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

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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

Aim: To study the association between characters through correlation and path analysis for 30 elite maize lines
Study Design: Randomized Block Design with three replications.
Place and Duration of Study: The experiment was conducted at Seed Research and Technology Centre *Rabi* 2020-21.
Methodology: Character association studies will help to assess the relationship between the yield and its contributing traits for enhancing efficiency selection. Because of this, the present research

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work was carried out to assess the correlation coefficient and path analysis among thirty maize inbred lines for eighteen yield, yield contributing characters and seedling vigour traits in maize (*Zea mays* L.).

Results: Correlation studies revealed that plant height (0.3566**), ear height (0.2135**), ear length (0.3505**), ear diameter (0.4973**), number of kernel rows (0.3471**), 100-seed weight (0.5359**), cob yield per plant (0.9883**) and seed vigour index-2 (0.3412**) were significant and positively correlated with the grain yield per plant. Path analysis showed that cob yield per plant had the highest positive direct effect on grain yield per plant followed by shelling percentage (0.0094), seed vigour index -1 (0.0131), seed vigour index-2 (0.0125), 100 seed weight (0.0122), days to tasseling (0.0108), germination first count (0.0094), speed of germination (0.0060), number of kernels per row (0.0058), ear diameter (0.0057) suggesting that grain yield could be indirectly enhanced by the selection of these characters.

Keywords: Maize; inbreds; correlation; path analysis; coefficient.

1. INTRODUCTION

Maize (*Zea mays* L.) is grown as a multipurpose crop of global importance and *queen of cereal*. Traditionally, maize is a *kharif* crop but can be grown around the year. In India, it is the third most important food crop after rice and wheat in terms of area (9.8 million hectares), production (31.6 million tonnes) and productivity (31.9 quintals per hectare) (*Indiastat*, 2020-21).

Grain yield is the most economically important character and the focus of many maize breeding programmes. The yield of maize like rest crops is the final product attributed to a complex chain of interrelating effects of different characters [1]. However, It is a complex trait, a product of many components which subjects it to high environmental influence. As a result, direct selection would not be effective and efficient. Only a better understanding and knowledge of the interrelations between grain yield and its contributing components through the use of correlation and path coefficient analysis can significantly improve the efficiency of breeding programmes through the use of appropriate selection indices [2].

Genetic correlation analysis is a handy technique which elaborates on the degree of association among important quantitative traits. It is not sufficient to describe their relationship when the causal association among characteristics is needed [3]. The studies on correlation are quite old and extensive but, unfortunately, there is hardly any rule set on how much a character contributes towards the expression of other characters in a plant population [4]. Sometimes, estimates of correlation coefficients provide misleading results as the correlation between two variables may be due to the involvement of a third factor. As the number of variables increases, the measurement of the contribution of each variable towards the observed correlation is imperative. Therefore, portioning the observed correlation coefficients into components of direct and indirect influences provide perceptions in the characterization of more complex traits like yield [5].

Under such conditions, path coefficient analysis [6] which partitions the correlation coefficient, provides precise information on the direct and indirect effects to perceive the most influencing characters to be utilized as selection criteria in maize breeding programmes. Such studies could lead plant breeders in the selection of traits contributing towards the characters of concern, and ultimately their improvement through hybridization [7]. Accordingly, the present study was carried out to generate information on the relationship between yield and yield contributing traits to find important traits for the selection process.

2. MATERIALS AND METHODS

The field experiment was conducted at Seed Research and Technology Centre (SRTC), Rajendranagar, during *rabi* 2020-21 laid out in Randomized Block Design. Thirty maize genotypes were sown by adopting a spacing of 75 X 20 cm, the plot size was 24m^2 in 6 metres in length with 4 rows and three replications. Recommended agronomic package of practices was followed to raise a healthy crop.

