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Studies on Genetic Association and Path Coefficient Analysis for Yield and Yield Attributing Characters 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

During *kharif*-2021, the present trial was carried out at the field experimentation centre of the Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Allahabad to assess genetic association and path coefficient analysis in forty-five maize genotypes, including one check variety SHAKTIMAN-5 for eighteen quantitative traits. Based on mean performance of 45 genotypes of maize, grain yield per plant was highest in case of MGC-240 [67.07 gm] and SHAKTIMAN-5 [64.87 gm] genotypes. On the basis of Analysis of variance, significant difference was recorded for all the grain yield and its components indicating presence of large amount of variability in the genotypes. The magnitude of GCV and PCV recorded highest for Grain yield per plant and Ear height. High heritability recorded in 100 grain weight, Ear height, plant height. High genetic advance was recorded in Plant height, biological yield per plant. High genetic advance as percent mean was recorded in Ear height, Grain yield per plant. Correlation studies revealed that Grain yield per plant at genotypic and phenotypic level was positively and significantly correlated with Cob weight, biological yield plant per plant and Cob girth. Path analysis revealed that Days to 75% maturity, biological yield per plant registered high and positive direct effect on Grain yield per plant in genotypic path analysis. In phenotypic path

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analysis revealed that Cob weight, Days to 50% silking registered high and positive direct effect on Grain yield per plant. It indicates true relationship between these traits and direct selection for these traits will be rewarding for yield improvement.

Keywords: Maize (Zea mays L.); genetic variability; heritability; genetic advance; genotypic correlation; phenotypic correlation; genotypic path analysis and phenotypic path analysis.

1. INTRODUCTION

The "Queen of Cereals," maize (*Zea mays* L.), is a significant cereal crop that is a member of the Maydeae tribe of the Poaceae grass family (Graminaceae). After rice and wheat, it is the third-most significant food crop in India. The suitability of maize to diverse environments is unmatched by any other crop. It is grown from latitude 58°N to 40°S, from sea level to higher than 3000 m altitudes and in areas receiving yearly rainfall of 250 mm to 5000 mm [1]. Maize plays a very important role in human and animal nutrition due to high nutritional significance enriched with abundant amount of starch, fibre, protein and fat along with micronutrients like vitamin B complex, B-carotene and essential minerals, i.e., magnesium, zinc, phosphorous, etc. Nutraceutical properties of phenolic and anthocyanin compounds in maize offer antioxidant activities that protects from various degenerative diseases [2]. Currently, 1147.7 million MT of maize is being produced together by over 170 countries from an area of 193.7 million ha with an average productivity of 5.75 t/ha [3]. In India, during the 2019-2020 cropping seasons, 9.7 million ha of land was covered with maize with national average productivity of 2.9 tonnes/ha and production of 28.6 million tonnes is still far below the world average 5.1 tons/ha (Department of Agriculture Cooperation, 2020). Whereas in Uttar Pradesh, it occupies an area 0.83 million hectares with an average productivity of 1.88 tonnes/ha and production of 1.56 million tonnes (Indian institute of maize research, 2019-2020).

Correlation coefficient analysis is a statistical technique which measures the degree and association between two or more variables. Estimates of correlation coefficient are useful in identifying the component traits which can be used for yield improvement of maize. Path coefficient analysis provides a thorough understanding of contribution of various characters by partitioning the correlation coefficient into components of direct and indirect effects [4], which helps the breeder in determining the yield components. To accumulate optimum contribution of yield contributing characters, it is essential to know the association of various characters along with path coefficients [5]. Therefore, present study was conducted to assess correlation and path analysis to identify component traits for developing high yielding varieties of maize.

1.1 Objectives

1. To evaluate of forty-five germplasms for yield and yield contributing characters.
2. To study the character association between yield and yield attributing traits.
3. To study direct and indirect effects of different characters on seed yield.

