

Original Research Article

Selection of tropical inbred lines for yield and morpho-agronomical traits in Maize (*Zea mays*.L)

Abstract:

The present study was carried out at MRC, Rajendranagar which is aimed to find correlation, cause and cause effect relationship for the morpho-agronomical traits among 52 maize inbred lines, traits such as Number of leaves above the ear, Number of leaves below the ear, Tassel branch number, Tassel main axis length (cm), Plant height (cm), Ear height (cm), Leaf angle, Leaf length, Leaf width, Total number of leaves per plant which influences the leaf and stem architecture of maize were phenotypically analyzed. Results suggested that traits like plant height, total number of leaves, leaf length, leaf width, No. of Kernels per row, No. of rows per cob and shelling percent were important for selection of genotypes as these traits recorded moderate to high range of GCV, PCV, heritability, genetic advance over mean and exhibited positive significant correlations along with direct effects on yield/cob for some of the mentioned traits.

Introduction:

Maize with its widespread cultivation across millions of hectares worldwide, it stands out as a staple food source and a key component of various industries. Thus, due to its versatile applications in food, feed and industrial raw material, maize has attained status of industrial crop (Shiferaw *et al.*, 2011). In India it is cultivated in 9.95 million hectares area with 33.72 million tones of production and 3.38 tonnes of productivity (www.indiastat.com). In Telangana state, the area under maize cultivation is 1.83 lakh hectares with production of 28.8 lakh per hectare (www.agri.telangana.gov.in). To meet the food demand, crop productivity must be doubled by 2050 with the enhanced rate of 2.4% per year (Ray *et al.* 2012). For the development of productive and adapted cultivars to supply the market demand it is important to understand the morphological, physiological, phenological, and allometric characteristics that contribute to better adaptation of maize to high plant densities (SANGOI *et al.* 2002). Breeding for tolerance to

high plant density (HPD) stress resulted in remarkable increase in grain yield per unit area in temperate maize. In spite of improved germplasm and reasonable adoption of hybrid technology, average maize productivity in tropics is still much below the achievable potential. So, the current study carried out to identify ideal plant architecture in tropical maize inbreds, inheriting distinguished agro-morphological yield attributing traits to enhance the potential of development of hybrids for high density planting.

The study of variability and genetic advance in the germplasm will help to ascertain the real potential of the genotype as suggested by Niji *et al* (2018). Whereas genetic advance shows the degree of gain obtained for the characters under a particular selection pressure. Accordingly, a study of genetic parameters like genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as per cent of mean provides a clear cut idea about the extent of variability present in a plant population and a relative measure of efficiency of selection of genotypes based on phenotype in a highly variable population (Bocanski *et al* 2009). The estimates of genetic parameters like heritability and genetic advance helps in predicting the gain under selection.

As yield is a dependent character and it is based on number of quantitative characters, it is important to study the association between pairs of these attributes for faster assessment of high yielding genotypes in selection programme. Correlation studies reflect the extent of association between two characters and helps in determining the yield contributing characters. Correlation coefficients generally show relationships among independent variables and the degree of linear relation between these characteristics, but it does not sufficiently predict the success of selection. However, path-coefficient analysis that is originally developed by Wright (1929) is the most valuable tool to establish the exact correlation in terms of cause and effect. It allows one to identify the direct, indirect and total (direct + indirect) causal effect, as well as to remove any spurious effect that may be present (Hefny, 2011).

Therefore, the present study was conducted to determine the genetic variability, heritability, genetic advance and the magnitude of the relations between yield and its contributing characters to improve the efficiency of selection in further crossing programme.

Materials and methods:

The field experiment was conducted at Maize Research Centre, Agricultural Research Institute, Rajendranagar, during *khari*f2023 in Randomized Block Design. Fifty two genotypes were sown by adopting 60 cm X 20 cm spacing and the plot size was 4 meters in length with 2 rows and two replications. Recommended agronomic package of practices were followed to raise a healthy crop. Data was recorded on five randomly selected plants for 17 characters viz., days to 50% tasseling, days to 50% silking, number of leaves above the ear, number of leaves below the ear, tassel branch number, tassel main axis length (cm), plant height(cm), ear height(cm), leaf angle of the leaf near the ear, leaf length of the leaf near the ear(cm), leaf width of the leaf near the ear(cm), total number of leaves per plant, number of rows per cob, number of kernels per row, 100 kernel weight(g), shelling percentage(%), Grain yield per plant(g). Readings from five plants were averaged replication wise and the mean value was used for statistical analysis.

