

Original Research Article

CORRELATION AND PATH COEFFICIENT ANALYSIS OF GRAIN YIELD AND YIELD RELATED TRAITS IN MAIZE (*Zea mays* L.)

ABSTRACT

Based on mean performance of 31 genotypes of maize. Grain yield per plant was highest in case of, MAKKA-3 (111.60 gm), MGC-240 (85.33 gm), GP (84.17 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. High GCV and PCV, high heritability recorded in 100 grain weight, cob weight. Cob weight, 100 grain weight are highly and significantly correlated with grain yield in genotypic and phenotypic correlation. And genotypic path analysis revealed that cob weight, 100 grain weight, number of rows per cob, cob length, days to 75% maturity, number of grains per row, ear height, in phenotypic path results shown that cob weight, 100 grain weight, number of grain rows per cob, number of grains per row, days to 75% maturity, ear height, had the highest direct effect on grain yield. It indicates true relationship between these traits and direct selection for these traits will be rewarding for yield improvement.

Key Words: Maize (*Zea mays* L.), Genetic variability, Heritability, Genetic advance, Genotypic correlation, Phenotypic correlation, Genotypic path analysis and Phenotypic path analysis.

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INTRODUCTION

Maize (*Zea mays* L.) is a C. plant that belongs to the family Gramineae with chromosome number ($2n-2x=20$). It is an important cereal crop with wider adaptability under varied agro-climatic conditions. It is known as queen of cereals due to its high genetic potential. About 9000 years ago maize originated through a single domestication from its wild progenitor, teosinte in South Mexico according to Matsuoka et al., (2002). Morphologically maize exhibits greater diversity of phenotypes than any other grain crop (Kuleshov, 1933) and is extensively grown in temperate, subtropical and tropical regions of the world. It is grown from 58°N to 40° S, from below sea level to altitudes higher than 3000 m and in areas with 250 mm to more than 5000 mm of rainfall per year (Downswell et al., 1996).

It can be grown throughout the year, due to availability of thermos and photo insensitive varieties. Usually three crops of maize, viz. Rabi, rabi and spring are grown in the country. It requires adequate moisture and warmth from sowing to end of flowering. The optimum temperature requirement for germination is 21°C; while for growth it is 32° C.

Maize is a tall, deep-rooted, warm weather and annual grass. A single long stalk will develop from seed. Long smooth leaves are attached at the stem nodes. Seed producing shoots originate from the base of the main stem. The female flowers are borne on the corn 'ear', which arises at a leaf axil near the mid-point along the stem. The flower organs, and later the grain kernels, are enclosed in several layers of papery tissue, termed husks. A mass of long styles (silks) protrudes from the tip as a mass of silky threads. These strands are actually the stigmas from the flowers. The male flowers are borne at the top of the plant and termed as tassel. The male flower emerges few days ahead of silk emergence, the condition commonly known as protandry. The pollen is windblown and comes in contact with the emerging silks of the same or different plant imparting cross pollination.

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

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tonnes is still far below the world average 5.1 tons/ha (Department of Agriculture Cooperation, 2020).

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1.1 Objectives

1. To evaluate of thirty-one germplasm for yield and yield contributing characters
2. To study the character association between maize germplasm for yield and yield attributing traits.
3. To study direct and indirect effects of different characters and to provide information on actual contribution of traits on seed yield

MATERIALS AND METHODS

The current study includes forty-five genotypes of maize in *rabi*-2021 at SHUATS, Prayagraj's experimentation centre of Genetics and Plant Breeding. During *rabi*--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. Data was collected on ~~d~~Days to 50% tasselling, ~~Days-days~~ to 50% silking, ~~Plant-plant~~ height (cm), ~~Ear-ear~~ height (cm), ~~Tassel-tassel~~ length (cm), ~~Days-days~~ to 75% maturity, ~~Cob-cob~~ weight (cm), ~~Cob-cob~~ length (cm), ~~Number-number~~ of grain rows per cob, ~~Number-number~~ of grains per row, 100 kernel weight (g), ~~Grain-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**, heritability **Burton and Devane (1953)** and genetic advance **Johnson et al., Ai Jibouriet al.**, 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 (1959)**.

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EXPERIMENTAL MATERIAL:

The 31 Genotypes were collected from (Source Professor Jaya Shankar Telangana State Agriculture University, Hyderabad).

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RESULT 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 (45.70 and 39.03), ear height (22.91 and 21.02), Number of grains per row (19.09 and 11.82), 100 grain weight (15.34 and 3.30), Plant height (14.52 and 12.03), Number of grain rows per cob (12.02 and 8.02), Cob length (10.51 and 4.48), Days to 50% tasselling (9.65 and 8.59), Tassel length (7.90 and 3.98), Days to 50% silking (6.23 and 3.59), Days to 75% maturity (2.36 and 1.96). Similar findings were reported by **Khan et al. (2018)**, **Shankar et al. (2018)**, **Tadesse et al. (2019)** and **Khulbe et al. (2020)**. The genotypic coefficient of variation estimations reflect 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 (1947)** 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 (72.90), Ear height (61.00). 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. (2019)** and **Mohammed al. (2020)**.

