

**Studies on Character Association and Path Coefficient Analysis
for Grain Yield and its Contributing Characters in Maize
(*Zea mays* L.)**

ABSTRACT: The present investigation was undertaken to study the cause of association and direct and indirect effects for yield and its contributing traits in fifteen hybrids along with their eight parents and three checks of maize. Grain yield was found to be significant and positively correlated with all characters studied except days to 50% tasseling and days to 50 % silking. Path coefficient analysis revealed that the characters days to 50 % tasseling exhibited the largest direct effect on grain yield followed by number of kernels per row, 100 kernel weight and ear diameter. The traits like no. of kernels/row, ear diameter and 100 kernel weight displayed positive significant correlation as well as positive direct effect on yield. Hence, due emphasis should be given to these traits in formulating selection criteria to bring high yield.

Keywords: Maize, Correlation, Path coefficient analysis, Grain yield

Introduction:

Maize (*Zea mays* L.; 2n=20) is known as “queen of cereals” and it is important food crop after rice and wheat in India. Maize grain serves as valuable nutrient feed for poultry and the green plants were used as forage or made into silage for dairy and beef industries. It is a cross-pollinated crop with wider genetic variability and able to grow successfully all over India covering tropical, subtropical and temperate agro-climatic conditions. In India, it was cultivated in an area of 9.8 million ha with an average production of 31.5 million metric tonnes and productivity 3.21 Metric tons/ha (USDA, 2022).

Yield is the end product of multiplicative interaction between various yield components and this necessitates a thorough understanding of character association and direct and indirect effects contributed by each character on grain yield before launching any breeding programme. The crop improvement efforts are directed to increase the grain production.

Studies on correlation coefficients of different characters are useful to identify desirable traits that contribute to improve the grain yield and help to ascertain the degree to which these traits are associated with economic productivity. Phenotypic correlation indicates the extent of the observation having relation between two traits while genotypic correlation provides an estimate of inherent association between the genes controlling any two traits.

Path coefficient analysis is the standardized partial regression helps to understand the various paths, i.e., the magnitude of direct influence of each character and the indirect influence through other characters.

Keeping this in view, the present study was therefore designed for genetic basis of grain yield components and to develop suitable selection criteria for future maize breeding program.

Material and methods:

Five maize lines were crossed with three testers in a line x tester mating design at Agricultural Research Station, Tornala during *rabi*, 2019-20 to generate a total of 15 hybrids. During *kharif*, 2020 the resultant 15 crosses and 8 parents along with 3 standard checks were evaluated in a Randomised Block Design (RBD) with 2 replications. Each entry was raised in two rows of three meter length with a spacing of 60 cm between rows and 20 cm between plants. The recommended package of practices were followed to raise a good crop.

The data was recorded on five randomly selected plants for plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), no. of kernel rows, no. of kernels per row and shelling %. Whereas days to 50% tasseling and days to 50% silking were recorded on plot basis and 100 kernel weight was recorded per replication in each genotype. Yield (kg/ha) was calculated from plot basis. The mean values were used for statistical analysis. The genotypic and phenotypic correlation coefficients were calculated using the method given by Falconer (1981) and path coefficient analysis were worked as suggested by Wright (1921) and Dewey and Lu (1959).

Results and Discussion:

The analysis of variance revealed the existence of significant differences among the genotypes for all the traits, indicating the existence of sufficient variation in the material studied. Hence, the data were further subjected to correlation (Table 1) and path coefficient analyses (Table 2) to estimate the association existing between yield and its contributing characters and the direct and indirect effects of these traits on yield, respectively.

Grain yield is a complex character and it is dependent on several contributing characters. Hence, character association was studied to assess the relationship among yield and its components for enhancing the usefulness of selection. The correlation studies were made for seed yield and other yield attributing traits. High genotypic correlations, in general, as compared to their phenotypic counterparts indicated the existence of strong inherent association between the characters and low phenotypic expression were due to environmental factors.

The results (Table 1) indicated that grain yield showed positive significant association with ear height (G- 0.8919, P- 0.7261) which is in agreement with the findings of Sravanti et al., (2016) and Archana et al., (2022). Ear length (G- 0.8781, P-0.8649) expressed positive significant association with grain yield. As ear length increases, no. of kernels/row also increases indicating increase in the yield. Similar reports were recorded by

Prasad et al., (2017) and Chaudhary et al., (2016). No. of kernels/row (G- 0.8720, P- 0.8525) showed positive significant association with grain yield, this is in consonance with the reports of Nataraj et al., (2014) and Jawaharlal et al., (2017).

Ear diameter (G- 0.8688, P- 0.8537) exhibited positive significant association with grain yield, which in turn increases in no. of kernel rows, ultimately this had direct bearing on the yield. Similar results were reported by Soumya et al., (2017) and Yahaya et al., (2021).