Data were recorded on 10 randomly selected plants for characters viz., plant height, ear height, ear length, ear diameter, number of rows per ear, number of kernels per row, 100-seed weight, shelling percentage, cob yield per plant, germination 1st count, germination 2nd count, seed vigour index-1, seed vigour index-2, speed of germination, and grain yield per plant. Days to 50% tasseling, days to 50% silking and days to maturity, observations were taken on the plot basis. Readings from ten plants were averaged replication wise and the mean value was used for statistical analysis. The data collected were subjected to statistical analysis using INDOSTAT software version 9.2 and the methods adopted by the software for the analysis of variance (ANOVA) was described by [8]. Correlation coefficients were calculated by using the formulae given by [9]. The direct and indirect effects at both the genotypic and phenotypic levels were measured by considering the grain yield per plant as a dependent variable, using path coefficient analysis, as proposed by [6] and [10].

3. RESULTS AND DISCUSSION

The direction and level of correlation between yield and its component features, as well as among themselves, determine the effectiveness of yield selection. Character association gives information on the kind and level of relationship between pairs of metric features and aids in character selection. In 30 genotypes, phenotypic and genotypic correlations on yield, yield contributing traits and seed vigour traits were determined. In general, genotypic correlations were higher than phenotypic correlations, showing a strong inherent link between the characters investigated.

Phenotypic correlation studies revealed that plant height (0.3566**), ear height (0.2135**), ear length (0.3505**), ear diameter (0.4973**), number of kernels of row (0.3471**), 100-seed weight (0.5359**), cob yield per plant (0.9883**), and seed vigour index-2 (0.3412**) were positive and significantly correlated with grain yield per plant (Table 1). The significant correlation indicates that there is a strong association between various traits and grain yield per plant. Therefore, selection for these characters will be rewarding in yield improvement. The results were in agreement with the findings of [11-16]. Hence simultaneous selection can be done in these positively correlated traits through further breeding programmes.

Number of rows per ear (0.1213), germination 1st count (0.1504), germination 2nd count (0.0884), seed vigour index-1 (0.1882) and speed of germination (0.1269) showed a positive correlation with grain yield per plant. Similar results were also reported by [4] Ahmed *et al.* (2020) for number of rows per ear, [17] and [18] for germination 1st count, germination 2nd count, seed vigour index-1, and speed of germination in soyabean. Therefore, it suggests that during the selection, preference should be given to these characters for a better yield. The correlation between two variables may be attributable to a third component, high correlation coefficients may not always give an accurate picture or may mislead the judgement.

Days to tasseling (-0.1746), days to maturity (-0.1758), and shelling percentage (-0.0677) exhibited non significant negative correlation whereas days to silking (-0.2280*) recorded a negatively significant correlation. The negative correlation will hinder the improvement in such situations some economic comprises have to be made. There result are in agreement with the finding of [13] and [14].

Path coefficient analysis provides an exact picture of the relative importance of direct and indirect effects of each of the component characters towards yield. It measures the cause of the association between two variables based on all possible simple correlations among the various characters and also based on the assumptions of linearity and additively. It provides an actual contribution of traits on the yield in the form of direct and indirect effects. As a result, it aids breeders in determining the best and most important component traits during selection to improve yield. The direct and indirect effects of yield contributing traits on grain yield are given in Table 2.

Path coefficient analysis revealed that days to tasseling (0.0108), ear diameter (0.0057), number of kernels per row (0.0058), 100-seed weight (0.0122), shelling percentage (0.1439), cob yield per plant (1.0014), germination 1st count (0.0094), seed vigour index-1 (0.0131), seed vigour index-2 (0.0125) and speed of germination (0.0060), had a positive direct effect on grain yield per plant, implying that selecting for these characteristics would likely to result in an overall improvement in grain yield per plant. Similar findings were reported by [4],[12], [14] and [19] for days to 50% tasseling, ear diameter, number of kernels per row, cob yield per plant, [20] for 100 seed weight, [15] for Shelling percentage, [18] for seed vigour traits in soyabean. As a result, it is advised that these characteristics should be prioritized in the yield

Table 1. Phenotypic (P) and Genotypic (G) correlation coefficients of yield, yield components and seed vigour traits in maize (*Zea mays* L.)

