International Journal of Plant & Soil Science

34(22): 1442-1455, 2022; Article no.IJPSS.91673
ISSN: 2320-7035

Genetic Variability and Character Association for Grain Yield Components in Maize (*Zea mays* L.)

Yeruva Venkata Subba Reddy [a*#], Gaibriyal M. Lal [a†], Kaja Yesu Babu [a#], Bheeram Vinod Kumar [a#] and Sirigireddy Ganga Maheshwar Reddy [a#]

[a] *Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, India.*

Authors' contributions

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

Article Information

DOI: 10.9734/IJPSS/2022/v34i2231517

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91673

Original Research Article

Received 12 July 2022
Accepted 06 September 2022
Published 07 September 2022

ABSTRACT

The present investigation was carried out to assess the genetic variability parameters, correlation and path analysis in twenty-one maize genotypes for sixteen quantitative traits *Kharif* seasons at Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Uttar Pradesh in Randomized Block Design replicated thrice. Analysis of variance for all sixteen quantitative characters revealed that treatment differences were highly significant under study at 1% level in *Kharif* season. The present investigation objective was oriented to calculate and estimate yield traits through analyzing the mean performance, variability, expected genetic advance, correlation coefficient and path analysis involving the yield attributing characters. Among 21 genotypes, BML-13 (109.67), MGW-376 (108.93) genotypes were found to be superior for grain yield per plant over the check (Shaktiman-5). GCV for all the characters were less than PCV, indicating the influence of environmental component on the expression of the character. High heritability coupled with high genetic advance as percent mean in the present genotypes was recorded for traits plant height, ear height, grain rows per cob, cob weight, biological yield per plant, 100 grain weight, grain yield per plant. Path coefficient and Correlation analysis revealed that ear height, cob length, cob girth, grain

[#] *M.sc (Agriculture);*
[†] *Assistant Professor;*
**Corresponding author: E-mail: venkatayv777@gmail.com;*

rows per cob, grains per row, number of cobs per plant, cob weight and biological yield per plant had positive correlation and direct effects with grain yield per plant. Therefore, it is concluded that effective selection must be attempted for these traits which would help in improvement of grain yield in maize genotypes.

Keywords: Variability parameters; heritability; genetic advance; association analysis; maize (Zea mays L.).

1. INTRODUCTION

Maize (*Zea mays* L.; 2n=20) is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America. It is one of the most versatile crops having wider adaptability that can be grown in diverse seasons and ecologies, is also known as “Miracle Crop” and “Queen of the Cereals” because of its highest genetic yield potential. The suitability of maize to diverse environments is unmatched by any other crop. Nutraceutical properties of phenolic and anthocyanin compounds in maize offer antioxidant activities that protects from various degenerative diseases [1]. In India, during the 2020-2021 cropping seasons, 9.2 million ha of land was covered with maize with national average productivity of 2.96 tonnes/ha and production of 27.8 million tonnes is still far below the world average 5.1 tonnes/ha. Whereas in Uttar Pradesh, it occupies an area 0.83 million hectares with an average productivity of 1.89 tonnes/ha and production of 1.56 million tonnes (Department of Agriculture Cooperation, 2021) [2]. The knowledge on the nature and magnitude of the genetic variation leading the inheritance of quantitative characters like yield and its components is crucial for effective genetic improvement The study of variability and genetic advance in the germplasm will help to ascertain the real potential of the genotype [3]. Yield is a complex quantitative character controlled by many genes interacting with the environment and is the product of many factors called yield components [4]. Association studies could lead plant breeders in the selection of traits contributing towards the characters of concern and ultimately their improvement [5]. The appropriate knowledge of such inter-relationships between yield and its contributing components can significantly improve the efficiency of breeding programmes through the use of appropriate selection indices [6]. A correlation coefficient tells that whether there is relationship between two variables and whether the relationship is positive or negative and how strong or weak the relationship [7]. An understanding of the nature and magnitude of variability for grain yield and its components among the inbred lines of maize and to ascertain the association among and between each component and yield is necessary for selecting an appropriate breeding procedure for evolving high yielding varieties. Therefore, present investigation was undertaken for the estimation of coefficient of variation, heritability and expected genetic advance for yield and yield attributing traits, the extent of correlation among traits at both phenotypic and genotypic levels, path coefficient analysis for direct and indirect effect of yield contributing traits on grain yield per plant which would be helpful for enhancing the maize grain productivity. The main objective of the study is to estimate Genetic Variability parameters for grain yield components and to study the Correlation between yield and yield attributing characters in Maize genotypes.

2. MATERIALS AND METHODS

The current study includes 21 genotypes of maize in *Kharif* 2021 at SHAUTS, Prayagraj experimentation Centre of Genetics and Plant Breeding. During Kharif -2021 the experiment was conducted in Randomised Block Design with 3 replications and row to row spacing is (60 cm) and plant to plant spacing is (30cm) with plot size is of 2mx2m. Replication wise data on the basis of 5 randomly taken best competitive genotype plants from each replication were recorded on following 16 quantitative traits, Days to tasseling (50%), Days to silking (50%), Anthesis-silking interval, Plant height (cm), Ear height (cm), Days to maturity (75%), Cob length (cm), Cob girth (cm), Number of grain rows per cob, Number of grains per row, Number of Cobs per plant, Cob weight (gm), Biological yield per plant (gm), Harvest index (%), 100 grain weight (gm), Grain yield per plant (gm). As per established methods, data were analyzed to determine Analysis of Variance [8], Coefficient of Variation [9], Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), Estimation of Heritability (Broad sense) [10], Genetic Advance [11], Genotypic and Phenotypic Correlation [12].

