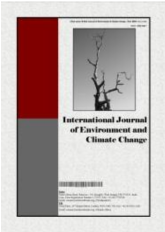

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Correlation and Path Coefficient Analysis in Maize (*Zea mays* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Maize is (*Zea mays* L.) is one of the versatile and diversified crop grown under different agro-climatic conditions. Twenty-eight experimental hybrids along with eight inbred lines and one commercial check were evaluated at agricultural polytechnic, Polasa, jagtial to determine correlation and path analysis for yield and yield attributing traits. The experiment was conducted in randomized block design with three replications. Correlation studies revealed that ear girth and 100 grain weight had showed highest positive significant correlation with grain yield per plant. Path coefficient analysis exhibited that days to 50% silking had highest positive direct effect on grain yield per plant followed by hundred grain weight, ear girth, number of kernels per row, number of kernels per row and plant height at phenotypic level and genotypic levels. Hence, these traits can be taken as the useful criteria for the development of superior hybrids that ultimately benefit the family community to improve their net income.

Keywords: Maize; correlation; path coefficient analysis.

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1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most popular feed, food and industrial crop among all the cereals in present world agriculture scenario due to its several uses and wider adaptability to different environments. Globally maize is grown in an area of 193.7 m ha with production and productivity levels of 1147.6 M T and 5920 kg/ha respectively. While in India production and productivity levels accounting for 27.23 M T and 2965 kg/ha. Hence there is a definite need of superior maize hybrids demand in the present scenario (FAO 2019) [1]. It is belonging to grass family Poaceae, tribe Maydeae and is highly cross-pollinated crop. It is considered as 'queen of cereals' due to its high adaptability and genetic potentiality. It is the third most important cereal crop after wheat and rice as it provides raw materials for agriculture-based industries in most growing regions of the world [2]. Maize has nutritive value it contains protein, starch, oil, fiber, ash and sugar in the content of 10%, 72%, 4.80%,8.50%, 1.70% and 30% respectively [3]. It is used as basic raw materials in numerous industrial products including oil, protein, starch alcoholic beverages, food sweeteners, pharmaceuticals, cosmetics, films, textiles, gums, packages, paper industries and so on [4].

Selection based on grain yield is not reliable because yield is a complex quantitative trait and it is governed by polygenes and also influenced by environmental factors in which the crop is grown. Correlation gives information about the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character Srijan et al. [5]. The path analysis gives the effective measures of direct and indirect causes of association and depicts the relative importance of each factor involved in contributing to the final product Jakhar et al. [6]. Correlation provides only the relation between two variables while path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations Wright [7].

2. MATERIALS AND METHODS

The current research work was carried out at Agricultural Polytechnic, Polasa, jagtial, Telangana during Kharif, 2020-2021, Rabi, 2021-2022. In Kharif, 2020-2021, twenty-eight (28) experimental hybrids were generated by crossing eight inbred lines in half-diallel mating design. These 28 experimental hybrids along with eight inbred lines and one commercial check were evaluated in Rabi, 2021-2022 for yield and yield attributing characters. These experimental hybrids were sown in Randomized Block Design with three replications. Every genotype was sown in three rows of three meters length with a spacing of 75 cm x 20 cm. The recommended dose of fertilizers N, P and K were applied in the ratio of 180: 60: 40 kg ha^{-1}. The complete P and K doses, as well as half of the nitrogen dose, were applied as a base, with the remaining half dose of nitrogen split into two equal split doses at the knee height and tasseling phases. Weeding operations, as well as necessary plant protection measures to protect the crop from pests and diseases, were carried out in accordance with the recommendations, as well as timely irrigation schedules to ensure a healthy crop. Observations were recorded i.e., days to 50% anthesis, days to 50% silking, anthesis silking interval, days to maturity, plant height (cm), ear height (cm), ear length (cm), ear girth (cm), number of kernel rows per ear, number of kernels per row, 100 grain weight and grain yield per plant. Genotypic and phenotypic correlations coefficients were worked out by adopting method described by Singh and Chaudhary [8]. Path coefficient analysis was done according to the procedure suggested by Dewey and Lu [9].