Character	DT	DS	DM	PHT	EHT	EL	ED	NR	NKR
DT	1.000	0.9722**	0.5781**	0.0142	-0.1081	0.1599	-0.0928	-0.1017	-0.0300
DS	1.000	0.9897	1.5602	0.0725	-0.1102	0.1380	-0.0780	-0.1867	-0.1022
DM		1.000	0.5671**	-0.0755	-0.1593	0.1600	-0.1112	-0.1114	-0.0475
PHT		1.000	1.6275	-0.0425	-0.1694	0.1050	-0.0993	-0.2019	-0.0950
EHT			1.000	-0.0587	-0.0203	0.0271	-0.1740	-0.1772	-0.1199
EL			1.000	-0.0343	-0.3300	0.2209	-0.1437	-0.2676	-0.0901
ED				1.000	0.4116**	0.3662**	0.1140	-0.1339	0.0924
NR				1.000	0.5699	0.4693	0.0418	-0.4786	0.0762
NKR					1.000	0.3187**	0.1000	-0.0785	0.2324*
100 SWT					1.000	0.4180	0.1477	-0.1115	0.3599
SHP						1.000	-0.1941	-0.1836	0.3829**
CYP						1.000	-0.2744	-0.5065	0.5995
GM 1st							1.000	0.5163**	0.1124
GM 2nd							1.000	0.7612	-0.0192
SVI-1								1.000	0.1861
SVI-2								1.000	0.2617
SPG									1.000

** Significant at 5 per cent level; ** Significant at 1 per cent level*

DT: Days to Tasseling, DS: Days to Silking,DM: Days to maturity, PHT: Plant height (m), EHT: Ear height (cm), EL: Ear length (cm), ED: Ear diameter, NR: Number of rows per ear, NKR: Number of kernels per row, 100 SW: 100-seed weight, SHP: Shelling %, CYP: Cob yield per plant (g), GM 1st: Germination 1st count,GM 2nd: Germination 2nd count, SVI-1: Seed Vigour index-1, SVI-2: Seed Vigour index-2, SPG: Speed of Germination, GYP: Grain yield per plant (g)

Table 1. (Contd.) Phenotypic (P) and Genotypic (G) correlation coefficients of yield, yield components and seed vigour traits in maize (*Zea mays* L.)