2.1 Layout Description

Season	:	*Kharif*-2021
Crop	:	Maize (*Zea mays* L.)
Experimental design	:	Randomized Block Design
Number of Replications	:	03
Number of Genotypes	:	21 (20 Genotypes + 1Check)
Size of each bund	:	0.3 m
Net area	:	252m^2
Gross area	:	297m^2
Row to row distance	:	60 cm
Plant to plant distance	:	20 cm
Date of Sowing	:	15/07/2021
Fertilizer dose	:	NPK @120:60:60 kg/ha

Recommended package of practices were followed to raise a healthy crop.

Table 1. List of experimental material used in the present investigation

S. No.	Genotypes	S. No.	Genotypes
1	GP-88	12	MGW-426
2	MGW-379	13	MGW-325
3	MGC-18	14	MGC-89
4	MGC-52-1	15	MGW-357
5	MGC-13	16	GP-19
6	MGW-376	17	BML-13
7	MGW-401	18	BML-14
8	GP-85	19	MGW-353
9	BML-80	20	GP-87
10	MGW-366	21	SHAKTIMAN – 5 (Check)
11	MGW-316		

Source – Professor Jayashankar Telangana State Agricultural University; Hyderabad

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

Analysis of variance for all sixteen quantitative characters (Table 2) revealed that treatment differences were highly significant under study at 1% level (α = 0.01) except for number of cobs per plant level (α = 0.05) indicating the presence of inherent genetic differences in our experimental material which means. Significant variation among genotypes indicated the presence of genotypic differences suggesting the importance of their genetic value in order to identify the best genetic makeup for a particular condition, there by provide better scope for selection.

3.1.1 Phenotypic and genotypic variance

The variability estimates such as phenotypic variance, genotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h^2), genetic advance (GA), genetic advance as a percent of mean (GAM) for fifteen characters are explained under the following heads. For all the traits PCV was higher than matching GCV indicating that the environment had an impact. In present study, Phenotypic coefficient of variation (PCV) was observed high for character grain yield per plant (37.34) followed by ear height (36.39), number of cobs per plant (34.56), anthesis-silking interval (33.47), cob weight (31.55), biological yield per plant (26.76) and 100 grain weight (20.66), The Genotypic coefficient of variation (GCV) was also observed in similar pattern as PCV, high GCV was observed for characters ear height (35.12) followed by grain yield per plant (34.86), cob weight (26.48), biological yield per plant (23.49) and anthesis-silking interval (21.66). The present findings are in accordance with earlier findings reported by Bello et al. [7], Rajesh et al. [13], Kumar et al. [14], Patil et al. [15], and Khan et al. [16].

3.1.2 Heritability

The estimates of genotypic coefficient of variation reflect the total amount of genotypic variability present in the material. However, the proportion of this genotypic variability which is transmitted from parents to progeny is reflected by heritability. [17] gave the concept of broad sense heritability. It determines the efficiency with which we can utilize the genotypic variability in a breeding programme. present study, broad sense heritability (h^2) estimates were observed to be high for characters such as for 100 grain weight (93.58%) followed by ear height (93.08%), grain yield per plant (87.16%) and days to 50% tasseling (86.07%), days to 75% maturity (79.31%), days to 50% silking (78.20%), biological yield per plant (77.05%), plant height (72.68%), cob weight (70.46%) and grain rows per cob (67.33%), High heritability values for characters 100 grain weight, ear height, grain yield per plant, days to 50% tasseling, days to 75% maturity, days to 50% silking, biological yield per plant, plant height, cob weight and grain rows per cob indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore may make his selection safely on the basis of phenotypic expression of these characters in the individual plant by adopting simple selection methods. The High heritability indicates the scope of genetic improvement of these characters through selection. Similar findings of heritability for grain yield per plant and other characters have also been reported by Bhoite and Sonone [18], Pandey et al. [19] and [16].

3.1.3 Genetic advance

In present study, estimates of genetic advance ranged from 0.25 to 50.12, highest GA estimates were observed for grain yield per plant (50.12), followed by biological yield per plant (36.65), plant height (28.56), ear height (28.55), cob weight (24.57), 100 grain weight (11.12), harvest index (7.07), days to 75% maturity (5.41), days to 50% silking (5.14), days to 50% tasseling (4.58), grain rows per cob (3.99), number of grains per row (2.95), cob length (1.76), cob girth (1.52), anthesis-silking interval (0.82) and number of cobs per plant (0.25). The results are in conformity with the findings of Rajesh et al. [13], Dagla et al. [20], Begum et al. [21], Patil et al. [15], Singh et al. [22] and Beulah et al. [23].