Plant height (G- 0.8183, P- 0.7331), no. of kernel rows (G- 0.7105, P- 0.6448), 100 kernel wt.(G- 0.6122, P- 0.5355), shelling % (G- 0.5789, P- 0.4236) also has positive significant association with grain yield. These observations are in agreement with the findings of Kharel et al., (2017) and Reddy et al., (2016) for plant height, Synrem et al., (2016) and Reddy et al., (2022) for no. of kernel rows, Jawaharlal et al., (2017) for 100 kernel weight, Kumar et al., (2014) for shelling %.

The characters days to 50 % tasseling (G- -0.4512, P- -0.4175) and days to 50 % silking (G- - 0.4834, P- - 0.4467) were significant and negatively correlated with grain yield and are similar to the results reported by Jilo et al., (2019). The negative correlation of grain yield with days to 50 per cent flowering is very much important for breeder to identify early and late maturing hybrids.

In selecting high yielding genotypes, correlation studies provide reliable information on the nature, extent and direction of selection. The knowledge of correlation between different yield attributes helps to find out the nature and magnitude of the association between these traits which are mostly used to attain better yield of the crop.

Sometimes, correlation coefficients give misleading results because the correlation between two variables may be due to third factor. It is therefore necessary to analyze the cause and effect relationship between dependent and independent variables to entangle the nature of relationship between the variables. Path coefficient analysis (Dewey and Lu 1959) furnished a method partitioning the correlation coefficient into direct and indirect effect and provides the information on actual contribution of a trait on the yield.

Path coefficient analysis (Table 2) showed that days to 50% tasseling (G-5.5858 , P- 0.9321) exhibited the largest direct effect on grain yield followed by no. of kernels per row (G-3.0467 , P-0.4960), 100 kernel weight (G-1.4823 , P-0.0438), ear diameter (G- 0.3269, P- 0.4092). These results are in conformity with the findings of Archana et al., (2022) for days to 50% tasseling, Sandeep et al., (2015) for no. of kernels per row, Mogesse (2021) for 100 kernel weight and Ubi et al., (2019) for ear diameter, indicating that the selection for these characters was likely to bring improvement in the yield. Hence, direct selection for these traits would be effective.

Days to 50% silking (G- -5.8668, P- -0.7919), ear length (G- -2.6538, P- -0.1186) and ear height (G- -0.2655, P- -0.1747) exhibited negative direct effect on grain yield and indicated that selection for high yield can be done by indirect selection through other yield components, which are in agreement with the findings of Singh et al., (2022) for days to 50%

silking, Archana et al., (2022) for ear length, Sumalini et al.,(2012) and Tejaswini et al., (2022) for ear height.

The genotypic and phenotypic residual effects recorded 0.2738 and 0.3146 respectively, it indicates that all the characters studied in our experiment explain above 50 percent of variations which may be contributed for higher yields in maize.

Conclusion

In conclusion, critical analysis of results obtained from character association and path analysis indicated that, the traits no. of kernels/row, ear diameter and 100 kernel weight displayed positive significant correlation as well as positive direct effect on yield. These characters play a major role in development of high yielding genotypes in future maize breeding programmes.

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Table 1: Estimates of genotypic and phenotypic correlation coefficients among different quantitative traits in maize

Character		Days to 50% Tasselling	Days to 50 % Silking	Plant Height (cm)	Ear Height (cm)	Ear Length (cm)	Ear diameter (cm)	No. of Kernel Rows	No. of Kernels/ Row	100 kernel wt.(g)	Shelling %	Yield (kg/ha)
Days to 50% Tasselling	G	1.0000	0.9947**	-0.4040**	-0.4267**	-0.6214**	-0.5036**	-0.5075**	-0.5974**	-0.2612	-0.4512**	-0.4512**
	P	1.0000	0.9930**	-0.4043**	-0.3945**	-0.5654**	-0.4500**	-0.3689**	-0.5721**	-0.1834	-0.2943*	-0.4175**
Days to 50 % Silking	G		1.0000	-0.4394**	-0.4614**	-0.6436**	-0.5200**	-0.5422**	-0.6212**	-0.2561	-0.4596**	-0.4834**
	P		1.0000	-0.4337**	-0.4210**	-0.5884**	-0.4665**	-0.3913**	-0.5946**	-0.1815	-0.2852*	-0.4467**
Plant Height (cm)	G			1.0000	0.9490**	0.8541**	0.8294**	0.6377**	0.8208**	0.6388**	0.1098	0.8183**
	P			1.0000	0.9256**	0.7663**	0.7118**	0.5192**	0.7705**	0.5353**	0.0128	0.7331**
Ear Height (cm)	G				1.0000	0.9384**	0.9592**	0.7997**	0.8851**	0.7251**	0.2591	0.8919**
	P				1.0000	0.7613**	0.7562**	0.5818**	0.7510**	0.5186**	0.0773	0.7261**
Ear Length (cm)	G					1.0000	0.8815**	0.8080**	0.9599**	0.6697**	0.4145**	0.8781**
	P					1.0000	0.8557**	0.7437**	0.9397**	0.5940**	0.2706	0.8649**
Ear diameter (cm)	G						1.0000	0.8160**	0.8335**	0.7288**	0.3231*	0.8688**
	P						1.0000	0.7389**	0.8009**	0.6479**	0.2189	0.8537**
No. of Kernel Rows	G							1.0000	0.6939**	0.7222**	0.2926*	0.7105**
	P							1.0000	0.6172**	0.6498**	0.1615	0.6448**
No. of Kernels/Row	G								1.0000	0.4657**	0.3976**	0.8720**
	P								1.0000	0.4005**	0.2140	0.8525**
100 kernel wt. (g)	G									1.0000	0.3060*	0.6122**
	P									1.0000	0.1213	0.5355**
Shelling%	G										1.0000	0.5789**
	P										1.0000	0.4236**