Character		100 SWT	SHP	CYP	GM 1st	GM 2nd	SVI-1	SVI-2	SPG	GYP
DT	**P**	-0.0693	-0.1684	-0.1318	-0.3042**	-0.4021**	-0.1850	-0.2652*	0.1587	**-0.1746**
	G	-0.0899	-0.3015	-0.1350	-0.3536	-0.4697	-0.1778	-0.3041	0.1955	**-0.1915**
DS	**P**	-0.1029	-0.1824	-0.1823	-0.3092**	-0.4228**	-0.1871	-0.3186**	0.1047	**-0.2280***
	G	-0.1381	-0.2879	-0.1758	-0.3679	-0.5052	-0.1832	-0.3796	0.1335	**-0.2311**
DM	**P**	-0.0461	-0.0803	-0.1459	-0.1236	-0.1475	-0.0523	-0.1836	0.1041	**-0.1758**
	G	-0.2459	-0.3632	-0.3554	-0.6629	-0.8890	-0.3933	-0.3082	0.0600	**-0.4287****
PHT	**P**	0.4220**	0.1899	0.3377**	0.1695	0.1539	0.0816	0.2818**	0.1212	**0.3566****
	G	0.5648	0.2609	0.3873	0.2816	0.2909	0.1565	0.3888	0.1825	**0.4185****
EHT	**P**	0.1817	0.1655	0.1844	0.1497	0.1219	0.3317**	0.3124**	0.0108	**0.2135***
	G	0.1761	0.1925	0.1957	0.1184	0.0754	0.0391	0.3007	-0.0021	**0.2244***
EL	**P**	0.1718	0.1666	0.3297**	0.0836	0.0686	0.2907**	0.5047**	0.1305	**0.3505****
	G	0.2323	0.2028	0.3910	0.1409	0.1556	0.3917	0.6170	0.1595	**0.4252****
ED	**P**	0.1883	-0.3850**	0.5371**	-0.1105	-0.2294*	-0.0760	-0.1253	0.2861**	**0.4973****
	G	0.2219	-0.7040	0.6311	-0.1212	-0.2772	-0.0834	-0.1414	0.3796	**0.5633****
NR	**P**	-0.3519**	-0.4008**	0.1677	-0.0839	-0.1254	0.0425	-0.1367	0.3902**	**0.1213**
	G	-0.4434	-0.9300	0.1846	-0.0603	-0.1471	0.0847	-0.1716	0.6084	**0.1069**
NKR	**P**	-0.2368*	-0.1269	0.3343**	0.1706	0.1585	0.4387**	0.3339**	0.1495	**0.3471****
	G	-0.3623	-0.1322	0.4489	0.2695	0.2806	0.6682	0.4761	0.2227	**0.4582****
100 SW	**P**	**1.000**	0.1727	0.5161**	-0.0209	-0.0148	-0.3014	0.1060	-0.1579	**0.5359****
	G	**1.000**	0.2237	0.5446	-0.0377	-0.0344	-0.3269	0.1017	0.1687	**0.5634****
SHP	**P**		**1.000**	-0.2052	0.1789	0.2125*	0.0944	0.2719**	-0.3837**	**-0.0677**
	G		**1.000**	-0.2894	0.2520	03084	0.1253	0.3573	-0.4917	**-0.1641**
CYP	**P**			**1.000**	0.1123	0.0481	0.1505	0.2826**	0.1729	**0.9883****
	G			**1.000**	0.1115	0.0464	0.1572	0.3004	0.1843	**0.9915****
GM 1st	**P**				**1.000**	0.8417**	0.5606**	0.2663*	0.0649	**0.1504**
	G				**1.000**	0.8372	0.5386	0.2413	0.0372	**0.1558**
GM 2nd	**P**					**1.000**	0.4474**	0.3945**	0.0672	**0.0884**
	G					**1.000**	0.4038	0.3808	0.0352	**0.0951**
SVI-1	**P**						**1.000**	0.5543**	0.1982	**0.1882**
	G						**1.000**	0.5464	0.1871	**0.1919**
SVI-2	**P**							**1.000**	0.2915**	**0.3412****
	G							**1.000**	0.2813	**0.3642****
SPG	**P**								**1.000**	**0.1269**
	G								**1.000**	**0.1363**

*** Significant at 5 per cent level; ** Significant at 1 per cent level**

DT: Days to Tasseling, DS: Days to Silking,DM: Days to maturity, PHT: Plant height (m), EHT: Ear height (cm), EL: Ear length (cm), ED: Ear diameter, NR: Number of rows per ear, NKR: Number of kernels per row, 100 SW: 100-seed weight, SHP: Shelling %, CYP: Cob yield per plant (g), GM 1st: Germination 1st count, GM 2nd: Germination 2nd count, SVI-1: Seed Vigour index-1, SVI-2: Seed Vigour index-2, SPG: Speed of Germination, GYP: Grain yield per plant (g)

Table 2. Phenotypic (P) and Genotypic (G) path coefficients of yield, yield components and seed vigour traits in maize (*Zea mays* L.)