3.1.4 Genetic advance as % of mean

In the present study, the estimates of genetic advance as % of mean varied from 5.97% to 69.79%. High GAM was observed for characters such as ear height (69.79%) followed by grain yield per plant (67.04%), cob weight (45.79%), biological yield per plant (42.46%), 100 grain weight (39.82%), anthesis-silking interval (28.87%), grain rows per cob (23.03%) and plant height (20.09%). Moderate level of GAM was recorded for number of cobs per plant (17.15%), cob length (14.09), number of grains per row (13.74%) and cob girth (12.99%), while low GAM was observed for the remaining character *viz.,* days to 50% silking (8.50%), days to 50% tasseling (8.04%) and days to 75% maturity (5.97%). These obtained results are in accordance to similar findings with some deviation of Nagabhusan et al. [24], Badawy et al. [25], Rajesh et al. Bekele and Rao [26], Beulah et al.[23] Hassan et al. [27], Bartaula et al. [28] and Supraja et al. [29].

3.2 Correlation Study

Phenotypic and Genotypic correlation coefficient among yield and yield components in Maize. The phenotypic (r_p) correlations were computed to know the nature and magnitude of relationship existing between yield and its component characters as well as the association among the component characters in Maize. The values of rg > rp depicted negative influence of environment in the development of an association. The information on correlation of grain yield with related traits is the prerequisite to form an effective selection strategy aimed at its improvement. The low phenotypic correlations could result due to masking and modifying effect of environment on the association of characters at genotypic level. The genotypic and phenotypic correlation amongst the traits followed almost similar trends of association, where the former being a little higher in most of the cases, indicated the existence of strong inherent association between the characters in the breeding material (Table 4,5). At both genotypic and phenotypic level, seed yield per plant exhibited a highly significant positive association with ear height, cob length, cob girth, grain rows per cob, grains per row, number of cobs per plant, cob weight and biological yield per plant.Similar findings were also reported by with some deviation of Aditi et al. (2014), Hussain et al. (2014), Kumar et al. [30], Kumar et al. (2015), Vijay et al. [31], Gurpinder et al. (2016) and Varalakshmi et al. [32].

Table 2. Analysis of Variance for sixteen quantitative characters of Maize (*Zea mays* L.) genotypes during *Kharif*-2021

S. No.	Characters	Mean Sum of Squares		
		Replication (d.f = 2)	**Treatment (d.f = 20)**	**Error (d.f = 40)**
1	Days to 50% tasselling	1.76	18.14**	0.93
2	Days to 50% silking	1.86	26.15**	2.22
3	Anthesis-silking interval	0.87	1.67**	0.53
4	Plant height (cm)	266.81	892.99**	99.42
5	Ear height (cm)	53.98	634.79**	15.35
6	Days to 75% maturity	1.00	28.34**	2.27
7	Cob length	0.70	4.98**	1.04
8	Cob girth	0.07	3.37**	0.63
9	Grain rows per cob	5.32	19.41**	2.70
10	Grains per row	3.26	21.12**	6.61
11	Number of cobs per plant	0.05	0.39*	0.19
12	Cob weight	2.38	690.56**	84.637
13	Biological yield per plant (gm)	52.16	1354.98**	122.40
14	Harvest Index (%)	60.92	127.36**	41.22
15	100 grain weight	19.24	95.63**	2.13
16	Grain yield per plant (gm)	344.83	2137.45**	100.08

**Significant at 5% level of significance ** Significant at 1% level of significance*

Table 3. Genetic parameters for 16 quantitative characters in 21 Maize genotypes

S. No.	Characters	GCV	PCV	Heritability	Genetic Advance (5%)	Genetic Advance as % of mean (5%)
1	Days to 50% tasseling	4.21	4.54	86.07	4.58	8.04
2	Days to 50% silking	4.67	5.28	78.20	5.14	8.50
3	Anthesis-silking interval	21.66	33.47	41.88	0.82	28.87
4	Plant height (cm)	11.44	13.42	72.68	28.56	20.09
5	Ear height (cm)	35.12	36.39	93.08	28.55	69.79
6	Days to 75% maturity	3.26	3.66	79.31	5.41	5.97
7	Cob length	9.15	12.25	55.83	1.76	14.09
8	Cob girth	8.19	10.64	59.29	1.52	12.99
9	Grain rows per cob	13.63	16.61	67.33	3.99	23.03
10	Grains per row	10.26	15.79	42.25	2.95	13.74
11	Number of cobs per plant	16.96	34.56	24.09	0.25	17.15
12	Cob weight	26.48	31.55	70.46	24.57	45.79
13	Biological yield per plant (gm)	23.49	26.76	77.05	36.65	42.46
14	Harvest Index (%)	11.44	17.86	41.06	7.07	15.10
15	100 grain weight	19.98	20.66	93.58	11.12	39.82
16	Grain yield per plant (gm)	34.86	37.34	87.16	50.12	67.04

GCV: Genotypic Coefficient of Variation, PCV: Phenotypic coefficient of variation

Table 4. Phenotypical Correlation Coefficients among different traits of Maize evaluated During *Kharif* – 2021

