9.114 | 1.94 |
| EH | 30.63 | 128.774 | 130.344 | 37.054 | 37.279 | 98.796 | 75.870 | 4.09 |
| PH | 91.90 | 363.457 | 370.211 | 20.745 | 20.937 | 98.176 | 42.343 | 2.83 |
| CL | 10.10 | 5.512 | 5.883 | 23.241 | 24.012 | 93.686 | 46.340 | 6.03 |
| CD | 11.28 | 1.043 | 1.703 | 9.056 | 11.572 | 61.250 | 14.601 | 7.20 |
| R/C | 11.60 | 2.304 | 3.058 | 13.087 | 15.075 | 75.363 | 23.403 | 7.48 |
| G/R | 16.46 | 18.004 | 19.115 | 25.782 | 26.566 | 94.187 | 51.545 | 6.40 |
| GW | 261.99 | 217.661 | 217.359 | 17.792 | 17.811 | 99.784 | 36.611 | 0.83 |
| Y/P | 177.72 | 639.897 | 639.586 | 44.990 | 45.003 | 99.942 | 92.652 | 1.08 |

**Legend:** Days to 50% silking =DS, Days to 50% tasseling = DT, Plant height=PH, Ear height =EH, Cob length =CL, Cob diameter =CD, rows/cob =R/C, grains/row = G/R, 1000-grain weight = GW and Grain yield/plant = Y/P

The $r_g$ and $r_p$ between all possible combinations of ten characters are presented in Table 2. In general, it was observed that $r_G$ were higher in magnitude than $r_p$ and in the same direction. Grain yield/plant showed genetically significant positive correlation with cob diameter (0.440), grains/row (0.265), and negatively significant correlation with plant height (0.175) and days to 50% tasseling (-0.115). Rest of characters should positively and negatively non-significant corelation with grain yield. Similar associations were also reported by Parh *et al.* (1986) and Khanday and Thakur (1990) and Singh *et al.* (1995).

Among the pair of characters, the days to 50% tasseling was the significantly positive correlated with days to 50% silking (0.992), cob length (0.487), grains/row (0.477) but negatively and significantly correlated with 1000-grain weight (-0.500) and yield/plant (-0.115). Debnath (1987), however, observed positive correlation of ear length with ear diameter and number of kernels/row. Days to 50% silking was significantly and positively correlated with cob length (0.992), cob length (0.482), grains/row (0.447) but negatively and significantly correlated with 1000-grain weight (-0.461). Ear height showed no significant

correlation with other characters except plant height (0.751). Plant height was positively significant with cob length (0.0.427) and 1000-grain weight (0.176) but negatively and significantly correlated with rows/cob (0.509), grain yield/plant (-0.175). Cob length was positively significant only in the character grains/row (0.743) but negatively and significantly correlated with rows/cob (0.509) and grain yield/plant (-0.175). Cob diameter was significantly positive correlated with rows/cob (0.817), grain yield/plant (0.440) but no negative correlation between the characters. Rows/cob were positively significant with grains/row (0.449) but negatively and significantly correlated with 1000-grain weight (0.433). Grains/row were the significantly and positively correlated with grain yield/plant (0.265) but negatively and significantly correlated with 1000-grain weight (0.487).

From the above discussion, we can show that cob diameter has the maximum contribution for increasing yield followed by grains/row. The learning propose of the experiment that selection on the basis of cob diameter and grains/row may bring out desired improvement towards the grain yield.

**Table 2. Genotypic ($r_g$) and Phenotypic ($r_p$) correlations among grain yield and yield different contributing characters in maize genotypes.**