Table1. List of inbred lines used in study

| S.No | Inbreds | S.No | Inbreds | S.No | Inbreds |
|-------------|----------------|-------------|----------------|-------------|----------------|
| 1 | MGC 90 | 19 | MGW 360 | 37 | PFSR 51 |
| 2 | PFSR 1 | 20 | MGC 331 | 38 | MGC 137 |
| 3 | PFSR 32 | 21 | GP 27 | 39 | PFSR 90 |
| 4 | P852 | 22 | BML 6 | 40 | PFSR 104 |
| 5 | MGW 316 | 23 | GP 311 | 41 | MGC 161 |
| 6 | PFSR 137 | 24 | PFSR 92 | 42 | GP 86 |
| 7 | MGC 89 | 25 | D1 | 43 | PFSR 3 |
| 8 | GP 35 | 26 | MGW 334 | 44 | MGC 6 |
| 9 | GP 82 | 27 | GP 125 | 45 | 3070 |
| 10 | BML 14 | 28 | PFSR 49 | 46 | MGC 61 |
| 11 | PFSR 129 | 29 | 7 11 | 47 | MGC 157 |
| 12 | GP 94 | 30 | GP 2 | 48 | CML 286 |
| 13 | GP 88 | 31 | MGW 270 | 49 | PFSR 95 |
| 14 | PFSR 132 | 32 | 3122 | 50 | GP 170 |
| 15 | MGW 325 | 33 | GP 83 | 51 | BML 45 |
| 16 | MGW 419 | 34 | PFSR 130 | 52 | CML 451 |
| 17 | BML 11 | 35 | BML 7 | | |
| 18 | PFSR 29 | 36 | BML 20 | | |

Statistical analysis

The data collected was subjected to statistical analysis using INDOSTAT software version 9.2 and the methods adopted by the software for the analysis of variance (ANOVA) was as described by Panse and Sukhatme (1985), mean, standard error and range were calculated as per Singh and Chaudhary

(1985). Phenotypic and genotypic coefficients of variation (PCV and GCV) were as per Burton (1952) and were categorized as low (0-10%), moderate (10-20%) and high (>30%) as indicated by Sivasubramanian and Madhavamenon (1973). Heritability in broad sense was estimated as the ratio of genotypic variance to the phenotypic variance as suggested by Hanson *et al.* (1956) and it was categorized as low (0-30%), moderate (30- 60%) and high (>60%) as indicated by Johnson *et al.* (1955). Genetic advance (GA) and genetic advance as percent of the mean (GAM) were calculated by using the formulae given by Johnson *et al.* (1955). The Genetic advance as percent of the mean was categorized as low (0-10%), moderate (10- 20%) and high (>20%) according to Johnson *et al.* (1955). Correlation coefficients were calculated by using the formulae given by Johnson *et al.* (1955). The direct and indirect effects for genotypes were estimated by using path coefficient analysis suggested by Wright (1921) and Dewey and Lu (1959).

Results and Discussion

Genetic variability:

The ANOVA revealed significant difference among genotypes for all the traits (Table 2) indicating the presence of considerable significant variation among the genotypes selected, which is prerequisite for the breeder to take up any breeding programme.

Table.2 Analysis of variance for yield and yield attributing traits in 52 maize inbred lines

| Source of variation | Mean sum of squares | | |
|-----------------------------|---------------------|-----------|--------|
| | Replications | Genotypes | Error |
| d.f | 1 | 51 | 51 |
| Days to 50% tasseling | 0.0878 | 68.527** | 4.871 |
| Days to 50% silking | 2.462 | 68.522** | 4.422 |
| Plant Height(cm) | 15.346 | 804.645** | 31.712 |
| Ear Height(cm) | 0.055 | 385.423** | 16.561 |
| Leaf Angle | 5.087 | 201.634** | 1.283 |
| No.of Leaves above ear | 0.025 | 1.154** | 0.061 |
| No.of Leaves below ear | 0.092 | 2.538** | 0.173 |
| Total Number of Leaves | 0.022 | 3.992** | 0.326 |
| Leaf Length(cm) | 32.906 | 98.378** | 11.761 |
| Leaf Width(cm) | 0.493 | 1.578** | 0.192 |
| Tassel Branch Number | 0.097 | 18.504** | 0.603 |
| Tassel Main Axis Length(cm) | 8.962 | 20.801** | 2.515 |
| No.of Kernels Per Row | 5.166 | 57.215** | 2.179 |
| No.of Rows Per Cob | 0.654 | 54.087** | 1.736 |
| Test Weight | 3.846 | 80.389** | 3.14 |
| Shelling% | 6.793 | 87.118** | 10.381 |
| Yield/Cob | 0.501 | 350.016** | 20.134 |

In the present study, wide variability can be assessed for all the traits among the inbred lines (Table 3). Inbred line MGW 316 recorded shortest plant height (84 cm) and GP 83 recorded highest (161 cm) with a mean of 121.18 cm indicating high range of genetic variability. Lower ear placement is very important in maize and inbred line BML 20 was recorded with lowest ear height (22.0 cm) and BML 6 recorded the highest ear height (82 cm) with a mean of 50.408 cm. For days to 50 % silking GP 83 registered as late (78 days) and D1 recorded as early (49 days) with a mean 62.385. For Days to 50% tasseling GP 83 recorded as late (76 days) and D1 recorded as early (47 days) with a mean 60.125 cm. The erect leaf is an ideal architecture to the plants for the adequate spatial distribution and can increase the interception of solar radiation and its use efficiency, inbred line GP 88 was observed with low leaf angle (25°) and highest in D1 (70°) with a mean 40.89° . For the observation number of leaves below the ear inbred 3070 (3) recorded lowest and highest in GP 83 (7.8) with a mean (5.18). In inbred line MGC 6 highest leaves number above the ear noted around (3.2) and lowest for MGC 331 with a mean 5.4. Total number of leaves are recorded high in PFSR 137 (13.80) and lowest for MGC 6 (7.4) with a mean of 10.609. Leaf length was recorded highest in PFSR 51 (66.6 cm) and lowest for MGW 319 (30 cm) with a mean (51.99 cm). Leaf width was recorded highest in CML 286 (9.2 cm) and lowest for MGW 360 (4.8 cm) with a mean (6.74 cm). Tassel branch number noted high in PFSR 32 (14.7) and low for BML 11 (2.26) with a mean 7.668. Tassel main axis length recorded lowest in 3070 (12.5 cm) and highest in MGC 89 (28.6 cm) with a mean (20.88).