Traits	DT	DS	ASI	PH	EH	DM	CL	CG	GRPC	NGPR	NCPP	CW	BYPP	HI	100GW	GYPP
DT	1	0.925**	0.201	-0.162	-0.319*	0.913**	-0.009	-0.296*	-0.069	-0.248*	-0.078	-0.283*	-0.369**	0.019	-0.079	-0.032
DS		1	0.399**	-0.235	-0.379**	0.985**	-0.121	-0.274*	-0.134	-0.251*	-0.088	-0.385**	-0.496**	-0.052	-0.108	-0.162
ASI			1	-0.208	-0.271*	0.415**	-0.379**	-0.198	-0.219	-0.150	-0.014	-0.389**	-0.555**	-0.011	-0.341**	-0.271*
PH				1	0.804**	-0.245	0.451**	0.153	0.047	0.108	0.073	0.272*	0.216	-0.013	-0.111	0.154
EH					1	-0.418**	0.564**	0.290*	0.280*	0.135	0.069	0.370**	0.355**	0.037	-0.015	0.274*
DM						1	-0.158	-0.304*	-0.137	-0.279*	-0.092	-0.387**	-0.491**	-0.059	-0.096	-0.147
CL							1	0.233	0.393**	0.221	0.055	0.446**	0.347**	0.210	0.049	0.325**
CG								1	0.289*	0.292*	0.116	0.309*	0.313*	0.194	-0.016	0.336**
GRPC									1	0.045	0.176	0.618**	0.476**	0.333**	0.149	0.435**
NGPR										1	0.274*	0.012	0.182	-0.089	-0.054	0.371**
NCPP											1	-0.042	0.201	-0.213	-0.086	0.502**
CW												1	0.745**	0.475**	0.316*	0.249*
BYPP													1	0.225	0.411**	0.463**
HI														1	0.138	-0.051
100GW															1	-0.095
GYPP																1

DT: Days To Tasseling, DS: Days To Silking , ASI: Anthesis-Silking Interval, PH: Plant Height (cm), EH: Ear Height (cm), DM: Days To Maturity, CL :Cob Length (cm), CG: Cob Girth (cm), GRPC: Grain Rows Per Cob, NGPR: Number Of Grains Per Row, NCPP: Number Of Cobs Per Plant, CW: Cob Weight (gm), BYPP: Biological Yield Per Plant (gm), HI: Harvest Index (%), 100GW: 100 Grain Weight (gm), GYPP: Grain Yield Per Plant (gm)

Table 5. Genotypical Correlation Coefficients among different traits of Maize evaluated during Kharif – 2021

Traits	DT	DS	ASI	PH	EH	DM	CL	CG	GRPC	NGPR	NCPP	CW	BYPP	HI	100GW	GYPP
DT	1	0.979**	0.314*	-0.214	-0.378**	0.980**	-0.114	-0.393**	-0.224	-0.419**	-0.239	-0.406**	-0.437**	-0.164	-0.087	-0.025
DS		1	0.485**	-0.329**	-0.479**	0.998**	-0.274*	-0.449**	-0.342**	-0.463**	-0.289*	-0.584**	-0.621**	-0.316*	-0.137	-0.143
ASI			1	-0.355**	-0.453**	0.488**	-0.733**	-0.505**	-0.623**	-0.274*	-0.106	-0.700**	-0.874**	-0.133	-0.508**	-0.334**
PH				1	0.957**	-0.349**	0.827**	0.215	0.112	0.292*	-0.103	0.312*	0.275*	-0.012	-0.150	0.193
EH					1	-0.511**	0.813**	0.361**	0.323**	0.287*	0.185	0.475**	0.453**	0.060	-0.019	0.315*
DM						1	-0.315*	-0.513**	-0.373**	-0.463**	-0.250*	-0.584**	-0.615**	-0.319*	-0.137	-0.144
CL							1	0.459**	0.614**	0.374**	0.229	0.676**	0.543**	0.124	0.050	0.443**
CG								1	0.306*	0.666**	0.384**	0.401**	0.488**	0.157	-0.038	0.478**
GRPC									1	0.217	0.341**	0.731**	0.603**	0.271*	0.152	0.529**
NGPR										1	0.509**	0.239	0.274*	0.059	-0.059	0.636**
NCPP											1	0.031	0.506**	-0.429**	-0.043	1.212**
CW												1	0.837**	0.527**	0.309*	0.295*
BYPP													1	0.328**	0.437**	0.529**
HI														1	0.079	-0.016
100GW															1	-0.104
GYPP																1

DT: Days To Tasseling, DS: Days To Silking , ASI: Anthesis-Silking Interval, PH: Plant Height (cm), EH: Ear Height (cm), DM: Days To Maturity, CL :Cob Length (cm), CG: Cob Girth (cm), GRPC: Grain Rows Per Cob, NGPR: Number Of Grains Per Row, NCPP: Number Of Cobs Per Plant, CW: Cob Weight (gm), BYPP: Biological Yield Per Plant (gm), HI: Harvest Index (%), 100GW: 100 Grain Weight (gm), GYPP: Grain Yield Per Plant (gm)

