

### **Path Coefficient and Correlation Analysis in Maize (*Zea Mays* L.) Hybrids over Southern Aravalli Regions of Rajasthan**

#### **ABSTRACT**

A complex trait such as grain yield is highly influenced by environment and indirect selection through component traits would be an advisable strategy to increase the efficiency of selection. The 45 F<sub>1</sub>s along with their 18 parents and with 2 checks were evaluated in three environments *viz.*, E1, E2 and E3 in RBD design with three replications to assess the correlation among the yield components and direct and indirect effects of yield components towards grain yield. The association analysis among the eleven traits on pooled basis revealed that the traits days to 50 per cent silking, plant height, ear height, ear length, ear girth, grain rows per ear, 100-grain weight and harvest index had showed positive and significant correlation with grain yield per plant. The perusal of the path coefficient analysis on pooled basis revealed that the maximum direct positive effect was depicted by the trait harvest index followed by the traits ear height, grain rows per ear, days to 50 per cent silking, 100-grain weight, days to 75 per cent brown husk, ear girth and plant height.

**Key words:** Path analysis, Correlation analysis, Maize hybrids, Southern Aravalli Regions of Rajasthan

**1. Introduction:** Maize is one of the three important cereal crops after wheat and rice consumed as staple food. It is a multipurpose cereal crop grown across the varied agro-ecological regions of the world due to its wider adaptability [1]. Throughout the world, the crop is a key source of calories, protein, vitamins, and minerals, especially in Africa, South America, and Asia [2]. It is used extensively as animal feed, particularly for poultry and pigs, in industry, it is currently used for ethanol production. In India, it is grown in 9.20 M ha with a total production of 28.00 MMT, and average productivity of 3.04 metric t/ha [3]. It is estimated that the maximum part of the increasing food demand in near future will be fulfilled from maize [4] and half of the increased world food demand in terms of cereals as a whole will be produced from maize [5]. It is challenging to quantify grain yield because it is highly influenced by the environment and is a result of the interrelationship between various yield components [6]. Information on genotypic and phenotypic correlation coefficients between various plant traits is useful for determining how they are related to economic productivity. The phenotypic correlation may depict the direct relationship between two variables or traits while genotypic correlation revealed the extent to which they are associated at genetic level. Correlation at genotypic and phenotypic levels among the traits offers opportunities for indirect selection in a crop improvement breeding programmes. The genetic basis of the material and role of environments are of great importance while studying genetic correlation among various quantitative characters in crops. These studies may guide plant breeders on the selection of traits that contribute to the character(s) of concern, and ultimately their improvement through hybridization. Breeders need to understand the correlations among different traits, especially for grain yield, which is the

ultimate goal of any breeding programme. Thus, the purpose of the study was to estimate the direct and indirect effects of yield components on grain yield as well to derive information about their correlation with grain yield. This helps in selection of superior cross combinations in hybrid maize.

**2. Materials and Methods:** The experimental material comprised of 45 single cross hybrids generated by crossing 15 inbred lines with 3 testers in Line x Tester mating design during *Rabi-2017-18*. Thus, these 45  $F_1$ s along with their 18 parents and with 2 checks were evaluated in three environments *viz.*, E1 (*Kharif-2019*, Instructional Farm, Rajasthan College of Agriculture, Udaipur), E2 (*Kharif-2019*, Agriculture Research Sub-Station, Vallabh Nagar) and E3 (*Rabi-2019-2020*, Instructional Farm, Rajasthan College of Agriculture, Udaipur) in RBD design with three replications. Each genotype was sown in single row plot of 4.0 m length and row to row and plant to plant distance was maintained at 60 cm and 20 cm, respectively. The Udaipur district is located in the Aravalli Hilly Ranges of Southern part of the Rajasthan with latitude  $24^{\circ}35'31.5''$  longitudes  $73^{\circ}44'18.2''$  with an altitude of 582.17 meters above mean sea level. The Vallabh Nagar is located in Bhinder town of Udaipur district of Rajasthan State with latitude  $24^{\circ}40'23''$  longitudes  $74^{\circ}00'09''$  with an altitude of 495.00 m above mean sea level. The soil of both experimental field locations were clay loam, deep, well drained, alluvial in origin and have good moisture holding capacity. All the recommended package of practices of zone IV-A (Sub-Humid Southern Plains) was used to raise a healthy crop. The observations were recorded on five randomly selected plants from each plot to record the data on 11 traits in all the environments. The data on three phenological traits *viz.*, days to 50 per cent tasseling, days to 50 per cent silking and days to 75 per cent brown husk and 100-grain weight were however, recorded on whole plot basis. The standardized traits mean values were pooled and used to investigate character association between different pairs of characters at phenotypic and genotypic levels as per method described by [7]. The path analysis was also carried out using the simple correlation coefficient to know the direct and indirect effects of the yield and components of yield as suggested by Wright, 1921 [8] and illustrated by Dewey and Lu, 1959 [9].