The range of genetic variability for the trait number of rows per cob varied from 5.7 (MGW 270) to 26.0 (BML 7) with a mean of 14.03. The range of variation for number of kernels per row was 41.0 (MGW 325) to 6.3 (GP 94) with a mean of 15.967. The highest test weight was recorded in GP 27 (38g) and lowest weight in MGW 419 (8g) with a mean 21.538g. Highest shelling% was recorded in MGC 6 (84.35%) and lowest in MGC 157 (59%) with a mean 70.72%. Wide range of variability noticed for the trait yield per cob with range of 30.98g (MGW 360) to 92.76 g (MGC 61) with a mean of 71.406g.

Phenotypic Coefficient of Variation (PCV) recorded slightly higher than Genotypic Coefficient of Variation (GCV) for all the traits, indicating the less influence of environment in expression of the traits (Table 3). Therefore, selection on the basis of phenotype alone can be effective for the selection of genotypes and improvement of these traits. Medium range of PCV and GCV were observed in the traits Plant height (16.875, 16.22), No. of leaves above the ear (14.376, 13.63), Total number of leaves (13.851, 12.762), Leaf length (14.272, 12.657), Leaf width (13.958, 12.352), Tassel main axis length (16.352, 14.481) and Yield/cob (19.052, 17.986). In traits Days to 50% tasseling (10.076, 9.383), Days to 50% silking (9.681, 9.075) and shelling% (9.873, 8.759) the estimates of PCV and GCV were recorded lowest. The difference between PCV and GCV estimates were found to be more for the traits Ear height, Leaf

length, No. of kernels per row, Yield/cob indicating that for these traits the phenotypic selection may be misleading.

Traits like Ear height, No. of leaves below the ear, Tassel branch number, Tassel main axis length, No. of kernels per row, No. of rows per cob and Test weight had high values of coefficient of variation indicates that the chances of getting substantial gains under selection are likely to be less for these characters.

The genetic components of variation together with heritability estimates would give the better picture of amount of genetic advance to be expected from the selection (Burton, 1952). All the traits were registered with high estimates of broad sense heritability. However, selection for improvement of such characters may not be useful, because broad sense heritability is based on total genetic variance which includes additive, dominant and epistatic variances. Thus, heritability estimates coupled with high genetic advance (at 5%) would be more reliable and useful on correlating selection criteria (Reddy et al., 2012). The traits Plant height, Ear height, leaf angle and Yield/cob exhibited high estimates of genetic advance. High heritability and moderate genetic advance for Days to 50% tasseling, Days to 50% silking, Leaf length, No. of kernels per row, No. of rows per cob, Test weight and Shelling percent indicating the role of additive gene effects, the moderate genetic advance may be due to environmental effects and selection would be rewarding for this trait. High heritability accompanied with high genetic advance as percent of mean were recorded for Plant height, Ear height, Leaf angle, Tassel branch number, Tassel main axis length, No. of kernels per row, No. of rows per cob and Test weight, indicating that the heritability is due to additive gene effects. High heritability with low genetic advance (at 5%) was recorded for No. of leaves above the ear, No. of leaves below the ear, Total number of leaves, Leaf width, Tassel branch number and Tassel main axis length indicates that heritability may be due to the non-additive type of gene action influenced by environmental effects and selection may not be rewarding for this trait and there is a need for creation of variability either by hybridization or mutation followed by selection.

Pic.1 Inbreds showing wide and narrow leaf angles



Pic.2 Inbreds showing dense and sparse tassel



Table.3 Genetic parameters for yield and yield attributing traits in inbred lines