Character		DT	DS	DM	PHT	EHT	EL	ED	NR	NKR
DT	**P**	0.0108	-0.0164	-0.0053	-0.0002	0.0002	-0.0032	-0.0005	0.0004	-0.0009
	G	0.5997	9.2149	0.8509	0.1199	0.0673	-0.1836	-0.0309	-0.1292	-0.2523
DS	**P**	0.0105	-0.0169	-0.0052	0.0013	0.0003	-0.0032	-0.0006	0.0005	-0.0015
	G	-0.5011	0.3106	0.8876	-0.0704	0.1035	-0.1397	-0.0393	-0.1397	-0.2347
DM	**P**	0.0063	-0.0096	-0.0092	0.0010	0.0000	-0.0005	-0.0010	0.0007	-0.0038
	G	-1.9779	15.1533	0.5453	-0.0567	0.2016	-0.2939	-0.0569	-0.1852	-0.2226
PHT	**P**	0.0002	0.0013	0.0005	-0.0168	-0.0007	-0.0074	0.0006	0.0006	0.0029
	G	-0.6958	-0.3961	-0.0187	1.6544	-0.3482	-0.6245	0.0165	-0.3312	0.1881
EHT	**P**	-0.0012	0.0027	0.0002	-0.0069	-0.0018	-0.0064	0.0006	0.0003	0.0073
	G	1.0577	-1.5772	-0.1800	0.9428	-0.6110	-0.5562	0.0585	-0.0772	0.8888
EL	**P**	0.0017	-0.0027	-0.0002	-0.0062	-0.0006	-0.0202	-0.0011	0.0008	0.0120
	G	-1.3248	0.9773	0.1205	0.7764	-0.2554	-1.3307	-0.1086	-0.3505	1.4805
ED	**P**	-0.0010	0.0019	0.0016	-0.0019	-0.0002	0.0039	0.0057	-0.0021	0.0035
	G	0.7491	-0.9247	-0.0784	0.0691	-0.0903	0.3651	0.3960	0.5267	-0.0474
NR	**P**	-0.0011	0.0019	0.0016	0.0022	0.0001	0.0037	0.0029	-0.0041	0.0058
	G	1.7919	-1.8794	-0.1459	-0.7917	0.0681	0.6740	0.3014	0.6920	0.6464
NKR	**P**	-0.0011	0.0019	0.0016	0.0022	0.0001	0.0037	0.0029	-0.0041	0.0058
	G	0.9808	-0.8847	-0.0491	0.1260	-0.2199	-0.7977	-0.0076	0.1811	2.4696
100 SWT	**P**	-0.0008	0.0017	0.0004	-0.0071	-0.0003	-0.0035	0.0011	0.0015	-0.0074
	G	0.8629	-1.2854	-0.1341	0.9344	-0.1076	-0.3091	0.0879	-0.3069	-0.8948
SHP	**P**	-0.0018	0.0031	0.0007	-0.0032	-0.0003	-0.0034	-0.0022	0.0017	-0.004
	G	2.8943	-2.6802	-0.198	0.4316	-0.1176	-0.2699	-0.2787	-0.6436	-0.3264
CYP	**P**	-0.0014	0.0031	0.0013	-0.0057	-0.0003	-0.0067	0.003	-0.0007	0.0105
	G	1.2958	-1.6366	-0.1938	0.6407	-0.1196	-0.5202	0.2499	0.1278	1.1085
GM 1st	**P**	-0.0033	0.0052	0.0011	-0.0028	-0.0003	-0.0017	-0.0006	0.0003	0.0054
	G	3.3945	-3.4258	-0.3615	0.4658	-0.0724	-0.1875	-0.0480	-0.0418	0.6654
GM 2nd	**P**	-0.0044	0.0072	0.0014	-0.0026	-0.0002	-0.0014	-0.0013	0.0005	0.0050
	G	4.5089	-4.7040	-0.4848	0.4812	-0.0461	-0.2070	-0.1098	-0.1018	0.6930
SVI-1	**P**	-0.0020	0.0032	0.0005	-0.0014	-0.0006	-0.0059	-0.0004	-0.0002	0.0138
	G	1.7068	-1.7053	-0.2145	0.2589	-0.1889	-0.5213	-0.0330	0.0586	1.6502
SVI-2	**P**	-0.0029	0.0054	0.0017	-0.0047	-0.0006	-0.0102	-0.0007	0.0006	0.0105
	G	2.9192	-3.5345	-0.3317	0.6432	-0.1837	-0.8211	-0.0560	-0.1187	1.1758
SPG	**P**	0.0017	-0.0018	-0.001	-0.002	0.0000	-0.0026	0.0016	-0.0016	0.0047
	G	-1.8766	1.2430	0.0327	0.3020	0.0013	-0.2123	0.1503	0.4211	0.5500