Table 6. Direct (bold) and indirect effects of yield component traits on grain yield in Maize at Phenotypic level

Traits	DT	DS	ASI	PH	EH	DM	CL	CG	GRPC	NGPR	NCPP	CW	BYPP	HI	100GW
DT	**0.733**	0.678	0.147	-0.119	-0.233	0.669	-0.007	-0.217	-0.051	-0.182	-0.057	-0.208	-0.270	0.014	-0.058
DS	-1.762	**-1.904**	-0.762	0.447	0.721	-1.876	0.230	0.523	0.255	0.478	0.167	0.733	0.945	0.098	0.205
ASI	0.001	0.001	**0.004**	-0.001	-0.001	0.002	-0.001	-0.001	-0.001	-0.001	0.000	-0.001	-0.002	0.000	-0.001
PH	0.043	0.063	0.056	**-0.267**	-0.215	0.065	-0.121	-0.041	-0.013	-0.029	-0.020	-0.073	-0.058	0.003	0.030
EH	-0.104	-0.124	-0.088	0.263	0.327	-0.136	0.184	0.095	0.092	0.044	0.023	0.121	0.116	0.012	-0.005
DM	1.295	1.398	0.589	-0.347	**-0.593**	1.419	-0.224	-0.431	-0.194	-0.397	-0.130	-0.549	-0.697	-0.084	-0.136
CL	0.000	-0.004	-0.014	0.016	0.020	**-0.006**	0.036	0.008	0.014	0.008	0.002	0.016	0.013	0.008	0.002
CG	-0.055	-0.051	-0.037	0.028	0.054	-0.057	**0.043**	0.186	0.054	0.054	0.022	0.057	0.058	0.036	-0.003
GRPC	-0.012	-0.024	-0.039	0.008	0.050	-0.024	0.069	**0.051**	0.177	0.008	0.031	0.109	0.084	0.059	0.026
NGPR	-0.055	-0.056	-0.033	0.024	0.030	-0.062	0.049	0.065	**0.010**	0.222	0.061	0.003	0.040	-0.020	-0.012
NCPP	-0.022	-0.025	-0.004	0.021	0.020	-0.026	0.015	0.033	0.050	**0.077**	0.282	-0.012	0.057	-0.060	-0.024
CW	0.025	0.033	0.034	-0.024	-0.032	0.034	-0.039	-0.027	-0.054	-0.001	**0.004**	-0.087	-0.065	-0.041	-0.027
BYPP	-0.133	-0.179	-0.200	0.078	0.128	-0.177	0.125	0.113	0.172	0.065	0.072	**0.268**	0.360	0.081	0.148
HI	-0.002	0.007	0.001	0.002	-0.005	0.007	-0.027	-0.024	-0.042	0.011	0.027	-0.060	**-0.028**	-0.126	-0.017
100 GW	0.018	0.024	0.075	0.025	0.003	0.021	-0.011	0.003	-0.033	0.012	0.019	-0.070	-0.091	**-0.031**	-0.221
GYPP	-0.032	-0.162	-0.271	0.154	0.274	-0.147	0.325	0.336	0.435	0.371	0.502	0.249	0.463	-0.051	**-0.095**
Partial R^2	-0.023	0.309	-0.001	-0.041	0.089	-0.208	0.012	0.063	0.077	0.083	0.142	-0.022	0.166	0.006	0.021

DT: Days To Tasseling, DS: Days To Silking , ASI: Anthesis-Silking Interval, PH: Plant Height (cm), EH: Ear Height (cm), DM: Days To Maturity, CL :Cob Length (cm), CG: Cob Girth (cm), GRPC: Grain Rows Per Cob, NGPR: Number Of Grains Per Row, NCPP: Number Of Cobs Per Plant, CW: Cob Weight (gm), BYPP: Biological Yield Per Plant (gm), HI: Harvest Index (%), 100GW: 100 Grain Weight (gm), GYPP: Grain Yield Per Plant (gm)

Table 7. Direct (bold) and indirect effects of yield component traits on grain yield in Maize at genotypic level