| Character | Mean | Range | | CV% | PCV% | GCV% | Heritability (%) in broad sense | GA 5% | GAM (%) 5% |
|------------------------------|---------|--------|--------|--------|--------|--------|---------------------------------|--------|------------|
| | | Min | Max | | | | | | |
| Days to 50% tasseling | 60.125 | 47.00 | 76.00 | 3.671 | 10.076 | 9.383 | 86.7 | 10.823 | 18.001 |
| Days to 50% silking | 62.385 | 49.00 | 78.00 | 3.371 | 9.681 | 9.075 | 87.9 | 10.932 | 17.524 |
| Plant Height (cm) | 121.182 | 84.00 | 161.00 | 4.647 | 16.875 | 16.222 | 92.4 | 38.931 | 32.126 |
| Ear Height (cm) | 50.408 | 22.00 | 82.10 | 8.073 | 28.125 | 26.941 | 91.8 | 26.799 | 53.164 |
| Leaf Angle | 40.894 | 25.00 | 70.00 | 2.769 | 24.631 | 24.475 | 98.7 | 20.487 | 50.098 |
| No.of Leaves above ear | 5.423 | 3.20 | 6.80 | 4.572 | 14.376 | 13.63 | 89.9 | 1.444 | 26.620 |
| No.of Leaves below ear | 5.186 | 3.00 | 7.80 | 8.012 | 22.45 | 20.972 | 87.3 | 2.093 | 40.357 |
| Total Number of Leaves | 10.609 | 7.40 | 13.80 | 5.383 | 13.851 | 12.762 | 84.9 | 2.57 | 24.224 |
| Leaf Length (cm) | 51.995 | 30.00 | 66.60 | 6.596 | 14.272 | 12.657 | 78.6 | 12.022 | 23.122 |
| Leaf Width (cm) | 6.74 | 4.80 | 9.20 | 6.502 | 13.958 | 12.352 | 78.3 | 1.518 | 22.515 |
| Tassel Branch Number | 7.668 | 2.26 | 14.70 | 10.123 | 40.311 | 39.019 | 93.7 | 5.966 | 77.803 |
| Tassel Main Axis Length (cm) | 20.881 | 12.50 | 28.60 | 7.594 | 16.352 | 14.481 | 78.4 | 5.516 | 26.419 |
| No.of Kernels Per Row | 15.967 | 6.30 | 41.00 | 9.245 | 34.129 | 32.853 | 92.7 | 10.402 | 65.147 |
| No.of Rows Per Cob | 14.033 | 5.70 | 26.00 | 9.388 | 37.657 | 36.458 | 93.8 | 10.206 | 72.73 |
| Test Weight | 21.538 | 8.00 | 38.00 | 8.228 | 30.005 | 28.855 | 92.5 | 12.312 | 57.162 |
| Shelling% | 70.721 | 59.09 | 84.35 | 4.556 | 9.873 | 8.759 | 78.7 | 11.32 | 16.007 |
| Yield/Cob | 71.406 | 30.988 | 92.76 | 6.284 | 19.052 | 17.986 | 89.1 | 24.976 | 34.978 |

Correlation:

No. of Kernels per row, No.of rows per cob and shelling percent were observed to exhibit significant positive correlations with Yield/Cob at phenotypic and genotypic level (Table 4). Whereas, Days to 50% tasseling, Days to 50% silking, Plant height, Ear height, No.of leaves below the ear, Total no. of leaves, Leaf length, Leaf width, Tassel branch number showed non-significant positive correlation with Yield/cob at both levels. Leaf angle, No.of leaves above the ear, Tassel main axis length recorded non-significant negative correlation at both phenotypic and genotypic levels with Yield/Cob. Test weight showed significant positive correlation for phenotype and non-significant positive correlation at genotypic

level with Yield/cob. Inter correlations among yield components revealed that days to 50% silking recorded significant positive correlation with days to 50% tasseling. Similarly, ear height with plant height, leaf angle is significant negatively correlated with days to 50% tasseling and days to 50% silking. No. of leaves above ear is significant positively correlated with plant height and ear height. No. of leaves below the ear is significant-positively correlated with plant height and ear height. Total number of leaves is significant positively correlated with plant height, ear height, No. of leaves above the ear and No. of leaves below the ear. Leaf length is significant-positively correlated with days to 50% tasseling, days to 50% silking, plant height, ear height, Leaves below the ear, total no. of leaves and significant-negatively correlated with leaf angle. Leaf width is positive-significantly correlated with leaves above the ear. Tassel branch number is positive-significantly correlated with tassel branch number. Tassel main axis length is significant-positively correlated with no. of leaves below the ear, leaf length and significant negatively correlated with leaf width. Kernels per row is negatively correlated with tassel main axis length. No. of rows per cob is positively correlated with days to 50% tasseling, days to 50% silking, no. of leaves below ear, tassel branch number, leaf length, leaf width and tassel branch number. Test weight is positively correlated with plant height, ear height, no. of leaves above the ear and negatively correlated with tassel main axis and no. of rows per cob. These traits can be improved through simultaneous selection of other traits. The results were in agreement with the findings of Reddy, V. Ret *et al.*, (2012), Rajwade, J.K *et al.*, (2018), Verma, V *et al.*, (2020) and Pranay *et al.*, (2022) for the traits days to 50% tasseling, days to 50% silking, no. of kernels per row, no. of rows per cob, plant height, ear height and test weight.

Path coefficient analysis:

High correlation coefficients may not be always giving the true picture or could mislead the decision because the correlation between two variables may be due to a third factor. Therefore, it is necessary to analyze the cause and effect relationship between dependent and independent variables to reveal the nature of relationship between the variables.