2. MATERIALS AND METHODS

The current study includes forty-five genotypes of maize in *kharif* 2021 at SHUATS, Prayagraj's experimentation centre of Genetics and Plant Breeding. During *kharif* -2021, the experiment was conducted in a randomised complete block design with three replications, with the indicated packages and practises for a healthy crop included. Days to 50% tasselling, Days to 50% silking, Anthesis-silking interval, Plant height (cm)Ear height (cm), Leaf width (cm), Leaf length (cm), Days to 75% maturity, Tassel length (cm), Cob weight (gm), Cob girth (cm), Cob length (cm), Number of grain rows per cob, Number of grains per row, 100 kernel weight (g), Biological yield per plant, Harvest index (%), Grain yield per plant (g). As per established methods, data were statistically analysed to determine genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability, genetic advance and genetic advance as a percent mean. For the analysis of variance, genotypic coefficient of variation and phenotypic coefficient of variation, standard statistical methods were utilised Burton [6], heritability Burton and Devane [7] and genetic advance Johnson et al. [8], Ai Jibouri et al. [9], used genotypic and phenotypic variances and co-variances to calculate genotypic and phenotypic correlation coefficients. The path coefficient study was carried out using the technique proposed by Dewey and Lu [10].

3. RESULTS AND DISCUSSION

For all of the traits studied, the analysis of variance indicated substantial differences between the genotypes (Table 1). As a result, it revealed a significant level of genetic heterogeneity among forty-five maize genotypes. Evaluation of genetic characteristics, correlation and path coefficient analysis aid in the examination of significant traits during the selection process for optimizing maize productivity. (Table 2) displays the genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance (GA) and genetic advance as a percent of mean GA (percent) for all yield contributing characteristics.

For all of the characters, PCV was higher than the matching GCV, indicating that the environment had an impact. The highest PCV and GCV were found for grain yield per plant (41.25 and 39.56), ear height (35.92 and 33.77), anthesis silking interval (35.74 and 20.70), cob weight (33.30 and 24.88), biological yield per plant (30.90 and 24.25), number of grain rows per cob (21.87 and 19.10) and plant height (20.44 and 18.89). Similar findings were reported by Khan et al. [11], Shankar et al. [12], Tadesse et al. [13] and Khulbe et al. [14]. The genotypic coefficient of variation estimations reflects the overall amount of genotypic variability present in the material.

Heritability, on the other hand, reflects the fraction of this genotypic polymorphism that is passed down from parents to offspring. Lush [15] proposed the broad sense heredity idea. It influences how effective genotypic variability may be used in a breeding programme. (Table 2) shows the heritability estimates obtained during the current investigation. The heritability of the qualities is moderate to high, ranging from 61.6 percent to 90.2 percent. 100 grain weight (90.2),

Table 1. Analysis of variance for 18 quantitative characters of 45 Maize genotypes

S. No.	Source	Replication	Genotypes	Error
	Degrees of freedom (df)	2	44	88
1	Days to 50% tasselling	7.78	45.78**	9.28
2	Days to 50% silking	2.85	34.62**	11.48
3	Anthesis- silking interval	4.76	94.05**	1.40
4	Plant height (cm)	278.15	103.73**	24.69
5	Ear height (cm)	2.30	3.64**	5.59
6	Leaf width (cm)	4.35	9.12**	6.25
7	Leaf length (cm)	49.29	3.38**	0.30
8	Days to 75% maturity	93.80	26.97**	19.25
9	Tassel length (cm)	13.74	3.81**	0.47
10	Cob weight (gm)	6.24	19.62**	1.11
11	Cob length (cm)	7.32	2.05**	5.59
12	Cob girth (cm)	12.09	6.79**	3.26
13	Number of Grains per row	44.82	16.96**	0.13
14	Number of grain rows per cob	13.12	16.85**	0.06
15	100 grain weight (gm)	39191.50	21.28**	0.15
16	Biological yield per plant	122.63	3.30**	15.63
17	Harvest index %	10.16	19.12**	8.96
18	Grain yield per plant (gm)	60.07	96.27**	20.59