Genotypic Residual effect = 0.1739 **Phenotypic Residual effect = 0.0499** **Bold values are direct effects**

DT: Days to Tasseling, DS: Days to Silking, DM: Days to maturity, PHT: Plant height (m), EHT: Ear height (cm), EL: Ear length (cm), ED: Ear diameter, NR: Number of rows per ear, NKR: Number of kernels per row, 100 SW: 100-seed weight, SHP: Shelling %, CYP: Cob yield per plant (g), GM 1st: Germination 1st count, GM 2nd: Germination 2nd count, SVI-1: Seed Vigour Index-1, SVI-2: Seed Vigour Index-2, SPG: Speed of Germination, GYP: Grain yield per plant (g).

Table 2. (Contd.) Phenotypic (P) and Genotypic (G) path coefficients of yield, yield components and seed vigour traits in maize (*Zea mays* L.)

Character		100 SWT	SHP	CYP	GM 1st	GM 2nd	SVI-1	SVI-2	SPG	GYP
DT	P	-0.0008	-0.0242	-0.1320	-0.0028	0.0054	-0.0024	-0.0033	0.0010	-0.1746
	G	-0.2478	0.3828	0.3055	-0.1829	0.1423	0.0907	-0.6045	-0.1348	-0.1915
DS	P	-0.0013	-0.0263	-0.1826	-0.0029	0.0057	-0.0025	-0.0040	0.0006	-0.2280
	G	-0.3806	0.3654	0.3978	-0.1903	0.1531	0.0934	-0.7546	-0.0920	-0.2311
DM	P	-0.0006	-0.0116	-0.1461	-0.0012	0.0020	-0.0007	-0.0023	0.0006	-0.1758
	G	-0.6778	0.4610	0.8044	-0.3429	0.2693	0.2006	-1.2089	-0.0414	-0.4287
PHT	P	0.0051	0.0273	0.3382	0.0016	-0.0021	0.0011	0.0035	0.0007	0.3566
	G	1.5569	-0.3312	-0.8764	0.1456	-0.0881	-0.0798	0.7729	-0.1259	0.4185
EHT	P	0.0022	0.0238	0.1847	0.0014	-0.0016	0.0044	0.0039	0.0001	0.2135
	G	0.4854	-0.2443	-0.4429	0.0613	-0.0229	-0.1576	0.5977	0.0015	0.2244
EL	P	0.0021	0.0240	0.3302	0.0008	-0.0009	0.0038	0.0063	0.0008	0.3505
	G	0.6402	-0.2575	-0.8848	0.0729	-0.0471	-0.1998	1.2266	-0.1100	0.4252
ED	P	0.0023	-0.0554	0.5379	-0.0010	0.0031	-0.0010	-0.0016	0.0017	0.4973
	G	0.6117	0.8937	-1.4282	-0.0627	0.0840	0.0425	-0.2811	-0.2617	0.5633
NR	P	-0.0043	-0.0577	0.1680	-0.0008	0.0017	0.0006	-0.0017	0.0024	0.1213
	G	-1.2224	1.1807	-0.4178	-0.0312	0.0446	-0.0432	-0.3410	-0.4195	0.1069
NKR	P	-0.0029	-0.0183	0.3347	0.0016	-0.0021	0.0058	0.0042	0.0009	0.3471
	G	-0.9988	0.1678	-1.0158	0.1394	-0.0850	-0.3408	0.9464	-0.1535	0.4582
100 SW	P	0.0122	0.0249	0.5169	-0.0002	0.0002	-0.0040	0.0013	-0.0010	0.5359
	G	2.7566	-0.2840	-1.2326	-0.0195	0.0104	0.1667	0.2021	0.1163	0.5634
SHP	P	0.0021	0.1439	-0.2055	0.0017	-0.0028	0.0012	0.0034	-0.0023	-0.0677
	G	0.6166	-1.2695	0.655	0.1303	-0.0934	-0.0639	0.7102	0.339	-0.1641
CYP	P	0.0063	-0.0295	1.0014	0.0011	-0.0006	0.002	0.0035	0.001	0.9883
	G	1.5014	0.3674	-2.2631	0.0577	-0.0141	-0.0802	0.5971	-0.1271	0.9915
GM 1st	P	-0.0003	0.0257	0.1124	0.0094	-0.0113	0.0074	0.0033	0.0004	0.1504
	G	-0.1038	-0.3199	-0.2523	0.5172	-0.2536	-0.2747	0.4797	-0.0256	0.1558
GM 2nd	P	-0.0002	0.0306	0.0482	0.0079	-0.0134	0.0059	0.0049	0.0004	0.0884
	G	-0.0947	-0.3915	-0.1050	0.4331	-0.3029	-0.2059	0.7569	-0.0243	0.0951
SVI-1	P	-0.0037	0.0136	0.1508	0.0052	-0.0060	0.0131	0.0069	0.0012	0.1882
	G	-0.9011	-0.1591	-0.3557	0.2786	-0.1223	-0.5100	1.0861	-0.1290	0.1990
SVI-2	P	0.0013	0.0391	0.2830	0.0025	-0.0053	0.0073	0.0125	0.0018	0.3412
	G	0.2802	-0.4535	-0.6798	0.1248	-0.1154	-0.2786	1.9878	-0.1940	0.3642
SPG	P	-0.0019	-0.0552	0.1731	0.0006	-0.0009	0.0026	0.0036	0.006	0.1269
	G	-0.4651	0.6242	-0.4172	0.0192	-0.0107	-0.0954	0.5593	-0.6895	0.1363