Path coefficient analysis (Table.5) revealed that the traits total number of leaves(0.1244,1.3677), leaf width(0.02169,0.11141), No. of kernels per row(0.3010,0.4630), No. of rows per cob(0.3970,0.50808), test weight(0.1836,0.2641), shelling percent (0.3147,0.259) had a positive direct effect on grain yield per plant at both phenotypic and genotypic analysis respectively, implying that selecting for these characteristics would likely to result in an overall improvement in grain yield per plant. On the other hand, plant height(-0.0911,-0.5180), leaf angle(-0.2501,-0.4474), Number of leaves above the ear (-0.1190,-0.8845), Number of leaves below the ear (-0.134,-1.1512), Leaf length(-0.2181,-0.5576) and Tassel branch number(-0.01978,-0.0070) exhibited negative direct effect on yield/cob at both phenotypic

and genotypic analysis. Most of the traits exhibited indirect influence on yield/cob through days to 50% tasseling, days to 50% silking, plant height, ear height, No. of leaves below the ear, Total number of leaves, Leaf length, Leaf width, Tassel branch number, Kernels per row, row per cob, test weight and shelling%. The results thus emphasize that selection could be more effective by indirect selection of these traits. Phenotypic and genotypic residual effects were 0.5467 and 0.3948 respectively, indicating that some characters which had due weightage in selection for yield improvement are to be included. These findings were in harmony with the findings of Raghu *et al.*, (2011) for plant height and ear height, Begum *et al.*, (2016) for days to 50% tasseling and ear height. Dan Singh Jakhar *et al.*, (2017) for ear height.

CONCLUSION

From the findings of the present investigation, it may be concluded that characters plant height, total number of leaves, leaf length, leaf width, No. of Kernels per row, No. of rows per cob and shelling percent were important for selection of genotypes as these traits recorded moderate to high range of GCV, PCV, heritability, genetic advance over mean and exhibited positive significant correlations along with direct effects on yield/cob for some of the mentioned traits.

| CHARACTER | | TBN | TML | KPR | RPC | TW | SH | Yield/Cob |
|-----------|---|----------------|----------------|----------------|----------------|----------------|----------------|-----------|
| DTT | P | 0.2267* | 0.0446 | -0.1973* | 0.4194** | -0.0725 | -0.0588 | 0.1048 |
| | G | 0.2483 | 0.0434 | -0.234 | 0.4533** | -0.1078 | -0.0704 | 0.129 |
| DTS | P | 0.2206* | 0.0475 | -0.2103* | 0.4221** | -0.0795 | -0.0702 | 0.0831 |
| | G | 0.2362 | 0.0643 | -0.2479 | 0.446** | -0.113 | -0.0692 | 0.1037 |
| PH | P | 0.1336 | 0.0651 | 0.0097 | 0.1155 | 0.3279** | -0.069 | 0.1026 |
| | G | 0.1243 | 0.1022 | 0.0169 | 0.1177 | 0.368** | -0.0731 | 0.1015 |
| EH | P | 0.1811 | -0.0116 | 0.0378 | 0.1231 | 0.3493** | 0 | 0.1913 |
| | G | 0.1761 | -0.0021 | 0.0295 | 0.1249 | 0.3829** | -0.0174 | 0.217 |
| LA | P | 0.0779 | -0.1278 | 0.2176* | -0.0856 | 0.0339 | 0.0347 | -0.0914 |
| | G | 0.0871 | -0.1415 | 0.2273 | -0.0937 | 0.0321 | 0.0513 | -0.091 |
| LAE | P | 0.1272 | -0.161 | 0.1135 | -0.085 | 0.2853** | -0.2063* | -0.0098 |
| | G | 0.1178 | -0.2444 | 0.1284 | -0.0641 | 0.3159* | -0.267 | -0.0084 |
| LBE | P | 0.1574 | 0.2654** | -0.1338 | 0.4045** | -0.0993 | 0.0083 | 0.0674 |
| | G | 0.1568 | 0.278* | -0.1381 | 0.4588** | -0.1157 | 0.0106 | 0.0795 |
| TNL | P | 0.1922 | 0.1248 | -0.0458 | 0.2754** | 0.0727 | -0.1029 | 0.0482 |
| | G | 0.1902 | 0.0899 | -0.0409 | 0.3335* | 0.0795 | -0.1372 | 0.0593 |
| LL | P | 0.1966* | 0.2307* | -0.1003 | 0.3188** | 0.0688 | 0.0734 | 0.0479 |
| | G | 0.2455 | 0.2888* | -0.1187 | 0.3992** | 0.092 | 0.0673 | 0.06 |
| LW | P | 0.3967** | -0.3047** | 0.1911 | 0.2586** | 0.1675 | -0.014 | 0.1594 |
| | G | 0.4908** | -0.4491** | 0.2373 | 0.3225* | 0.2075 | -0.0204 | 0.2035 |
| TBN | P | 1.000** | -0.1691 | 0.0297 | 0.4195** | -0.0243 | 0.1063 | 0.164 |
| | G | 1.000** | -0.2056 | 0.025 | 0.4463** | -0.0285 | 0.1478 | 0.1825 |
| TML | P | | 1.000** | -0.3218** | 0.1397 | -0.3173** | 0.012 | -0.1723 |
| | G | | 1.000** | -0.3752** | 0.166 | -0.3951** | -0.0389 | -0.2323 |
| KPR | P | | | 1.000** | -0.2313 | 0.2604** | 0.1078 | 0.2961** |
| | G | | | 1.000** | -0.2512 | 0.2718 | 0.1419 | 0.3561** |
| RPC | P | | | | 1.000** | -0.3276** | 0.1857 | 0.275** |
| | G | | | | 1.000** | -0.348* | 0.2344 | 0.2982* |
| TW | P | | | | | 1.000** | 0.1085 | 0.2146* |
| | G | | | | | 1.000** | 0.1205 | 0.2185 |
| SH% | P | | | | | | 1.000** | 0.441** |
| | G | | | | | | 1.000** | 0.4614** |