*Level of significance at 5 %, ** Level of significance at 1%*

Table 2. Genetic parameters for 18 quantitative characters in Maize genotypes

Traits	GCV	PCV	Heritability (Broad sense) %	GA 5%	GAM 5%
Days to 50% tasselling	4.06	4.40	85.1	4.39	7.71
Days to 50% silking	4.45	5.00	79.0	4.93	8.15
Anthesis- silking interval	20.70	35.74	33.5	0.88	24.70
Plant height (cm)	18.89	20.44	85.4	48.49	35.95
Ear height (cm)	33.77	35.92	88.4	26.71	65.41
Leaf width (cm)	15.86	17.39	83.2	1.36	29.81
Leaf length (cm)	10.06	12.72	62.5	10.79	16.39
Days to 75% maturity	3.04	3.41	79.8	5.06	5.60
Tassel length (cm)	16.86	19.15	77.5	7.75	30.56
Cob weight (gm)	24.88	33.30	55.8	21.04	38.28
Cob length (cm)	16.80	19.16	76.9	3.57	30.36
Cob girth (cm)	9.81	11.93	67.5	1.79	16.59
Number of Grains per row	19.45	23.30	69.7	5.65	33.45
Number of grain rows per cob	19.10	21.87	76.2	3.63	34.35
100 grain weight (gm)	17.20	17.20	90.2	10.63	35.44
Biological yield per plant	24.25	30.90	61.6	31.87	39.21
Harvest index %	9.55	16.18	34.9	5.31	11.62
Grain yield per plant (gm)	39.56	41.25	56.2	17.70	45.72

PCV: Phenotypic Coefficient of Variation, GCV: Genotypic Coefficient of Variation, h^2bs: heritability (broad sense), GA: Genetic Advance, GAM: Genetic Advance as Percent of Mean

Table 3. Genotypic and Phenotypic correlation among the different traits evaluated in Maize during Kharif-2021

TRAITS		Days to 50% tasselling	Days to 50% silking	Anthesis- silking interval	Plant height (cm)	Ear height (cm)	Leaf width (cm)	Leaf length (cm)	Days to 75% maturity	Tassel length (cm)	Cob weight (gm)	Cob length (cm)	Cob girth (cm)	Number of Grains per row	Number of grain rows per cob	100 grain weight (gm)	Biological yield per plant	Harvest index %	Grain yield per plant (gm)
Days to 50% tasselling	G	1.000	0.944**	0.259	-0.106	-0.172	-0.028	-0.268	0.941**	-0.179	-0.431**	0.121	-0.414**	-0.285	-0.537**	0.026	-0.423**	-0.575**	-0.472**
	P	1.000	0.902**	0.152	-0.065	-0.121	-0.016	-0.205	0.901**	-0.138	-0.265	0.13	-0.268	-0.161	-0.398**	0.024	-0.277	-0.29	-0.285
Days to 50% silking	G		1.000	0.555**	-0.106	-0.215	-0.123	-0.333*	0.999**	-0.135	-0.527**	0.002	-0.508**	-0.297*	-0.620**	-0.128	-0.502**	-0.645**	-0.562**
	P		1.000	0.519**	-0.07	-0.162	-0.09	-0.233	0.999**	-0.082	-0.334*	0.062	-0.347*	-0.142	-0.430**	-0.114	-0.343*	-0.348*	-0.367*
Anthesis- silking interval	G			1.000	-0.087	-0.195	-0.287	-0.399**	0.564**	0.049	-0.415**	-0.361*	-0.390**	-0.244	-0.449**	-0.488**	-0.370*	-0.525**	-0.459**