Traits	DT	DS	ASI	PH	EH	DM	CL	CG	GRPC	NGPR	NCPP	CW	BYPP	HI	100GW
DT	0.660	0.646	0.207	-0.141	-0.249	0.647	-0.075	-0.259	-0.148	-0.277	-0.158	-0.268	-0.288	-0.108	-0.058
DS	-1.655	-1.690	-0.819	0.557	0.809	-1.686	0.464	0.759	0.578	0.782	0.489	0.987	1.050	0.534	0.232
ASI	0.157	0.242	0.498	-0.177	-0.226	0.243	-0.365	-0.252	-0.310	-0.138	-0.053	-0.349	-0.436	-0.066	-0.253
PH	0.132	0.204	0.219	-0.619	-0.592	0.216	-0.511	-0.133	-0.069	-0.181	0.064	-0.193	-0.170	0.008	0.093
EH	-0.104	-0.131	-0.124	0.262	0.274	-0.140	0.223	0.099	0.088	0.079	0.051	0.130	0.124	0.017	-0.005
DM	1.149	1.169	0.572	-0.410	-0.599	1.172	-0.369	-0.601	-0.437	-0.542	-0.293	-0.684	-0.720	-0.374	-0.161
CL	-0.106	-0.256	-0.684	0.772	0.759	-0.294	0.934	0.428	0.574	0.349	0.214	0.631	0.506	0.115	0.047
CG	0.008	0.009	0.010	-0.004	-0.008	0.011	-0.010	-0.021	-0.006	-0.014	-0.008	-0.008	-0.010	-0.003	0.001
GRPC	-0.029	-0.044	-0.080	0.015	0.042	-0.048	0.079	0.039	0.129	0.028	0.044	0.094	0.078	0.035	0.020
NGPR	-0.106	-0.117	-0.070	0.074	0.072	-0.117	0.094	0.168	0.055	0.252	0.128	0.060	0.069	0.015	-0.015
NCPP	-0.142	-0.172	-0.063	-0.061	0.110	-0.149	0.136	0.228	0.202	0.302	0.594	0.018	0.300	-0.255	-0.025
CW	0.291	0.419	0.502	-0.224	-0.341	0.419	-0.485	-0.288	-0.525	-0.171	-0.022	-0.717	-0.601	-0.378	-0.222
BYPP	-0.239	-0.339	-0.478	0.150	0.247	-0.336	0.296	0.267	0.329	0.149	0.276	0.458	0.546	0.179	0.239
HI	-0.044	-0.085	-0.036	-0.003	0.016	-0.086	0.033	0.042	0.073	0.016	-0.115	0.141	0.088	0.268	0.021
100 GW	0.002	0.002	0.009	0.003	0.000	0.002	-0.001	0.001	-0.003	0.001	0.001	-0.005	-0.008	-0.001	-0.017
GYPP	-0.025	-0.143	-0.334	0.193	0.315	-0.144	0.443	0.478	0.530	0.636	1.212	0.295	0.529	-0.016	-0.104
Partial R^2	-0.016	0.241	-0.167	-0.119	0.086	-0.169	0.414	-0.010	0.068	0.160	0.720	-0.211	0.289	-0.004	0.002

DT: Days To Tasseling, DS: Days To Silking , ASI: Anthesis-Silking Interval, PH: Plant Height (cm), EH: Ear Height (cm), DM: Days To Maturity, CL :Cob Length (cm), CG: Cob Girth (cm), GRPC: Grain Rows Per Cob, NGPR: Number Of Grains Per Row, NCPP: Number Of Cobs Per Plant, CW: Cob Weight (gm), BYPP: Biological Yield, Per Plant (gm), HI: Harvest Index (%), 100GW: 100 Grain Weight (gm), GYPP: Grain Yield Per Plant (gm)