**3. Results and Discussion:** Analysis of variance revealed significant differences for all the eleven quantitative traits under the study. The estimates of correlation coefficients at both genotypic and phenotypic level between different traits on pooled basis are presented in Table 1. The magnitude of genotypic correlations was found higher in general than the respective phenotypic correlation indicating strong inherent relationship among the characters under study. The grain yield per plant had showed highly significant positive correlation with days to 50 per cent silking, plant height, ear height, ear length, ear girth, grain rows per ear, 100-grain weight and harvest index at both genotypic and phenotypic level. The two phenological traits *viz.*, days to 50 per cent tasseling and days to 75 per cent brown husk had showed positive but non-significant association with grain yield under the study. In some cases, correlation coefficients give misleading results because the correlation between two variables may be due to third factor. For this reason, it is crucial to know the cause and effect relationship between dependent and independent variables to understand the relationship between them. Path analysis splits the correlation coefficient among into the measures of direct and indirect effects and provides the actual contribution of a trait on the yield. The estimates of direct and indirect effects of yield component traits towards grain yield per plant at both genotypic (G) and phenotypic path (P) level are presented in Table 2 on pooled basis. The estimates of path analysis revealed that the harvest index had showed maximum direct effect followed by ear height, grain rows per ear, days to 50 per cent silking, 100-grain weight, days to 75 per cent brown husk, ear girth and plant height. The one phenological trait as days to 50 per cent tasseling had showed negative direct effect on grain yield per plant

under the study. Those traits that are not only correlated positively and significantly with grain yield but also have positive direct effects towards grain yield are likely to be useful as selection criteria in selection programmes. Considering the above criteria, the traits days to 50 per cent silking, plant height, ear height, ear girth, grain rows per ear, 100-grain weight and harvest index were found suitable as they had showed high positive and significant correlation as well as high positive direct effect towards grain yield per plant in maize. These results are found in accordance with the earlier findings of Manivannan, 1998 [10], Krishan and Natarajan, 1995 [11], Umakantha and Khan, 2001 [12], Sofi and Rather, 2007 [13], Ali *et al.* 2010 [14] in maize. The estimates of residual effects provide explanation of the pattern of interaction between other possible components of yield. The estimates of genotypic and phenotypic residual effects were found 0.36841 and 0.42797, respectively. It indicates the characters used in the experiment explain approximately above 60 per cent of variations which may be contributed to higher yields in maize. The genetic linkage or pleiotropy effect may also responsible for genetic correlation between different characters of plant [15]. The perusal of the Table 1 revealed that the magnitude of genotypic correlation coefficient were slightly higher in magnitude than phenotypic once. It is also observed there was a general agreement in the sign and magnitude between estimates of genotypic and phenotypic correlations. Since selection is based on phenotype, the correlation at genetic level (genotypic correlation) alone may not be of practical value in selection.