3. RESULTS AND DISCUSSION

Grain yield is the ultimate product desired in any resource programme which is dependent on various component traits. However, extent of association among various component traits and also with the grain yield is highly essential for selection of traits which aid the improvement in grain yield.

Genotypic correlation proved stable which brings in genetic improvement of a trait through the selection of genetically correlated traits. Observable association between two variables which is due to the genotypic and environmental effects which varies with the set of environmental conditions.

Persual of data presented indicated that genotypic values are higher than phenotypic values proved that the two characters are strongly correlated genotypically (Table1). The findings are in close proximity with the results Begum et al. [10], Reddy and Jabeen [11], Dash et al. [12]. Phenotypic correlation values provide the useful information on phenotypic expression of the traits which are very useful tools to discuss under set of environmental conditions.

Plant height was positive and significantly correlated with ear height, ear length, ear girth, number of kernels per row and 100 grain weight while, positive and non-significantly correlated with grain yield per plant. These results of significant and positive association are in consonance with findings of Kumar et al. [13] for ear length, ear girth and 100 grain weight; Chaurasia et al. [14], for ear length, ear diameter, number of kernels per row and 100 grain weight.

Ear height was positively and significantly associated with ear length, ear girth and number of kernels per row and 100 grain weight while, positive and non-significantly associated with number of kernel rows per ear with grain yield per plant.

Ear length was positively and significantly correlated with ear girth, number of kernels per row and 100 grain weight while, positive and non-significantly correlated with number of kernel rows per ear and grain yield per plant. These results collaborate the findings of Hosamani et al. [15] for Ear girth, number of kernels per row and 100-grain weight; Lenka et al. [16], for ear girth, number of kernels per row, number of kernel rows per ear and 100-grain weight.

Ear girth was positive and significantly correlated with number of kernel rows per ear, number of kernels per row and 100 grain weight while, positive and non-significantly correlated with grain yield per plant. Similar results were also reported by Amin et al. [17] for number of kernels per row, 100-grain weight and number of kernel rows per ear; Dash et al. [12] for number of kernels per row and number of kernel rows per ear.

Number of kernel rows per ear was positively and significantly correlated with number of kernels per row and 100 grain weight while, positive and non-significantly correlated with grain yield per plant. These results of significant and positive association were earlier reported by Sandeep et al. [18], Hosamani et al. [15] for number of kernel rows ear.

Number of kernels per row was positive and significantly correlated with 100 grain weight while, positive and non-significantly correlated with grain yield per plant. 100 grain weight positive and non-significantly correlated with grain yield per plant. These results of significant and positive association were earlier reported by Kumar et al. [13], Rajwade et al. [19] for 100-grain weight.

Perusal of the data on days to 50 per cent anthesis, days to 50% silking and days to maturity revealed that early maturing hybrids performed well under the situation which might be attributed to the escape from the higher temperatures in the later stages of the crop growth. In addition, tall growing hybrids also recorded higher grain yield due to their ability to synthesize higher photosynthetic assimilates and subsequent partitioning.

3.1 Path Coefficient Analysis

Correlation coefficient cannot depict the true association between traits as it will not provide information on direct and indirect effects which can obtained by path coefficient analysis, which is a kind of standardized partial regression coefficient. Further, it is difficult to identify the particular traits when multiple effects of genes are associated where the total correlation between yield and components are under estimated or overestimated and hence the association will be misleading. Keeping in view of the above, path analysis was also worked out for the purpose.

Direct effects of days to 50% tasseling was negative (-0.5336) and it was estimated significantly negative correlation with grain yield (-0.6041) which was mainly due to the indirect negative contribution exerted through days to 50% silking and days to maturity. The results of direct negative effect of days to 50 per cent tasseling on grain yield are in agreement with the earlier findings of Raghu et al. [20].