Table.5 Phenotypic (P) and genotypic (G) path coefficients for yield and yield attributing traits in inbred lines

| CHARACTER | | DTT | DTS | PH | EH | LA | LAE | LBE | TNL | LL | LW |
|-----------|---|----------------|----------------|----------------|---------------|----------------|----------------|----------------|---------------|----------------|----------------|
| DTT | P | 0.9082 | -0.9077 | -0.0262 | 0.0582 | 0.0771 | -0.0042 | -0.0099 | 0.0097 | -0.0723 | 0.0032 |
| | G | -0.6898 | 0.7902 | -0.1725 | 0.2002 | 0.1501 | -0.0425 | -0.0829 | 0.1150 | -0.2399 | 0.0221 |
| DTS | P | 0.9016 | -0.9144 | -0.0264 | 0.0575 | 0.0775 | -0.0040 | -0.0094 | 0.0091 | -0.0728 | 0.0031 |
| | G | -0.6934 | 0.7862 | -0.1721 | 0.1938 | 0.1488 | -0.0469 | -0.07655 | 0.1126 | -0.2408 | 0.0211 |
| PH | P | 0.2615 | -0.2649 | -0.0911 | 0.2017 | 0.0436 | -0.0544 | -0.0492 | 0.0663 | -0.0948 | 0.0020 |
| | G | -0.2298 | 0.2613 | -0.5180 | 0.7004 | 0.0804 | -0.4313 | -0.4602 | 0.8032 | -0.2756 | 0.0126 |
| EH | P | 0.2069 | -0.2061 | -0.0720 | 0.2552 | 0.0095 | -0.4476 | -0.0503 | 0.0617 | -0.0904 | -0.00004 |
| | G | -0.1697 | 0.1873 | -0.4458 | 0.8137 | 0.0179 | -0.3727 | -0.4917 | 0.7839 | -0.2838 | 0.0058 |
| LA | P | -0.2801 | 0.2832 | 0.0158 | -0.0097 | -0.2501 | 0.0102 | 0.0168 | -0.0180 | 0.0888 | -0.00091 |
| | G | 0.2314 | -0.2616 | 0.0931 | -0.0327 | -0.4474 | 0.0803 | 0.1565 | -0.2172 | 0.2517 | -0.0052 |
| LAE | P | 0.0327 | -0.0307 | -0.0415 | 0.0958 | 0.0214 | -0.1190 | -0.0144 | 0.0766 | -0.0300 | 0.00751 |
| | G | -0.0331 | 0.0416 | -0.2526 | 0.3428 | 0.0406 | -0.8845 | -0.0745 | 0.8178 | -0.0588 | 0.04451 |
| LBE | P | 0.0675 | -0.0641 | -0.0334 | 0.0959 | 0.0314 | -0.0128 | -0.1340 | 0.1057 | -0.0797 | 0.00054 |
| | G | -0.0496 | 0.0522 | -0.2071 | 0.3475 | 0.0608 | -0.0573 | -1.1512 | 1.1469 | -0.2419 | 0.0019 |
| TNL | P | 0.0710 | -0.0671 | -0.0486 | 0.1268 | 0.0362 | -0.0734 | -0.1139 | 0.1244 | -0.0791 | 0.00443 |
| | G | -0.0580 | 0.0647 | -0.3042 | 0.4664 | 0.0710 | -0.5289 | -0.9653 | 1.3677 | -0.2264 | 0.02584 |
| LL | P | 0.3013 | -0.3053 | -0.0396 | 0.1059 | 0.1018 | -0.0164 | -0.0490 | 0.0451 | -0.2181 | 0.00376 |
| | G | -0.2968 | 0.3395 | -0.2560 | 0.4143 | 0.2019 | -0.0933 | -0.49944 | 0.5553 | -0.5576 | 0.02579 |
| LW | P | 0.1336 | -0.1317 | -0.0086 | -0.0004 | 0.0104 | -0.0413 | -0.0033 | 0.0253 | -0.0378 | 0.02169 |
| | G | -0.1370 | 0.1487 | -0.0584 | 0.0428 | 0.0207 | -0.3533 | -0.0198 | 0.3172 | -0.1291 | 0.11141 |
| TBN | P | 0.2059 | -0.2017 | -0.0121 | 0.0462 | -0.0194 | -0.0151 | -0.0210 | 0.0238 | -0.0428 | 0.00861 |
| | G | -0.1712 | 0.1857 | -0.0643 | 0.1433 | -0.0389 | -0.1042 | -0.1804 | 0.2601 | -0.1368 | 0.05468 |
| TML | P | 0.0405 | -0.0434 | -0.0059 | -0.0029 | 0.0319 | 0.0191 | -0.0355 | 0.0155 | -0.0503 | -0.00661 |
| | G | -0.0299 | 0.0505 | -0.0529 | -0.0017 | 0.0633 | 0.2162 | 0.3200 | 0.1228 | -0.1611 | -0.05004 |
| KPR | P | -0.1792 | 0.1923 | -0.0008 | 0.0096 | -0.0544 | -0.0135 | 0.0179 | -0.0057 | 0.0218 | 0.00414 |
| | G | 0.1614 | -0.1949 | -0.0087 | 0.02400 | -0.1017 | -0.1136 | 0.1590 | -0.0558 | 0.0662 | 0.02644 |
| RPC | P | 0.3809 | -0.3859 | -0.0105 | 0.0314 | 0.0214 | 0.0101 | -0.0542 | 0.0342 | -0.0695 | 0.00561 |
| | G | -0.3127 | 0.3506 | -0.0609 | 0.1016 | 0.04191 | 0.05669 | -0.5281 | 0.4561 | -0.2225 | 0.03593 |
| TW | P | -0.0658 | 0.0727 | -0.0298 | 0.0892 | -0.0084 | -0.0340 | 0.0133 | 0.0090 | -0.0150 | 0.00364 |
| | G | 0.0743 | -0.0888 | -0.1906 | 0.3115 | -0.01435 | -0.2794 | 0.1332 | 0.1087 | -0.0513 | 0.02312 |
| SH% | P | -0.0534 | 0.0641 | 0.0062 | 0.0000 | -0.0086 | 0.0246 | -0.0011 | -0.0127 | -0.0160 | -0.00030 |
| | G | 0.0485 | -0.0543 | 0.0378 | -0.0142 | -0.02297 | 0.2361 | -0.0122 | -0.1876 | -0.03753 | -0.0023 |