	P			1.000	-0.059	-0.153	-0.137	-0.15	0.520**	0.058	-0.194	-0.112	-0.213	-0.056	-0.157	-0.282	-0.193	-0.251	-0.259
Plant height (cm)	G				1.000	0.895**	0.319*	0.601**	-0.121	0.294*	0.497**	0.411**	0.460**	0.505**	0.412**	0.185	0.644**	0.182	0.566**
	P				1.000	0.855**	0.319*	0.561**	-0.083	0.311*	0.402**	0.371*	0.357*	0.436**	0.317*	0.171	0.556**	0.057	0.443**
Ear height (cm)	G					1.000	0.281	0.563**	-0.239	0.218	0.519**	0.389**	0.485**	0.575**	0.522**	0.181	0.689**	0.124	0.591**
	P					1.000	0.273	0.470**	-0.184	0.227	0.386**	0.310*	0.396**	0.493**	0.424**	0.17	0.553**	0.077	0.446**
Leaf width (cm)	G						1.000	0.496**	-0.126	0.077	0.386**	0.332*	0.068	0.193	0.16	0.195	0.426**	0.017	0.327*
	P						1.000	0.523**	-0.093	0.126	0.363*	0.324*	0.114	0.219	0.178	0.178	0.424**	0.005	0.308*
Leaf length (cm)	G							1.000	-0.345*	0.495**	0.425**	0.231	0.342*	0.430**	0.515**	0.204	0.453**	0.371*	0.484**
	P							1.000	-0.243	0.436**	0.348*	0.222	0.241	0.359*	0.342*	0.161	0.432**	0.107	0.356*
Days to 75% maturity	G								1.000	-0.153	-0.528**	-0.016	-0.523**	-0.315*	-0.646**	-0.117	-0.507**	-0.645**	-0.568**
	P								1.000	-0.096	-0.337*	0.047	-0.360*	-0.157	-0.453**	-0.105	-0.348*	-0.350*	-0.373*
Tassel length (cm)	G									1.000	0.309*	0.275	0.434**	0.465**	0.500**	-0.087	0.302*	0.122	0.304*
	P									1.000	0.273	0.239	0.346*	0.396**	0.385**	-0.076	0.281	0.024	0.247
Cob weight (gm)	G										1.000	0.225	0.723**	0.669**	0.704**	0.229	0.938**	0.691**	0.967**
	P										1.000	0.347*	0.688**	0.653**	0.576**	0.171	0.931**	0.527**	0.944**
Cob length (cm)	G											1.000	0.2	0.094	0.168	0.074	0.350*	-0.186	0.262
	P											1.000	0.236	0.222	0.209	0.065	0.403**	0.015	0.355*
Cob girth (cm)	G												1.000	0.546**	0.794**	0.082	0.660**	0.757**	0.804**
	P												1.000	0.556**	0.742**	0.067	0.640**	0.597**	0.766**
Number of Grains per row	G													1.000	0.637**	-0.056	0.674**	0.398**	0.737**
	P													1.000	0.620**	-0.047	0.653**	0.401**	0.708**
Number of grain rows per cob	G														1.000	-0.145	0.644**	0.665**	0.740**
	P														1.000	-0.127	0.532**	0.472**	0.612**
100 grain weight (gm)	G															1.000	0.273	0.023	0.198
	P															1.000	0.214	0.013	0.148
Biological yield per plant	G																1.000	0.453**	0.936**
	P																1.000	0.333*	0.897**
Harvest index %	G																	1.000	0.720**
	P																	1.000	0.641**
Grain yield per plant (gm)	G																		1.000
	P																		1.000