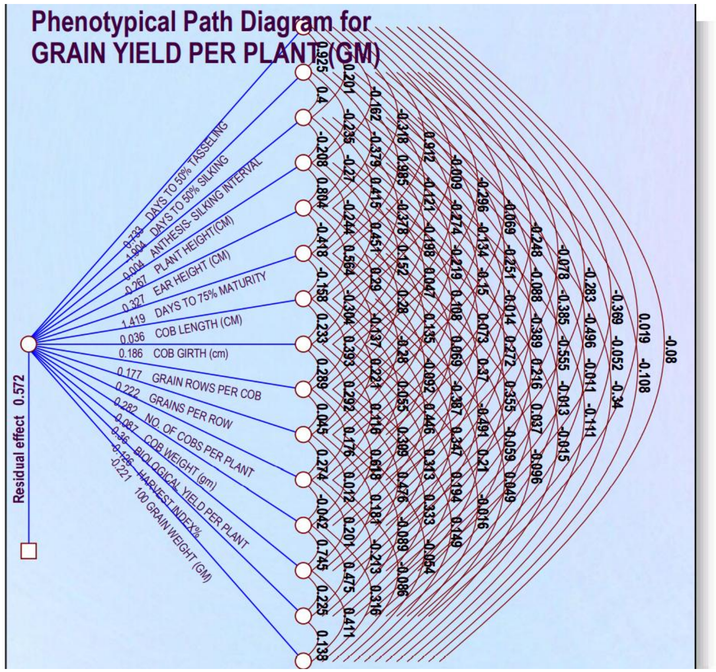

Fig. 1. Genotypic Path Coefficient

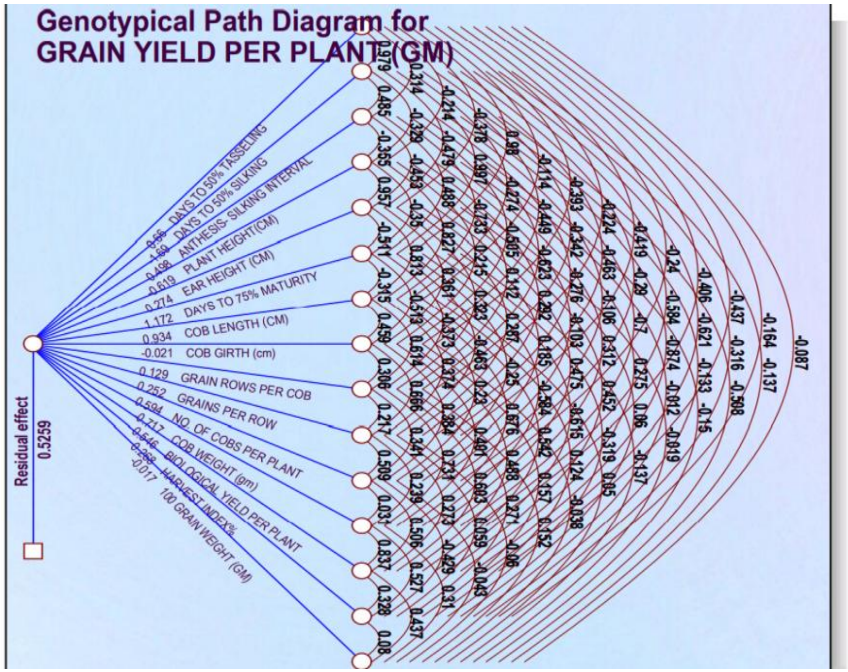

Fig. 2. Phenotypic Path Coefficient

3.3 Path Coefficient Analysis

Path analysis furnishes the cause and effect of different yield components with would provide better index for selection rather than mere correlation coefficient. Correlation gives only the relation between two variables whereas path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlation [31]. On partitioning the components for correlation of seed yield with characters showing positive correlation, direct effect was found to be low indicating that while selecting these characters seed yield per plant can't be improved through these characters. The results suggests that the acquisition of new germplasm and its evaluation is essential to select the new desirable genotypes and to use them in the breeding programme for the development of high yielding varieties. The path analysis splits the correlation into direct and indirect effects via alternative characters and thus permits a critical examination of components that influence a given correlation and can be helpful in formulating an efficient selection strategy. Similar results in maize have earlier been reported by Rafiq et al. (2010), Vijay et al. [31] and Gurpinder et al. (2016). (Table 6,7) The traits viz., ear height, cob length, cob girth, grain rows per cob, grains per row, number of cobs per plant, cob weight and biological yield per plant were found to possess positive significant association and positive direct effect with yield per plant at both genotypic and phenotypic level. Therefore, selection programme should be based on these traits for obtaining high yielding genotypes of Maize [33,34].

4. CONCLUSION

From the present investigation, it is concluded that analysis of variance showed significant variation to all the characters except for number of cobs per plant (α=0.05). Among 21 genotypes, BML-13 (109.67), MGW-376 (108.93) genotypes were found to be superior for grain yield per plant over the check (Shaktiman-5). GCV for all the characters were less than PCV, indicating the influence of environmental component on the expression of the character. High heritability coupled with high genetic advance as percent mean in the present genotypes was recorded for for traits plant height, ear height, grain rows per cob, cob weight, biological yield per plant, 100 grain weight, grain yield per plant. Path coefficient and Correlation analysis revealed that ear height, cob length, cob girth, grain rows per cob, grains per row, number of cobs per plant, cob weight and biological yield per plant had positive correlation and direct effects with grain yield per plant. Therefore, it is concluded that effective selection must be attempted for these traits which would help in improvement of grain yield in Maize genotypes. To increase the productivity we have to go for high yielding hybrids with better grain yield character lines, so that we can reduce the hunger for the future generation and knowledge on the nature and magnitude of the genetic variation leading the inheritance of quantitative characters like yield and its components its crucial for genetic improvement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shikha B, Manpreet J, Ramanjit K. Nutritive value of Maize. Maize – production and use. Intech Open. 2019; 1-14.
2. Department of Agriculture Cooperation. Ministry of Agriculture & farmers welfare (DAC&FW). government of India; 2021.
3. Larik AS, Malik SI, Kakar AA, Naz MA. Assessment of heritability and genetic advance for yield and yield components in Gossypium hirsutum L. Sci Khyber. 2000;13:39-44.
4. Langade DM, Shahi JP, Srivastava K, Singh A, Agarwal VK, Sharma A. Appraisal of genetic variability and seasonal interaction for yield and quality traits in maize (*Zea mays* L.). Plant Gene Trait. 2013;4(18):95-103.
5. Bhusal TN, Lal GM, Marker S, Synrem GJ. Genetic variability and traits association in Maize (*Zea mays* L.) genotypes. Annals Plant Soil Res. 2017;19(1):59-65.
6. Mohammadi SA, Prasanna BM, Singh NN. Sequential path model for determining interrelationship among grain yield and related characters in maize. Crop Sci. 2003;43(5):1690-7.
7. Bello OB, Ige SA, Azeez MA, Afolabi MS, Abdulmaliq SY, Mahamood J. Heritability and genetic advance for grain yield and its component characters in Maize (*Zea mays* L.). Int J Plant Res. 2012; 2(5):138-45.