| Characters | | DS | PH | EH | CL | CD | R/C | G/R | GW | Y/P |
|---|---|---|---|---|---|---|---|---|---|---|
| DT | $r_g$ | 1.034 | -0.080 | -0.029 | 0.487* | 0.045 | 0.326 | 0.477* | -0.500* | -0.115* |
| | $r_p$ | 0.923** | -0.075 | -0.013 | 0.446* | 0.055 | 0.283 | 0.439* | -0.464* | -0.105* |
| DS | $r_g$ | | -0.059 | -0.015 | 0.482* | 0.029 | 0.314 | 0.447* | -0.461* | -0.139 |
| | $r_p$ | | -0.054 | -0.008 | 0.436* | 0.005 | 0.213 | 0.393 | -0.428* | -0.129 |
| EH | $r_g$ | | | 0.751** | 0.356 | 0.114 | -0.313 | 0.209 | 0.165 | -0.113 |
| | $r_p$ | | | 0.744** | 0.345 | 0.103 | -0.273 | 0.204 | 0.164 | -0.112 |
| PH | $r_g$ | | | | 0.427* | -0150 | -0.509** | 0.173 | 0.176* | -0.175* |
| | $r_p$ | | | | 0.414* | -0.111 | -0.428* | 0.171 | 0.173 | -0.173 |
| CL | $r_g$ | | | | | 0.140 | 0.197 | 0.743** | -0.215 | -0.071 |
| | $r_p$ | | | | | 0.102 | 0.147 | 0.710** | -0.206 | -0.069 |
| CD | $r_g$ | | | | | | 0.817** | 0.327 | -0.109 | 0.440* |
| | $r_p$ | | | | | | 0.509** | 0.266 | -0.012 | 0.346* |
| R/C | $r_g$ | | | | | | | 0.449* | -0.433* | 0.309 |
| | $r_p$ | | | | | | | 0.374 | -0.377 | 0.272 |
| G/R | $r_g$ | | | | | | | | -0.487* | 0.265* |
| | $r_p$ | | | | | | | | -0.469* | 0.256* |
| GW | $r_g$ | | | | | | | | | -0.039 |
| | $r_p$ | | | | | | | | | -0.039 |

*: significant at 0.05 level, **: significant at 0.01 level

The path coefficient analysis (Table 3) revealed that most of the traits had positive direct effect on grain yield. The highest direct effect on grain yield was exhibited by rows/cob followed by days to 50% silking and plant height. Ear diameter had highest indirect effect on grain yield through grain rows followed by days to 50% tassel through rows/cob and days to 50% silking through rows/cob. Similar results in maize have earlier been reported by El-Shouny *et al.,* (2005), Mohammadia *et al.,* (2003) and Rafiq *et al.,*(2010).

**Table 3. Path coefficient analysis of genotypic correlation showing direct (bold) and indirect effects of yield contributing characters towards yield in maize genotypes.**

| Characters | DT | DS | EH | PH | CL | CD | R/C | G/R | G/W | Correlation With grain yield |
|---|---|---|---|---|---|---|---|---|---|---|
| DT | **-0.431** | 7.139 | -0.428 | -0.194 | -3.953 | -0.879 | 8.193 | 1.125 | -3.746 | -0.1149* |
| DS | -8.391 | **0.541** | -0.315 | -0.101 | -3.907 | -0.560 | 7.899 | 1.055 | -3.454 | -0.139 |
| EH | 0.652 | -0.409 | **0.483** | 5.028 | -2.892 | -2.216 | -7.876 | 0.493 | 1.240 | -0.113 |
| PH | 0.235 | -0.104 | 3.998 | **0.534** | -3.468 | 2.910 | -12.820 | 0.409 | 1.318 | -0.175* |
| CL | -3.953 | 3.324 | 1.898 | 2.862 | **-0.422** | -2.705 | 4.951 | 1.753 | -1.609 | -0.071 |
| CD | -0.368 | 0.200 | 0.610 | -1.007 | -1.134 | **-0.843** | 20.572 | 0.772 | -0.064 | 0.440* |
| R/C | -2.641 | 2.167 | -1.666 | -3.411 | -1.596 | -15.820 | **-0.862** | 1.059 | -3.248 | 0.309 |
| G/R | -3.869 | 3.085 | 1.113 | 1.161 | -6.026 | -6.332 | 11.293 | **0.231** | -3.650 | 0.265* |
| GW | 4.053 | -3.179 | 0.881 | 1.177 | 1.741 | 0.165 | -10.901 | -1.148 | **0.693** | -0.039 |

*: significant at 0.05 level, **: significant at 0.01 level

**Residual effect, R**=0.392

**Legend:** Days to 50% silking =DS, Days to 50% tasseling = DT, Plant height=PH, Ear height =EH, Cob length =CL, Cob diameter =CD, rows/cob =R/C, grains/row = G/R, 1000-grain weight = GW and Grain yield/plant = Y/P

Correlation and path coefficient analysis showed that cob diameter and grains/row were the important yield components in maize. Grains/row and ear height also showed high GCV, heritability coupled with high genetic advance. Therefore, the result revealed that grains/row and ear height were important yield contributing traits for hybridization programme based on these traits.

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