| CHARACTER | | TBN | TML | KPR | RPC | TW | SH | Yield/Cob |
|-----------|---|-----------------|----------------|---------------|----------------|---------------|----------------|-----------|
| DTT | P | -0.00448 | -0.0018 | -0.0594 | 0.1665 | -0.0133 | -0.0185 | 0.1048 |
| | G | -0.0017 | 0.00576 | -0.10833 | 0.2303 | -0.0284 | -0.01828 | 0.1291 |
| DTS | P | -0.00436 | -0.0020 | -0.0633 | 0.1675 | -0.0146 | -0.0221 | 0.0831 |
| | G | -0.0016 | 0.0085 | -0.1147 | 0.2266 | -0.02985 | -0.01796 | 0.1037 |
| PH | P | -0.00264 | -0.0027 | 0.0029 | 0.0458 | 0.0602 | -0.0217 | 0.1026 |
| | G | -0.00087 | 0.01358 | 0.00784 | 0.05978 | 0.0972 | -0.01897 | 0.1015 |
| EH | P | -0.00358 | 0.0004 | 0.0113 | 0.0488 | 0.0641 | 0.0000 | 0.1913 |
| | G | -0.00124 | -0.00028 | 0.01365 | 0.06344 | 0.1011 | -0.00452 | 0.2170 |
| LA | P | -0.00154 | 0.0053 | 0.0655 | -0.0339 | 0.0062 | 0.0109 | -0.0914 |
| | G | -0.00061 | -0.01881 | 0.10526 | -0.0476 | 0.0085 | 0.01333 | -0.0910 |
| LAE | P | -0.00251 | 0.0067 | 0.0341 | -0.0337 | 0.0524 | -0.0650 | -0.0098 |
| | G | -0.00083 | -0.03248 | 0.05945 | -0.03256 | 0.08343 | -0.06932 | -0.0084 |
| LBE | P | -0.00311 | -0.0111 | -0.0402 | 0.1606 | -0.0182 | 0.0026 | 0.0674 |
| | G | -0.0011 | 0.03694 | -0.06396 | 0.23308 | -0.03057 | 0.00276 | 0.0795 |
| TNL | P | -0.00380 | -0.0052 | -0.0137 | 0.1093 | 0.0134 | -0.0324 | 0.0482 |
| | G | -0.00133 | 0.01194 | -0.01892 | 0.1694 | 0.02099 | -0.03563 | 0.0593 |
| LL | P | -0.00389 | -0.0097 | -0.0302 | 0.1265 | 0.0126 | 0.0231 | 0.0479 |
| | G | -0.00172 | 0.03839 | -0.05495 | 0.2028 | 0.02431 | 0.01748 | 0.0600 |
| LW | P | -0.00785 | 0.0128 | 0.0575 | 0.1026 | 0.0307 | -0.0044 | 0.1594 |
| | G | -0.00344 | -0.05969 | 0.10989 | 0.1638 | 0.05482 | -0.0052 | 0.2035 |
| TBN | P | -0.01978 | 0.00711 | 0.0089 | 0.1665 | -0.0044 | 0.0334 | 0.1640 |
| | G | -0.0070 | -0.02732 | 0.01159 | 0.2267 | -0.00752 | 0.03836 | 0.1826 |
| TML | P | 0.00334 | -0.0421 | -0.0968 | 0.0554 | -0.0582 | 0.0037 | -0.1723 |
| | G | 0.00144 | 0.13289 | -0.17373 | 0.08433 | -0.1043 | -0.0101 | -0.2322 |
| KPR | P | -0.00059 | 0.0135 | 0.3010 | -0.0918 | 0.0478 | 0.0339 | 0.2961 |
| | G | -0.00018 | -0.04986 | 0.4630 | -0.12764 | 0.0717 | 0.03685 | 0.3561 |
| RPC | P | -0.0083 | -0.0058 | -0.0696 | 0.3970 | -0.0602 | 0.0584 | 0.2750 |
| | G | -0.0031 | 0.02206 | -0.11632 | 0.50808 | -0.0919 | 0.0608 | 0.2982 |
| TW | P | 0.00048 | 0.0133 | 0.0784 | -0.1301 | 0.1836 | 0.0342 | 0.2146 |
| | G | 0.00020 | -0.05251 | 0.1258 | -0.17682 | 0.2641 | 0.03127 | 0.2185 |
| SH% | P | -0.0021 | -0.0005 | 0.0324 | 0.0737 | 0.0199 | 0.3147 | 0.4411 |
| | G | -0.00104 | -0.00517 | 0.06571 | 0.1191 | 0.0318 | 0.25964 | 0.4614 |