G: genotypic correlation, P*: phenotypic correlation*

Table 4. Direct (Bold) and indirect effect at genotypic and phenotypic level for different quantitative traits on seed yield

TRAITS		Days to 50% tasselling	Days to 50% silking	Anthesis-silking interval	Plant height (cm)	Ear height (cm)	Leaf width (cm)	Leaf length (cm)	Days to 75% maturity	Tassel length (cm)	Cob weight (gm)	Cob length (cm)	Cob girth (cm)	Number of Grains per row	Number of grain rows per cob	100 grain weight (gm)	Biological yield per plant	Harvest index %	Grain yield per plant (gm)
Days to 50% tasselling	G	**-1.1514**	-1.0872	-0.2986	0.122	0.1984	0.0319	0.3084	-1.0832	0.2057	0.4958	-0.139	0.477	0.328	0.6188	-0.03	0.4869	0.6618	-0.472**
	P	**0.004**	0.0036	0.0006	-0.0003	-0.0005	-0.0001	-0.0008	0.0036	-0.0006	-0.0011	0.0005	-0.0011	-0.0007	-0.0016	0.0001	-0.0011	-0.0012	-0.285
Days to 50% silking	G	-1.6366	**-1.7332**	-0.9614	0.1845	0.3725	0.2129	0.5762	-1.7311	0.2344	0.9125	-0.0036	0.8804	0.5154	1.0751	0.2222	0.8693	1.1175	-0.562**
	P	0.2899	**0.3214**	0.1666	-0.0225	-0.052	-0.029	-0.0749	0.321	-0.0262	-0.1073	0.0198	-0.1116	-0.0456	-0.1381	-0.0366	-0.1101	-0.1119	-0.367*
Anthesis- silking interval	G	-0.074	-0.1583	**-0.2854**	0.0248	0.0555	0.0819	0.114	-0.1608	-0.0138	0.1183	0.103	0.1114	0.0695	0.1281	0.1391	0.1056	0.1499	-0.459**
	P	-0.0049	-0.0168	**-0.0324**	0.0019	0.0049	0.0044	0.0049	-0.0168	-0.0019	0.0063	0.0036	0.0069	0.0018	0.0051	0.0091	0.0063	0.0081	-0.259
Plant height (cm)	G	0.0314	0.0316	0.0258	**-0.2966**	-0.2655	-0.0945	-0.1784	0.0359	-0.0872	-0.1472	-0.1218	-0.1364	-0.1499	-0.1222	-0.0547	-0.1909	-0.0541	0.566**
	P	-0.0014	-0.0016	-0.0013	**0.0223**	0.019	0.0071	0.0125	-0.0018	0.0069	0.009	0.0083	0.008	0.0097	0.0071	0.0038	0.0124	0.0013	0.443**
Ear height (cm)	G	-0.0152	-0.019	-0.0172	0.0792	**0.0884**	0.0248	0.0497	-0.0212	0.0193	0.0459	0.0344	0.0429	0.0509	0.0462	0.016	0.0609	0.011	0.591**
	P	0.0019	0.0026	0.0024	-0.0136	**-0.0159**	-0.0043	-0.0075	0.0029	-0.0036	-0.0061	-0.0049	-0.0063	-0.0078	-0.0067	-0.0027	-0.0088	-0.0012	0.446**
Leaf width (cm)	G	0.0003	0.0013	0.0031	-0.0034	-0.003	**-0.0108**	-0.0053	0.0014	-0.0008	-0.0042	-0.0036	-0.0007	-0.0021	-0.0017	-0.0021	-0.0046	-0.0002	0.327*
	P	0.0004	0.002	0.003	-0.0071	-0.0061	**-0.0223**	-0.0116	0.0021	-0.0028	-0.0081	-0.0072	-0.0025	-0.0049	-0.004	-0.004	-0.0094	-0.0001	0.308*
Leaf length (cm)	G	-0.0412	-0.0511	-0.0614	0.0924	0.0864	0.0763	**0.1536**	-0.053	0.0761	0.0653	0.0355	0.0526	0.066	0.0791	0.0314	0.0696	0.057	0.484**
	P	-0.0034	-0.0039	-0.0025	0.0093	0.0078	0.0087	**0.0166**	-0.004	0.0073	0.0058	0.0037	0.004	0.006	0.0057	0.0027	0.0072	0.0018	0.356*
Days to 75% maturity	G	2.9867	3.1705	1.7891	-0.3841	-0.7596	-0.3983	-1.095	**3.1745**	-0.4845	-1.6766	-0.0501	-1.6597	-0.9999	-2.0516	-0.3725	-1.6087	-2.0466	-0.568**