Thus in the present investigation it may be concluded that the traits ear girth, grain rows per ear, and 100-grain weight were the important yield components and selection for these traits could be considered as important selection criteria in improving yield of hybrid maize.

## 5. References:

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Table 1 The estimates of genotypic ( $r_g$ ) and phenotypic ( $r_p$ ) correlation coefficients for grain yield and its components on pooled basis in maize.

| Characters                     | r     | Days to 50 per cent silking | Days to 75 per cent brown husk | Plant height (cm)   | Ear height (cm)     | Ear length (cm)      | Ear girth (cm)      | Grain rows per ear   | 100-Grain weight (g) | Harvest index (%)    | Grain yield per plant (g) |
|--------------------------------|-------|-----------------------------|--------------------------------|---------------------|---------------------|----------------------|---------------------|----------------------|----------------------|----------------------|---------------------------|
| Days to 50 per cent tasseling  | $r_g$ | 0.771**                     | 0.600**                        | 0.062 <sup>NS</sup> | 0.045 <sup>NS</sup> | 0.138 <sup>NS</sup>  | 0.117 <sup>NS</sup> | -0.082 <sup>NS</sup> | 0.024 <sup>NS</sup>  | 0.157*               | 0.171*                    |
|                                | $r_p$ | 0.756**                     | 0.507**                        | 0.037 <sup>NS</sup> | 0.008 <sup>NS</sup> | 0.102 <sup>NS</sup>  | 0.065 <sup>NS</sup> | -0.039 <sup>NS</sup> | 0.044 <sup>NS</sup>  | 0.109 <sup>NS</sup>  | 0.100 <sup>NS</sup>       |
| Days to 50 per cent silking    | $r_g$ |                             | 0.704**                        | 0.120 <sup>NS</sup> | 0.084 <sup>NS</sup> | 0.002 <sup>NS</sup>  | 0.032 <sup>NS</sup> | 0.002 <sup>NS</sup>  | 0.091 <sup>NS</sup>  | 0.075 <sup>NS</sup>  | 0.236**                   |
|                                | $r_p$ |                             | 0.611**                        | 0.096 <sup>NS</sup> | 0.059 <sup>NS</sup> | -0.038 <sup>NS</sup> | 0.002 <sup>NS</sup> | 0.030 <sup>NS</sup>  | 0.106 <sup>NS</sup>  | 0.077 <sup>NS</sup>  | 0.144*                    |
| Days to 75 per cent brown husk | $r_g$ |                             |                                | 0.201**             | 0.174*              | 0.151*               | 0.137 <sup>NS</sup> | 0.074 <sup>NS</sup>  | 0.315**              | 0.021 <sup>NS</sup>  | 0.216**                   |
|                                | $r_p$ |                             |                                | 0.134 <sup>NS</sup> | 0.108 <sup>NS</sup> | 0.046 <sup>NS</sup>  | 0.093 <sup>NS</sup> | 0.054 <sup>NS</sup>  | 0.231**              | -0.008 <sup>NS</sup> | 0.130 <sup>NS</sup>       |
| Plant height (cm)              | $r_g$ |                             |                                |                     | 0.813**             | 0.464**              | 0.425**             | 0.376**              | 0.197**              | 0.454**              | 0.547**                   |
|                                | $r_p$ |                             |                                |                     | 0.811**             | 0.375**              | 0.316**             | 0.288**              | 0.165*               | 0.351**              | 0.496**                   |
| Ear height (cm)                | $r_g$ |                             |                                |                     |                     | 0.528**              | 0.484**             | 0.341**              | 0.181*               | 0.400**              | 0.561**                   |
|                                | $r_p$ |                             |                                |                     |                     | 0.388**              | 0.326**             | 0.225**              | 0.148*               | 0.285**              | 0.481**                   |
| Ear length (cm)                | $r_g$ |                             |                                |                     |                     |                      | 0.990**             | 0.326**              | 0.001 <sup>NS</sup>  | 0.371**              | 0.409**                   |
|                                | $r_p$ |                             |                                |                     |                     |                      | 0.843**             | 0.248**              | -0.049 <sup>NS</sup> | 0.290**              | 0.329**                   |
| Ear girth (cm)                 | $r_g$ |                             |                                |                     |                     |                      |                     | 0.325**              | -0.026 <sup>NS</sup> | 0.446**              | 0.479**                   |
|                                | $r_p$ |                             |                                |                     |                     |                      |                     | 0.238**              | -0.048 <sup>NS</sup> | 0.291**              | 0.328**                   |
| Grain rows per ear             | $r_g$ |                             |                                |                     |                     |                      |                     |                      | 0.011 <sup>NS</sup>  | 0.225**              | 0.379**                   |
|                                | $r_p$ |                             |                                |                     |                     |                      |                     |                      | 0.027 <sup>NS</sup>  | 0.154*               | 0.308**                   |
| 100-Grain weight (g)           | $r_g$ |                             |                                |                     |                     |                      |                     |                      |                      | 0.104 <sup>NS</sup>  | 0.196**                   |
|                                | $r_p$ |                             |                                |                     |                     |                      |                     |                      |                      | 0.097 <sup>NS</sup>  | 0.174*                    |
| Harvest index (%)              | $r_g$ |                             |                                |                     |                     |                      |                     |                      |                      |                      | 0.780**                   |
|                                | $r_p$ |                             |                                |                     |                     |                      |                     |                      |                      |                      | 0.662**                   |