8. Fisher RA. XV.—The correlation between relatives on the supposition of Mendelian inheritance. Trans R Soc Edinb. 1919; 52(2):399-433.
9. Burton GW. Quantitative inheritance in grasses. Proceedings of the 6th intern grasslands congress. 1952;1:277-83.
10. Burton GW, Devane EH. Estimating heritability in tall fescue (Festuca Arundinaceae) from replicated clonal material. Agron J. 1953;51:515-8.
11. Johnson HW, Robinson HF, Comstock RE. Estimation of genetic and environmental variability in Soyabean. Agron J. 1955; 47(7):314-8.
12. Al-Jibouri HA, Miller PA, Robinson HF. Genotypic and environmental variation and correlation in upland cotton cross of interspecies origin. Agron J. 1958;50(10): 633-6.
13. Rajesh V, Kumar SS, Reddy VN, Sankar AS. Studies on genetic variability, heritability and genetic advance estimates in newly developed maize genotypes (*Zea mays* L.). Int J Appl Biol Pharm Technol. 2013;4(4):242-5.
14. Kumar SVVP, Babu DR. Character association and path analysis of grain yield and yield components in maize (*Zea mays* L.). Electron J Plant Breed. 2015;6(2):550-4.
15. Patil SM, Kumar K, Jakhar DS, Rai A, Borle UM, Singh P. Studies on variability, heritability, genetic advance and correlation in maize (*Zea mays* L.). Int J Agric Environ Biotechnol. 2016;9(6): 1103-8.
16. Khan AS, Ullah H, Shahwar D, Fahad S, Khan N, Yasir M et al. Heritability and correlation analysis of morphological and yield traits in maize. J Plant Biol Crop Res. 2018;2:1008.
17. Lush JL. Inter-size correlation regression of offspring on dairy as a method of estimating heritability of characters. Proceedings of the American Society of Animal Production. 1940;33:293-301.
18. Bhoite KD, Sonone AH. Variability, heritability and genetic advance in forage Maize. J Maharashtra Agric Universities. 2007;32(2):283-4.
19. Pandey Y. Heritability, correlation, path coefficient analysis for determining interrelationships among grain yield and related characters in maize (*Zea mays* L.). Int J Pure App Biosci. 2017;5(2):595-603.
20. Dagla MC, Gadag RN, Sharma OP, Kumar N. Genetic variability and correlation among yield and quality traits in sweet corn. Electron J Plant Breed. 2015; 6(2):500-5.
21. Begum S, Ahmed A, Omy SH, Rohman MM, Amiruzzaman M. Genetic variability, character association and path analysis in Maize (*Zea mays* L.). Bangladesh J Agric Res. 2016;41(1):173-82.
22. Singh G, Kumar R, Jasmine. Genetic parameters and character association study for yield traits in maize (*Zea mays* L.). J Pharmacogn Phytochem. 2017;6(5):808-13.
23. Beulah G, Marker S, Rajsekhar D. Assessment of quantitative genetic variability and character association in Maize (*Zea mays* L.). J Pharmacogn Phytochem. 2018;7(1):2813-6.
24. Biotica C. Nagabushan, Mallikarjuna, N.M., Hradari, C. Shashibhaskar, M.S. and Prahalada, G. D.. 2012 Genetic variability and correlation studies for yield and related characters in single cross hybrids of maize (*Zea mays* L.);5(2):157-63.
25. El-Badawy MEM. Estimation of genetic parameters in three maize crosses for yield and its attributes. Asian J Crop Sci. 2012;4(4):127-38.
26. Bekele A, Rao TN. Estimates of heritability, genetic advance and correlation study for yield and its attributes in Maize (*Zea mays* L.). J Plant Sci. 2014;21:4-6.
27. Hassan AA, Abdikadir Md, Hasan M, Azad MdAK, Hasanuzzaman Md. Genetic variability and diversity studies in Maize (*Zea mays* L.) inbred lines. IOSR JAVS (IOSR-JAVS) e-ISSN: 11(11). 2018:2319-80.
28. Bartaula S, Panthi U, Timilsena K, Acharya SS, Shrestha J. Variability, heritability and genetic advance of Maize (*Zea mays* L.) genotypes. Res Agric Livest Fish. 2019;6(2):163-9.
29. Supraja V, Sowmya HC, Kuchanur PH, Arunkumar B, Kisan B. Genetic variability and character association studies in maize (*Zea mays* L.) inbred lines. Int J Curr Microbiol Appl Sci. 2019;8(10):646-56.
30. Kumar GP, Reddy VN, Kumar SS, Rao PP. Genetic variability, heritability and genetic advance in newly developed maize genotypes (*Zea mays* L.). Int J Pure Appl Biosci. 2014;2(1):272-5.

31. Vijay K, Singh SK, Bhati PK, Amita S, Sharma SK, Vinay M. Correlation, path and genetic diversity analysis in maize (*Zea mays* L.). Environ Ecol. 2015;33(2A):971-5.
32. Varalakshmi S, C. Wali MC, Deshpande SK, Harlapur SI. Correlation and Path coefficient analysis in single cross hybrids in maize. Int J Curr Microbiol Appl Sci. 2018;7(4):1840-3.
33. Wright S. Correlation and causation. J Agric Res. 1921;20:557-85.
34. Khan S, Mahmud F. Am J Plant Sci. (*Zea mays* L.). 2021;12(11):1691-704.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91673