	P	-0.3041	-0.3374	-0.1757	0.0279	0.062	0.0314	0.082	**-0.3377**	0.0325	0.1138	-0.0158	0.1217	0.0531	0.153	0.0354	0.1175	0.118	-0.373*
Tassel length (cm)	G	0.0358	0.0271	-0.0097	-0.059	-0.0437	-0.0155	-0.0993	0.0306	**-0.2007**	-0.062	-0.0551	-0.087	-0.0932	-0.1004	0.0174	-0.0606	-0.0245	0.304*
	P	0.0062	0.0037	-0.0026	-0.014	-0.0102	-0.0057	-0.0197	0.0043	**-0.0451**	-0.0123	-0.0108	-0.0156	-0.0179	-0.0174	0.0034	-0.0127	-0.0011	0.247
Cob weight (gm)	G	-0.0333	-0.0407	-0.032	0.0384	0.0401	0.0298	0.0329	-0.0408	0.0239	**0.0773**	0.0174	0.0559	0.0517	0.0544	0.0177	0.0726	0.0534	0.967**
	P	-0.1025	-0.1289	-0.075	0.1552	0.149	0.1401	0.1343	-0.1301	0.1055	**0.3862**	0.1339	0.2656	0.2522	0.2224	0.0661	0.3594	0.2034	0.944**
Cob length (cm)	G	0.0193	0.0003	-0.0576	0.0655	0.062	0.0529	0.0369	-0.0025	0.0438	0.0358	**0.1595**	0.0319	0.015	0.0269	0.0117	0.0558	-0.0297	0.262
	P	0.0065	0.0031	-0.0056	0.0185	0.0154	0.0161	0.0111	0.0023	0.0119	0.0173	**0.0499**	0.0118	0.0111	0.0104	0.0032	0.0201	0.0007	0.355*
Cob girth (cm)	G	-0.1332	-0.1633	-0.1255	0.1478	0.1559	0.0219	0.1099	-0.168	0.1393	0.2324	0.0642	**0.3214**	0.1754	0.2552	0.0263	0.2122	0.2432	0.804**
	P	-0.0387	-0.0501	-0.0307	0.0515	0.0571	0.0164	0.0347	-0.052	0.0499	0.0992	0.034	**0.1443**	0.0801	0.1071	0.0097	0.0923	0.0861	0.766**
Number of Grains per row	G	-0.0463	-0.0483	-0.0396	0.0821	0.0935	0.0313	0.0698	-0.0512	0.0755	0.1087	0.0152	0.0887	**0.1625**	0.1035	-0.0091	0.1095	0.0647	0.737**
	P	-0.0205	-0.018	-0.0071	0.0554	0.0626	0.0279	0.0457	-0.02	0.0503	0.083	0.0282	0.0706	**0.1271**	0.0787	-0.0059	0.083	0.0509	0.708**
Number of grain rows per cob	G	-0.0957	-0.1105	-0.08	0.0734	0.093	0.0285	0.0917	-0.1151	0.0891	0.1253	0.03	0.1414	0.1135	**0.1781**	-0.0258	0.1147	0.1185	0.740**
	P	0.0336	0.0363	0.0133	-0.0267	-0.0358	-0.0151	-0.0289	0.0383	-0.0326	-0.0486	-0.0177	-0.0627	-0.0523	**-0.0845**	0.0107	-0.0449	-0.0399	0.612**
100 grain weight (gm)	G	0.0014	-0.0067	-0.0256	0.0097	0.0095	0.0102	0.0107	-0.0062	-0.0046	0.012	0.0039	0.0043	-0.0029	-0.0076	**0.0524**	0.0143	0.0012	0.198
	P	-0.0004	0.002	0.0049	-0.003	-0.003	-0.0031	-0.0028	0.0018	0.0013	-0.003	-0.0011	-0.0012	0.0008	0.0022	**-0.0175**	-0.0037	-0.0002	0.148
Biological yield per plant	G	-0.2393	-0.2838	-0.2094	0.3642	0.3898	0.2409	0.2565	-0.2867	0.1709	0.531	0.1979	0.3736	0.3811	0.3643	0.1543	**0.5658**	0.256	0.936**
	P	-0.0874	-0.1081	-0.061	0.1755	0.1743	0.1337	0.1362	-0.1098	0.0885	0.2935	0.127	0.2019	0.206	0.1677	0.0675	**0.3154**	0.105	0.897**
Harvest index %	G	-0.0807	-0.0906	-0.0738	0.0256	0.0174	0.0023	0.0521	-0.0906	0.0171	0.097	-0.0261	0.1063	0.0559	0.0935	0.0032	0.0636	**0.1405**	0.720**
	P	-0.0642	-0.0771	-0.0555	0.0126	0.0171	0.0012	0.0238	-0.0775	0.0052	0.1167	0.0033	0.1323	0.0888	0.1046	0.0029	0.0738	**0.2216**	0.641**