\* and \*\* represent level of significance at 5 and 1%, respectively

r = correlation

NS= Non-significant

Table 2 The estimates of direct (diagonal values) and indirect effects for yield components towards grain yield per plant on pooled basis in maize.

| Characters                     |   | Days to 50 per cent tasseling | Days to 50 per cent silking | Days to 75 per cent brown husk | Plant height (cm) | Ear height (cm) | Ear length (cm) | Ear girth (cm)  | Grain rows per ear | 100-Grain weight (g) | Harvest index (%) | Correlation with grain yield per plant (g) |
|--------------------------------|---|-------------------------------|-----------------------------|--------------------------------|-------------------|-----------------|-----------------|-----------------|--------------------|----------------------|-------------------|--|
| Days to 50 per cent tasseling  | G | <b>-1.10622</b>               | 0.92871                     | 0.01883                        | -0.02919          | -0.00224        | 0.82867         | -0.68774        | -0.00735           | -0.00268             | 0.22990           | <b>0.171*</b>                              |
|                                | P | <b>-0.05073</b>               | 0.05886                     | 0.02876                        | 0.00165           | 0.00180         | -0.00003        | 0.00330         | -0.00543           | 0.00270              | 0.05915           | <b>0.100<sup>NS</sup></b>                  |
| Days to 50 per cent silking    | G | -0.85320                      | <b>1.20412</b>              | 0.02208                        | -0.05653          | -0.00417        | 0.01237         | -0.18926        | 0.00017            | -0.01035             | 0.11077           | <b>0.236<sup>**</sup></b>                  |
|                                | P | -0.03836                      | <b>0.07785</b>              | 0.03463                        | 0.00431           | 0.01311         | 0.00001         | 0.00010         | 0.00424            | 0.00646              | 0.04173           | <b>0.144*</b>                              |
| Days to 75 per cent brown husk | G | -0.66377                      | 0.84726                     | <b>0.03137</b>                 | -0.09486          | -0.00861        | 0.90696         | -0.80367        | 0.00656            | -0.03574             | 0.03035           | <b>0.216<sup>**</sup></b>                  |
|                                | P | -0.02572                      | 0.04754                     | <b>0.05671</b>                 | 0.00602           | 0.02408         | -0.00001        | 0.00471         | 0.00761            | 0.01412              | -0.00458          | <b>0.130<sup>NS</sup></b>                  |
| Plant height (cm)              | G | -0.06836                      | 0.14408                     | 0.00630                        | <b>-0.47244</b>   | -0.04034        | 2.79341         | -2.49309        | 0.03354            | -0.02235             | 0.66652           | <b>0.547<sup>**</sup></b>                  |
|                                | P | -0.00186                      | 0.00746                     | 0.00758                        | <b>0.04502</b>    | 0.18104         | -0.00009        | 0.01610         | 0.04051            | 0.01007              | 0.19000           | <b>0.496<sup>**</sup></b>                  |
| Ear height (cm)                | G | -0.05003                      | 0.10133                     | 0.00545                        | -0.38426          | <b>-0.04959</b> | 3.17865         | -2.83776        | 0.03045            | -0.02050             | 0.58750           | <b>0.561<sup>**</sup></b>                  |