Days to 50% silking exhibited positive direct effect (0.5901) on grain yield was showed significantly negative correlation (-0.5758) which has been mainly attributed to the indirect negative contribution through anthesis silking interval, plant height, ear height, ear girth, ear length, number of kernel rows per ear, number of kernels per row and 100 grain weight. Anthesis silking interval exhibited direct positive effect on grain yield with positive significant correlation (0.3866) which was due to indirect contribution through days to 50% tasseling, days to 50% silking and days to maturity. The similar results reported by Matin et al. [21] for days to 50% silking and anthesis silking interval.

Table 1. Phenotypic and genotypic correlation coefficient for yield and yield attributing traits

Character		DT	DS	ASI	DM	PH	EH	EL	EG	KRE	KPR	100GW	GY
DT	P	1.000	0.9895***	-0.3780***	0.8110***	-0.4418***	-0.1424	-0.5993***	-0.6136***	-0.2298*	-0.6170***	-0.4462***	-0.6041
	G	1.000	0.9917	-0.4063	0.8184	-0.4446	-0.1472	-0.6061	-0.6275	-0.2379	-0.6648	-0.4577	-0.6082
DS	P		1.000	-0.2532**	0.8154***	-0.4214***	-0.1370	-0.5738***	-0.5898***	-0.1954*	-0.5894***	-0.4392***	-0.5758
	G		1.000	-0.2911	0.8236	-0.4234	-0.1414	-0.5825	-0.6041	-0.2010	-0.6369	-0.4516	-0.5797
ASI	P			1.000	-0.1968*	0.2199*	0.1041	0.3353***	0.4415***	0.3985***	0.3887***	0.1618	0.3866
	G			1.000	-0.2192	0.2418	0.1038	0.3573	0.4781	0.4387	0.4417	0.1806	0.4237
DM	P				1.000	-0.5008***	-0.2433*	-0.5873***	-0.4794***	-0.1438	-0.5708***	-0.5003***	-0.5819
	G				1.000	-0.5071	-0.2472	-0.5952	-0.4944	-0.1448	-0.6109	-0.5208	-0.5890
PH	P					1.000	0.6525***	0.8210***	0.3377***	-0.0508	0.6529***	0.4433***	0.6040
	G					1.000	0.6699	0.8334	0.3462	-0.0510	0.7037	0.4574	0.6064
EH	P						1.000	0.5300***	0.1907*	0.0401	0.4786***	0.3756***	0.4114
	G						1.000	0.5383	0.2006	0.0392	0.5237	0.4000	0.4260
EL	P							1.000	0.5352***	0.1282	0.7327***	0.5225***	0.7255
	G							1.000	0.5521	0.1345	0.7933	0.5382	0.7403
EG	P								1.000	0.7022***	0.5168***	0.5213***	0.8109
	G								1.000	0.7302	0.5564	0.5470	0.8260
KRE	P									1.000	0.2060*	0.2425*	0.5182
	G									1.000	0.2206	0.2638	0.5383
KPR	P										1.000	0.3129***	0.6550
	G										1.000	0.3377	0.7030
100GW	P											1.000	0.7729
	G											1.000	0.7965