G: genotypic path analysis, P*: phenotypic path analysis.*

Ear height (88.4), Plant height (85.4), Days to 50% tasselling (85.1), Leaf width (83.2), Days to 75% maturity (79.8), Days to 50% silking (79), Tassel length (77.5), Cob length (76.9), Number of grain rows per cob (76.2), Number of grains per row (69.7), Cob girth (67.5), Leaf length (62.5), Biological yield per plant (61.6). The high heritability values of the qualities examined in this study revealed that they were less influenced by the environment, allowing for successful selection of traits based on phenotypic appearance using a simple selection strategy and indicating the possibility of genetic progress. Similar findings were reported by Supraja et al. [16] and Mohammedali et al. [17].

High genetic advance was recorded for Plant height (48.49), Biological yield per plant (31.87), Ear height (26.71), Cob weight (21.04). Similar findings were reported by Al-Amin et al. [18] and Khulbe et al. [14].

High genetic advance as percent mean was recorded for Ear height (65.41), Grain yield per plant (45.72), Biological yield per plant (39.21), Cob weight (38.28), Plant height (35.95), 100 grain weight (35.44), Number of grain rows per cob (34.35), Number of grains per row (33.45), Tassel length (30.56), Cob length (30.36), Leaf width (29.81), Anthesis-silking interval (24.70). Similar findings were reported by Shankar et al. [12], Supraja et al. [16] and Khulbe et al. [14].

During the correlation study, associations between yield and yield contributing features were investigated under study. (Table 3) shows the phenotypic and genotypic correlation coefficients between the investigated features of 45 maize genotypes on different quantitative traits. In most cases, the genotypic correlation was higher than that of phenotypic correlation; reveal that association may be largely due to genetic reason (strong coupling linkage) [19]. Cob weight (0.967**, 0.944**), biological yield per plant (0.936**, 0897**), cob grith (0.804**, 0.766**), number grain rows per cob (0.740**, 0.612**), number grain per row (0.737**, 0.708**), Harvest index (0.720**, 0.641**), ear height (0.591**, 0.466**), plant height (0.566**, 0.443**), leaf length (0.484**, 0.356*) are positively and significantly correlated with grain yield per plant in both genotypic and phenotypic correlation. Similar findings were reported by Varalakshmi et al. [20], Barrtaula et al. [21] and Dash et al. [22].

Path analysis is one of the most accurate statistical techniques for determining the interdependence of features and the degree of control of independent characters on seed production, either directly or indirectly Mushtaq et al. [23]. When it comes to choosing high yielding germplasm, the idea of direct and indirect influence of yield contributing traits on the final end product yield in any crop is crucial. (Table 4) depicted the direct and indirect effects of 18 different quantitative characters. In genotypic path analysis revealed that days to 75% maturity (3.1745), Biological yield per plant (0.5658). Cob girth (0.3214), Number of grain rows per cob (0.1781), Number of grains per row (0.1625), Cob length (0.1595), Leaf length (0.1536), Harvest index (0.1405) are direct effect on grain yield per plant. Similar findings were reported by Sharma RK et al., [24], Kumar S et al., [25], Hemavathy AT et al., [26], Gazal A et al., [27].

In phenotypic path analysis revealed that cob weight (0.3862), Days to 50% silking (0.3214), Biological yield per plant (0.3154), Harvest index (0.2216), Cob girth (0.1443), Number of grains per row (0.1271) are direct effect on grain yield per plant. Similar findings were reported by Sharma RK et al., [24], Kumar S et al., [25] Hemavathy AT et al., [26], Gazal A et al., [27], Sood BC et al., [28], Ulaganathan V et al., [29].

4. CONCLUSION

Cob weight, Ear height, Number of grains per row, 100 grain weight, Number of grain rows per cob, Cob length, biological yield per plant, Harvest index %, Plant height, Days to 75% maturity all these characters contribute to higher grain yield per plant, according to genetic association and path coefficient analysis in this study. Therefore, these characters should be given previously during selection for yield improvement in maize.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dowswell CR, Paliwal RL, Cantrell RP. Maize in the Third World. Westview Press. 1996;268.
2. Shikha B, Manpreet J, Ramanjit K. Nutritive value of Maize. Maize – Production and Use, IntechOpen. 2019;1-14.
3. FAOSTAT Statistical Database. Food and Agriculture Organization of the United Nations. [Rome]: FAO; 2020.