|                                | P | -0.00041                      | 0.00457                     | 0.00612                        | 0.03652           | <b>0.22316</b>  | -0.00010        | 0.01659         | 0.03167            | 0.00901              | 0.15391           | <b>0.481<sup>**</sup></b>                  |
| Ear length (cm)                | G | -0.15216                      | 0.00247                     | 0.00472                        | -0.21905          | -0.02617        | <b>6.02457</b>  | -5.79871        | 0.02908            | -0.00017             | 0.54464           | <b>0.409<sup>**</sup></b>                  |
|                                | P | -0.00517                      | -0.00296                    | 0.00260                        | 0.01688           | 0.08648         | <b>-0.00025</b> | 0.04292         | 0.03498            | -0.00300             | 0.15666           | <b>0.329<sup>**</sup></b>                  |
| Ear girth (cm)                 | G | -0.12985                      | 0.03890                     | 0.00430                        | -0.20102          | -0.02402        | 5.96234         | <b>-5.85923</b> | 0.02900            | 0.00299              | 0.65542           | <b>0.479<sup>**</sup></b>                  |
|                                | P | -0.00329                      | 0.00015                     | 0.00525                        | 0.01424           | 0.07277         | -0.00021        | <b>0.05089</b>  | 0.03347            | -0.00292             | 0.15745           | <b>0.328<sup>**</sup></b>                  |
| Grain rows per ear             | G | 0.09125                       | 0.00236                     | 0.00231                        | -0.17770          | -0.01694        | 1.96530         | -1.90580        | <b>0.08916</b>     | -0.00121             | 0.33027           | <b>0.379<sup>**</sup></b>                  |
|                                | P | 0.00196                       | 0.00234                     | 0.00306                        | 0.01295           | 0.05018         | -0.00006        | 0.01209         | <b>0.14082</b>     | 0.00164              | 0.08324           | <b>0.308<sup>**</sup></b>                  |
| 100-Grain weight (g)           | G | -0.02615                      | 0.11003                     | 0.00990                        | -0.09323          | -0.00898        | 0.00896         | 0.15489         | 0.00095            | <b>-0.11328</b>      | 0.15287           | <b>0.196<sup>**</sup></b>                  |
|                                | P | -0.00224                      | 0.00825                     | 0.01313                        | 0.00744           | 0.03298         | 0.00001         | -0.00243        | 0.00378            | <b>0.06099</b>       | 0.05231           | <b>0.174*</b>                              |
| Harvest index (%)              | G | -0.17323                      | 0.09085                     | 0.00065                        | -0.21449          | -0.01985        | 2.23501         | -2.61579        | 0.02006            | -0.01180             | <b>1.46810</b>    | <b>0.780<sup>**</sup></b>                  |
|                                | P | -0.00555                      | 0.00601                     | -0.00048                       | 0.01582           | 0.06352         | -0.00007        | 0.01482         | 0.02168            | 0.00590              | <b>0.54076</b>    | <b>0.662<sup>**</sup></b>                  |

Genotypic Residual=0.36841, Phenotypic Residual= 0.42797  
G= Genotypic Path P= Phenotypic Path NS= Non-significant

\* and \*\* represent level of significance at 5 and 1%, respectively

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