** Significance at 0.05, ** significance at 0.01 and *** significance at 0.005*

Table 2. Phenotypic and genotypic path coefficient analysis for traits

Character		DT	DS	ASI	DM	PH	EH	EL	EG	KRE	KPR	100GW	GY
DT	P	-0.5336	-0.5280	0.2017	-0.4328	0.2358	0.0760	0.3198	0.3274	0.1226	0.3293	0.2381	-0.6041
	G	-1.7364	-1.7220	0.7055	-1.4211	0.7719	0.2557	1.0524	1.0895	0.4130	1.1543	0.7948	-0.6082
DS	P	0.5839	0.5901	-0.1494	0.4812	-0.2487	-0.0808	-0.3386	-0.3480	-0.1153	-0.3478	-0.2592	-0.5758
	G	1.7823	1.7972	-0.5232	1.4802	-0.7609	-0.2541	-1.0468	-1.0858	-0.3612	-1.1447	-0.8116	-0.5797
ASI	P	0.0355	0.238	-0.0939	0.0185	-0.0206	-0.0098	-0.0315	-0.0415	-0.0374	-0.0365	-0.0152	0.3866
	G	0.1099	0.0788	-0.2706	0.0593	-0.0654	-0.0281	-0.0967	-0.1294	-0.1187	-0.1195	-0.0489	0.4237
DM	P	-0.0041	-0.0041	0.0010	-0.0050	0.0025	0.0012	0.0029	0.0024	0.0007	0.0029	0.0025	-0.5819
	G	0.0230	0.0232	-0.0062	0.0281	-0.0143	-0.0070	-0.0167	-0.0139	-0.0041	-0.0172	-0.0147	-0.5890
PH	P	-0.0779	-0.0743	0.0388	-0.0883	0.1763	0.1150	0.1447	0.0595	-0.0090	0.1151	0.0781	0.6040
	G	-0.0492	-0.0468	0.0268	-0.0561	0.1107	0.0741	0.0922	0.0383	-0.0056	0.0779	0.0506	0.6064
EH	P	0.0108	0.0104	-0.0079	0.0185	-0.0496	-0.0760	-0.0403	-0.0145	-0.0030	-0.0364	-0.0286	0.4114
	G	0.0171	0.0164	-0.0121	0.0287	-0.0778	-0.1161	-0.0625	-0.0233	-0.0045	-0.0608	-0.0464	0.4260
EL	P	-0.0456	-0.0436	0.0255	-0.0447	0.0624	0.0403	0.0760	0.0407	0.0097	0.0557	0.0397	0.7255
	G	-0.0149	-0.0143	0.0088	-0.0146	0.0205	0.0132	0.0245	0.0136	0.0033	0.0195	0.0132	0.7403
EG	P	-0.1880	-0.1807	0.1353	-0.0468	0.1034	0.0584	0.1639	0.3063	0.2151	0.1583	0.1597	0.8109
	G	-0.1925	-0.1854	0.1467	-0.1517	0.1062	0.0616	0.1694	0.3068	0.2240	0.1707	0.1678	0.8260
KRE	P	-0.011	-0.0349	0.0712	-0.0257	-0.0091	0.0072	0.0229	0.1255	0.1787	0.0368	0.0433	0.5182
	G	-0.0397	-0.0335	0.0732	-0.0241	-0.0085	0.0065	0.0224	0.1218	0.1667	0.0368	0.0440	0.5383
KPR	P	-0.1483	-0.1416	0.0934	-0.1371	0.1569	0.1150	0.1760	0.1242	0.0495	0.2403	0.0752	0.6550
	G	-0.2756	-0.2640	0.1831	-0.2532	0.2917	0.2171	0.3288	0.2307	0.0915	0.4145	0.1400	0.7030
100GW	P	-0.1959	-0.1929	0.0710	-0.2197	0.1947	0.1649	0.2294	0.2289	0.1065	0.1374	0.4391	0.7729
	G	-0.2324	-0.2293	0.0917	-0.2644	0.2322	0.2031	0.2733	0.2777	0.1339	0.1715	0.5077	0.7965

DT: days to 50% tasseling, DS: days to 50% silking, ASI: anthesis silking interval, DM: days to maturity, PH: plant height, EH: ear height, EL: ear length, EG: ear girth, KRE: number of kernel rows per ear, KPR: number of kernels per row, 100GW: hundred grain weight, GY: grain yield

Days to maturity exhibited negative direct effect (-0.0050) with grain yield and was recorded significantly negative correlated (-0.5819) which was due to negative indirect effect through days to 50% tasseling and days to 50% silking.