Genotypic Residual effect = 0.1768 Phenotypic Residual effect = 0.0499 Bold values are direct effects

DT: Days to Tasseling, DS: Days to Silking,DM: Days to maturity, PHT: Plant height (m), EHT: Ear height (cm), EL: Ear length (cm), ED: Ear diameter, NR: Number of rows per ear, NKR: Number of kernels per row, 100 SW: 100-seed weight, SHP: Shelling %, CYP: Cob yield per plant (g), GM 1st: Germination 1st count, GM 2nd: Germination 2nd count, SVI-1: Seed Vigour index-1, SVI-2: Seed Vigour index-2, SPG: Speed of Germination, GYP: Grain yield per plant (g) improvement programme. This means that if other characters remain constant, an increase in one of these characters will increase grain yield, confirming that these characters are significant contributors to phenotypic crop improvement.

On the contrary, negative direct effect exhibited by some traits like days to silking (-0.0169), days to maturity (-0.0092), plant height (-0.0168), ear height (-0.0018), ear length (-0.0202), number of rows per ear (-0.0041), germination 2nd count (-0.0134) exhibited negative direct effect. These results are in conformity with the findings of [12], [14] and [21] for days to silking, ear height and ear length, [5] and [13] for days to maturity, plant height and number of rows per ear, [18] for germination 2nd count. As a result, the findings suggest that the indirect selection of these traits could be more effective.

Residual effect for phenotypic and genotypic are 0.0499, and 0.1768 respectively and are low in magnitude. Low values of residual effect indicate that the traits included in the study explained a high percentage of variation in grain yield.

4. CONCLUSION

According to the findings of this study, the traits ear height, ear diameter, ear length, number of kernels per row, 100 seed weight, seed vigour index-2 and cob weight per plant were important for selecting maize genotypes because these traits had a positive significant correlation, and most of these traits also had direct effects on cob weight per plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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