4. Wright S. Correlation and causation. Journal of Agriculture Research. 2019; 21:557-587.
5. Bhutia P, Lal GM, Thomas N. Studies on genetic variability, correlation and path analysis in green gram [*Vigna radiata* (L.) Wilczek] germplasm. International Journal of Agriculture Science. 2016;8(51):2267-2272.
6. Burton GW. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress. 1952;1:227-283.
7. Burton GW, Dewane EM. Estimating heritability from replicated clonal material. Agronomy Journal. 1953;45:478-481.
8. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlations in soybeans and their implication in selection. Agronomy Journal. 1955;47:477-483.
9. Al-Jibouri HA, Miller PA, Robinson HF. Genotypic and environmental variances and covariances in upland cotton crosses of interspecific origin. Agronomy Journal. 1958;50:633-636.
10. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass and seed production. Agronomy Journal. 1959;51:515-7.
11. Khan AS, Ullah H, Shahwar D, Fahad S, Khan N, Yasir M, Wahid F, Adnan M, Noor M. Heritability and correlation analysis of morphological and yield traits in maize. Journal of Plant Biology and Crop Research. 2018;2:1008.
12. Shankar M, Singh R, Shahi JP. Studies on genetic variability, heritability and genetic advance in maize (*Zea mays* L.) for yield and its components. Maize Journal. 2018; 7(1):23-26.
13. Tedesse J, Leta T. Association and path coefficient analysis among grain yield and related traits in Ethiopian maize (*Zea mays* L.) inbred lines. African Journal of Plant Science. 2019;13(9):264-272.
14. Khulbe RK, Sharma D, Pattanayak A, Kant L. Genetic variability, association and contribution of different characters towards grain yield in sweet corn (*Zea mays* var. saccharata) in North Western Hills. Indian Journal of Hill. 2020;33(2):254-260.
15. Lush JL. Heritability off quantitative characters in farm animals. Proc. Amer. Soc. Animal Prod. 1947;35:293-301.
16. Supraja V, Sowmya HC, Kuchanur PH, Kisan B. Genetic variability and character association studies in maize (*Zea mays* L.) inbred lines. International Journal of Current Microbiology and Applied Sciences. 2019;8(10):646-656.
17. Mohammedali A. Md., Omer A. Md., Abdalla G. Md., Kamaleldin AMAT, Ahmed EMM. Genetic variability, heritability and genetic advance estimates in some Maize (*Zea mays* L.) Varieties in Sudan. International Journal of Food Science and Agriculture. 2020;5(1):85-90.
18. Al-Amin Md, Azad AK Md., Shovon SR, Haque F. 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.
19. Sharma JR. Statistical and biometrical techniques in plant breeding. New age international (Pvt) Ltd., New Delhi. Reprint: 1988;2008:35.
20. Varalakshmi S, Wali MC, Deshpande SK, Harlapur SI. Correlation and path coefficient analysis in single cross hybrids in maize. International Journal of Current Microbiology and Applied Sciences. 2018; 7:1840-1843.
21. Bartaula S, Panthi U, Timilsena K, Acharya SS, Shrestha J. Variability, heritability and genetic advance of Maize (*Zea mays* L.) genotypes. Research in Agriculture, Live-stock and Fisheries. 2019;6(2):163-169.
22. 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;3:2750-2758.
23. Mushtaq MA, Bajwa MM, Saleem M. Estimation of genetic variability and path analysis of grain yield and its components in chickpea (*Cicer arietinum* L.). International Journal of Science and Engineering Research. 2013;4(1):1-4.
24. Sharma RK, Kumar S. Association analysis for grain yield and some quantitative traits in popcorn. Crop Improvement. 1987;14(2):201-204.
25. Kumar S, Shahi JP, Singh J, Singh SP. Correlation and path analysis in early generation inbreds of maize (*Zea mays* L.). Crop Improvement. 2006;33(2):156-160.
26. Hemavathy AT, Balaji K, Ibrahim SJ, Anand G, Deepa S. Genetic variability and correlation studies in maize (*Zea mays* L.). Agricultural Science Digest. 2008;28(2): 112-114.

27. Gazal A, Dar ZA, Lone AA, Yousuf N, Gulzar S. Studies on maize yield under drought using correlation and path coefficient analysis. International Journal of Current Microbiology and Applied Sciences. 2018;7(1):516-521.
28. Sood BC, Khajuria V. Genetic and anatomical characterization of land races of maize (*Zea mays* L.) for lodging and yield related traits. Indian Journal of Genetics. 2006;66(4):337-338.
29. Ulaganathan V, Ibrahim SM, Gurusamy A. Path analysis studies in maize genotypes. Ecology, Environment and Conservation. 2015;2(21):909-913.

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