Plant height exhibited direct positive effect (0.1763) on grain yield with positive correlation (0.6040) was due to indirect positive effects through anthesis silking interval, ear height, ear length, ear girth, number of kernels per row and 100 grain weight. Ear height showed positive direct effect (-0.0760) on grain yield with positive correlation (04114) was due to indirect positive effects through days to 50% tasseling, days to 50% silking and days to maturity. The similar findings reported by Dash et al. [12] for plant height and ear height.

Ear length registered positive direct effect (0.0760) on grain yield with positive correlation (0.7255) was due to indirect positive effects via plant height, ear height, ear girth, number of kernel rows per ear, number of kernels per row and 100 grain weight. The similar results accordance with Singh et al. [22].

Ear girth exhibited positive direct (0.3063) on grain yield with positive correlation (0.8109) was due to indirect positive effects through anthesis silking interval, plant height, ear height, ear length, number of kernel rows per ear, number of kernels per row and 100 grain weight. The same results reported by Gokulakrishnan et al. [23], Kanna et al. [24],

Number of kernel rows per ear had positive direct effect (0.1787) on grain yield with positive correlation (0.5182) was due to indirect positive effects through ear height, ear length, anthesis silking interval, number of kernels per row and 100 grain weight. The similar findings reported by Ahmed et al. [25], Chaurasia et al. [14].

Number of kernels per row showed positive direct effects (0.2403) on grain yield with positive correlation (0.6550) was due to indirect contribution through plant height, anthesis silking interval, ear height, ear girth, ear length, number of kernel rows per ear and 100 grain weight. For this trait Shikha et al. [26] reported same results.

Hundred grain weight showed positive direct effect (0.4391) on grain yield with positive correlation (0.7229) was due to indirect positive effect through anthesis silking interval, plant height, ear height, ear length, ear girth, number of kernel rows per ear and number of kernels per row. The same results reported by Dash et al. [12].

4. CONCLUSION

Correlation and Path analysis revealed that the traits ear girth and 100 grain weight exhibited the highest positive correlation and direct effect on the grain yield per plant both at phenotypic and genotypic levels. These characters play a major role in development of high yielding genotypes in future breeding programmes.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO, 2019. Agricultural production year book; (http://faostat.fao.org.).
2. Anees MU, Khan HZ, Ahmad Z, Akhtar MJ, Ahmad A, Choudhary FA, Ahmad N. Role of organic amendments and micronutrients in maize (*Zea mays* L.) sown on calcareous soils. American-Eurasian Journal of Agriculture and Environmental Science. 2016;16(4):795-800.
3. Mustafa FSB, Aslam M, Hasan EU, Hussain F, Farooq J. Genetic variability and path coefficient in maize (*Zea mays* L.) genotypes. The Journal of Agricultural Sciences, 2014;9(1):37-43.
4. Avinash J, Mishra DK. Genetic studies of elite landraces of maize based on divergence for yield and its components. Environment and Ecology. 2016;34 (3): 858-862.
5. Srijan A, Sudheer Kumar S, Damodar Raju Ch, Jagadeeshwar, R. Character association and path coefficient analysis