* Significant at 0.05 probability level ($r = > 0.2732$); **Significant at 0.01 probability level ($r = > 0.3541$);

P:Phenotypic correlation

G: Genotypic correlation

Table 2: Direct (bold & diagonal values) and indirect (normal values) effects of grain yield component traits on grain yield at phenotypic and genotypic level in maize

Character		Days to 50% Tasseling	Days to 50 % Silking	Plant Height (cm)	Ear Height (cm)	Ear Length (cm)	Ear diameter (cm)	No. of Kernel Rows	No. of Kernels/ Row	100 kernel wt.(g)	Shelling %	Yield (kg/ha)
Days to 50% Tasseling	G	5.5858	5.5561	-2.2566	-2.3833	-3.4711	-2.8133	-2.8349	-3.3372	-1.4590	-2.5203	-0.4512
	P	0.9321	0.9256	-0.3769	-0.3677	-0.5270	-0.4195	-0.3438	-0.5333	-0.1710	-0.2743	-0.4175
Days to 50 % Silking	G	-5.8356	-5.8668	2.5776	2.7067	3.7759	3.0508	3.1809	3.6445	1.5022	2.6966	-0.4834
	P	-0.7863	-0.7919	0.3435	0.3334	0.4659	0.3694	0.3098	0.4708	0.1437	0.2258	-0.4467
Plant Height (cm)	G	0.1623	0.1765	-0.4018	-0.3813	-0.3431	-0.3332	-0.2562	-0.3298	-0.2566	-0.0441	-0.8183
	P	-0.1239	-0.1329	0.3065	0.2837	0.2349	0.2182	0.1591	0.2361	0.1641	0.0039	0.7331
Ear Height (cm)	G	0.1133	0.1225	-0.2519	-0.2655	-0.2491	-0.2547	-0.2123	-0.2350	-0.1925	-0.0688	0.8919
	P	0.0689	0.0735	-0.1617	-0.1747	-0.1330	-0.1321	-0.1016	-0.1312	-0.0906	-0.0135	0.7261
Ear Length (cm)	G	1.6491	1.7080	-2.2666	-2.4904	-2.6538	-2.3392	-2.1443	-2.5475	-1.7773	-1.1001	0.8781
	P	0.0670	0.0698	-0.0908	-0.0903	-0.1186	-0.1014	-0.0882	-0.1114	-0.0704	-0.0321	0.8649
Ear diameter (cm)	G	-0.1647	-0.1700	0.2712	0.3136	0.2882	0.3269	0.2668	0.2725	0.2383	0.1056	0.8688
	P	-0.1842	-0.1909	0.2913	0.3095	0.3502	0.4092	0.3024	0.3277	0.2651	0.0896	0.8537
No. of Kernel Rows	G	0.2379	0.2542	-0.2990	-0.3749	-0.3788	-0.3825	-0.4688	-0.3253	-0.3386	-0.1372	0.7105
	P	-0.0083	-0.0088	0.0117	0.0131	0.0168	0.0167	0.0226	0.0139	0.0147	0.0036	0.6448
No. of Kernels/Row	G	-1.8202	-1.8926	2.5006	2.6967	2.9246	2.5394	2.1141	3.0467	1.4188	1.2113	0.8720
	P	-0.2838	-0.2949	0.3822	0.3725	0.4661	0.3973	0.3062	0.4960	0.1987	0.1062	0.8525
100 kernel wt. (g)	G	-0.3872	-0.3795	0.9468	1.0748	0.9927	1.0803	1.0705	0.6903	1.4823	0.4536	0.6122
	P	-0.0080	-0.0079	0.0234	0.0227	0.0260	0.0284	0.0285	0.0175	0.0438	0.0053	0.5355
Shelling%	G	0.0080	0.0082	-0.0020	-0.0046	-0.0074	-0.0058	-0.0052	-0.0071	-0.0055	-0.0178	0.5789
	P	-0.0910	-0.0881	0.0040	0.0239	0.0836	0.0676	0.0499	0.0661	0.0375	0.3090	0.4236

* Significant at 0.05 probability level; **Significant at 0.01 probability level;

G: Genotypic level; P:Phenotypic level

Genotypic residual effect = 0.2738 ; Phenotypic residual effect = 0.3146