Phenotypic and genotypic residual effects were 0.5467 and 0.3948 respectively

References

Begum, S., Ahmed, A., Omy, S.H., Rohman, M.M and Amiruzzaman, M. 2016. Genetic variability, character association and path analysis in maize (*Zea mays* L.). *Bangladesh J. Agril. Res.* 41(1): 173-182.

Bocanski ,J., Sreckov, Z., Nastasic, A. 2009. Genetic and phenotypic relationship between grain yield and components of grain yield of maize (*Zea mays* L.). *Genetika.* 41(2):145-154.

Burton, G. M. 1952. Quantitative inheritance in grasses. *Proceedings of 6th International Grassland Cong.* 1: 277- 283.

Dewey, D.R and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* 51: 515-518.

Hanson, C. H., Robinson, H. F and Comstock, R. E. 1956. Biometrical studies of yield in segregating populations of Korean Lespedeza. *Agron. J.* 48: 268-272.

Hefny, M. 2011. Genetic parameters and path analysis of yield and its components in corn inbred lines (*Zea mays* L.) at different sowing dates. *Asian Journal of Crop Science.* 3(3):106-117.

<http://www.agri.telangana.gov.in/>

Johnson, H.W., Robinson, H.F and Comstock, R.E. 1955. Estimation of genetic and environmental variability in soybeans. *Agronomy Journal.* 47: 314-318.

Niji ,M.S. 2018. Genetic variability, heritability and character association studies in sweet corn (*Zea mays* L. *saccharata*). *Electronic Journal of Plant Breeding.*9(3):1038- 1044

Panse, V.G and Sukhatme P.V. 1985. Statistical methods for agricultural workers. Indian Council of Agricultural research, New Delhi.

Pranay, G., Shashibhushan, D., Rani, K.J., Bhadru, D and Kumar, C.V. 2022. Correlation and path analysis in elite maize (*Zea mays* L.) lines. *International Journal of Plant & Soil Science.* 34(24): 414-422.

Raghu, B., Suresh, J., Kumar, S.S and Saidaiah, P. 2011. Character association and path analysis in maize (*Zea mays* L.). *Madras Agricultural Journal*. 98: 1.

Rajwade, J.K., Jagadev, P.N., Lenka, D and Gupta, S. 2018. Correlation and path coefficient studies on elite genotypes of maize inbred lines. *Journal of Pharmacognosy and Phytochemistry*. 7(2): 2765-2771.

Ray, D.K ., Ramankutty, N., Mueller, N.D., West, P.C and Foley, J.A. 2012. Recent patterns of crop yield growth and stagnation. *Nature communications*. 3(1): 1293.

Reddy, V. R., Jabeen, F., Sudarshan, M. R and Rao, A. S. 2012. Studies on genetic variability, heritability, correlation and path analysis in maize (*Zea mays* L.) over locations. *International Journal of Applied Biology and Pharmaceutical Technology*. 4(1): 196-199.

Sangoi, L., Gracietti, M.A., Rampazzo, C and Bianchetti, P. 2002. Response of Brazilian maize hybrids from different eras to changes in plant density. *Field Crops Research*. 79(1): 39-51.

Shiferaw, B., Prasanna, B. M., Hellin, J and Banziger, M. 2011. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food security*. 3: 307-327.

Singh, R.K and Chaudhary, B.D. 1985. Biometrical Methods in Quantitative Genetic Analysis. *Kalayani Publishers*, New Delhi, India. 318.

Sivasubramanian, V and Madhavamenon, P. 1973. Path analysis for yield and yield components of rice. *Madras Ag. Journal*. 60: 217-221.

Sonal Chavan, Bhadr, D., Swarnalatha, V and Mallaiah, B. 2020. Studies on Genetic Parameters, Correlation and Path Analysis for Yield and Yield Attributing Traits in Sweet Corn (*Zea mays* L. *saccharata*). *Int.J.Curr.Microbiol.App.Sci*. 9(07): 1725-1734.

Verma, V., Yadav, M.S., Kumar, A and Gathiye, G.S. 2020. Correlation and path analysis for seed yield and components traits in maize (*Zea mays* L.). *Journal of Pharmacognosy and Phytochemistry*. 9(1): 2278-2280.

Wright, S. 1921. Correlation and causation. *J. Agric. Res.* 20: 557-585

Wright, S. 1929. Path coefficients and path regression: Alternative complementary concepts. *Biometric.* 16: 189-202.

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