for grain yield of parents and hybrids in rice (Oryza sativa L.). Journal of Applied and Natural Science. 2016; 8(1):167-172.
6. Jakhar DS, Singh R, Kumar A. Studies on Path Coefficient Analysis in Maize (*Zea mays* L.) for Grain Yield and Its Attributes. International Journal of Current Microbiology and Applied Sciences. 6, 2851-2856.
7. Wright S. Correlation and causation. Journal of Agricultural Research. 1921;20:557-85.
8. Singh PK, Prasad MK, Chaudhari LB. Diversity study in maize (*Zea mays* L.). Journal of Applied Biology. 1977;9 (2):129 – 132
9. Dewey, D.R and Lu, K.H. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal. 1959; 51:515- 518.
10. Begum S, Ahmed A., Omy SH, Rohman, MM, Amiruzzaman, M. Genetic variability, character association and path analysis in maize (*Zea mays* L.). Bangladesh Journal of Agricultural Research. 2016;41(1):173-182
11. Reddy RV, Jabeen F. Narrow sense heritability, correlation and path analysis in maize (*Zea mays* L.). SABRAO Journal of Breeding and Genetics. 2016;48 (2):120-126.
12. Dash AP, Lenka D, Tripathy SK, Swain D Lenka D. Character association and path analysis of grain yield and its components in maize (*Zea mays* L.) under heat stress. International Journal of Current Microbiology and Applied Sciences. 2020;9(3): 2750-2758.
13. Kumar GP, Reddy VN, Kumar SS, Rao PV. Combining ability studies in newly developed inbred lines in maize (*Zea mays* L.). International Journal of Plant, Animal and Environmental Sciences. 2014;4(4): 229-234.
14. Chaurasia NK, Nirala RBP, Singh B Mandal SS. Trait association and path coefficient analysis in maize (*Zea mays* L.) for grain yield and its attributes. Journal of Pharmacognosy and Phytochemistry. 2020;9(6): 527-531.
15. Hosamani M, Kuchanur PH, Swamy N, Karajgi D.S, Honnappa. Studies on phenotypic correlation and path coefficient analysis of grain yield and its component traits in maize (*Zea mays* L.) hybrids. Journal of Pharmacognosy and Phytochemistry. 2018;7(5):1374-1377.
16. Lenka D, Singh B.P., Lenka, D and Tripathy, S.K. Inter-relationship of morphoeconomic traits in a set of maize inbred lines under deficit moisture condition. The Pharma Innovation Journal. 2020;9 (1):189-191.
17. Amin MdA, Azad MdAK, Shovon SR, Haque MF. Genetic variability and character association in maize (*Zea mays* L.) inbred lines. Turkish Journal of Agriculture-Food science and Technology. 2019;7(8):1125-1131.
18. Sandeep S, Bharathi M, Reddy VN. Intercharacter associations for grain yield and its attributes in inbreds of maize (*Zea mays* L.). International Journal of Pure and Applied Bioscience. 2017;5(4):1697 -1701.
19. Rajwade JK, Jagadev PN, Lenka D, Gupta S. Correlation and path coefficient studies on elite genotypes of maize inbred lines. Journal of Pharmacognosy and Phytochemistry. 2018;7(2): 2765-2771.
20. Raghu B, Suresh J, Sudheer Kumar S Saidaiah P. Character association and path analysis in maize (*Zea mays* L.). Madras Agricultural Journal. 2011;98 (1-3):7-9.
21. Matin MQI, Uddin MS, Rohman MM, Amiruzzaman M, Azad AK, Banik BR. Genetic variability and path analysis studies in hybrid maize (*Zea mays* L.). American Journal of Plant Sciences. 2017;8(12):3101-3109.
22. Singh D, Kumar A, Kumar R, Singh SK, Kushwaha N, Mohanty TA. Correlation and path coefficient analysis for ‘yield contributing ‘traits in quality protein Maize (*Zea mays* L.). Current Journal of Applied Science and Technology. 2020;39(25):91-99.
23. Gokulakrishnan M, Patel JM, Patel R.M., Chaudhary DR, Vaghela GK. Genetic variability of quantitative characters over diverse environments in maize inbred lines. Electronic Journal of Plant Breeding. 2021;12(4):1236-1243.
24. Ramesh Kanna M, Barman H, Sivasankarreddy K, Gogoi D, V Rao T, Sarma Barua N. Validation of Maize (*Zea mays* L.) Hybrids for the Study on Variability, Trait Association, and Path Analysis. International Journal of Plant & Soil Science. 2021; 33(23): 298-308.
25. Ahmed N, Chowdhury AK, Uddin MS, Rashad MMI. Genetic variability,

correlation and path analysis of exotic and local hybrid maize (*Zea mays* L.) genotypes. Asian Journal of Medical and Biological Research.2020; 6(1):.8-15.

26. Shikha K, Shahi JP, Singh S. Path coefficient analysis in maize (*Zea mays* L.) hybrids. Journal of Pharmacognosy and Phytochemistry. 2020:9(2):278-282.

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