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High genetic advance was recorded for Grain yield per plant (31.89), Cob weight (22.86), Ear height (17.11). Similar findings were reported by **Al-Amin et al. (2019) and Khulbeet al. (2020)**.

High genetic advance as percent mean was recorded for Grain yield per plant (68.67), Cob weight (37.38), Ear height (28.81). Similar findings were reported by **Shankar et al. (2018), Supraja et al. (2019) and Khulbeet al. (2020)**.

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 31 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) (**Sharma, 1988**). Cob weight (0.8958**,0.6974**), 100 grain weight (0.8496**,0.7183**), no.of grain rows per cob (0.7338**,0.6083**),cob length (0.6941**,0.5735**), days to 75% maturity (0.4896**,0.4129**), no.of grains per row (0.4672**,0.4638**), ear height (0.4470**,0.3813**). are positively and significantly correlated with grain yield per plant in both genotypic and phenotypic correlation. Similar findings were reported by **Varalakshmi et al. (2018), Barrtaula et al. (2019) and Dash et al. (2020)**.

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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.(2013)**.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 12 different quantitative characters. In genotypic Cob weight (0.8958**), 100 grain weight (0.8496**), Number of grain rows per cob (0.7338**), Cob length (0.6941**), Days to 75% maturity (0.4896**), Number of grains per row (0.4672**), Ear height (0.4470**). Similar findings were reported by **Sharma RK et al.,(1987), Kumar S et al.,(2006) Hemavathy AT et al.,(2008)Gazal A et al., (2018)**

In Phenotypic 100 grain weight (0.7183**), Cob weight (0.6974**), Number of grain rows per cob (0.6083**), Cob length (0.5735**), Number of Grains per row (0.4638**),

Days to 75% maturity (0.4129**), Ear height (0.3813**). Similar findings were reported by Sharma RK *et al.*, (1987), Kumar S *et al.*, (2006) Hemavathy AT *et al.*, (2008) Gazal A *et al.*, (2018), Sood BC *et al.*, (2006), Ulaganathan V *et al.*, (2015).

CONCLUSION:

1. among thirty-one genotypes MAKKA-3 (111.60 gm), MGC-240 (85.33 gm), GP (84.17 gm), are the superior lines.
2. grain yield per plant, cob weight had shown High GCV and PCV, high heritability recorded in Grain yield per plant, Ear height. Cob weight, 100 grain weight are highly and significantly correlated with grain yield in genotypic and phenotypic correlation.
3. genotypic path analysis revealed that cob length, ear height, in phenotypic path results shown that cob weight, 100 grain weight has highest direct effect on grain yield.
4. Therefore, these characters should be given previously during selection for yield improvement in maize. this conclusion is not clear, you have to improve on your writing.

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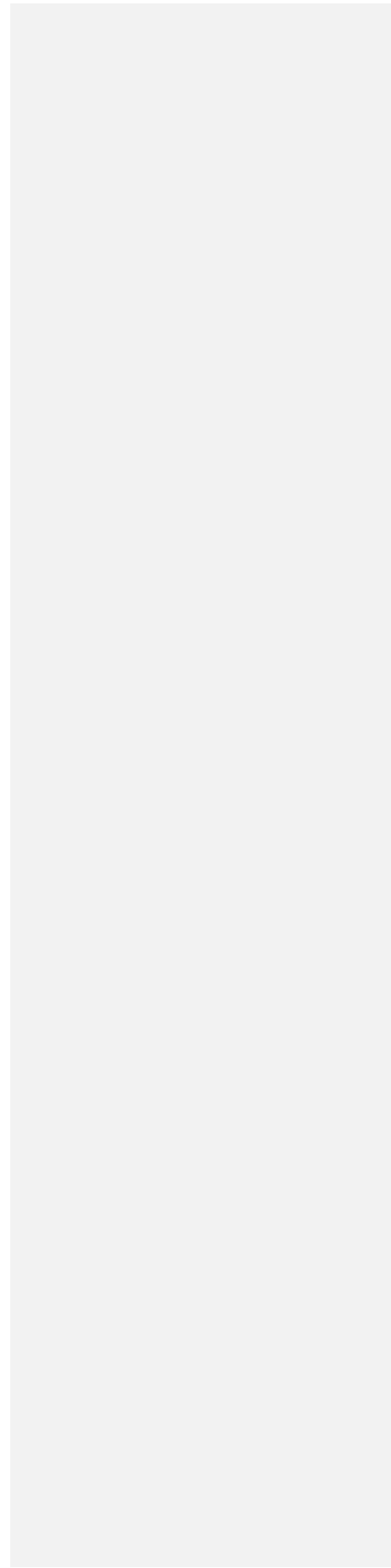


Table 1: Analysis of variance for 12 quantitative characters of 31 Maize genotypes.

S.No.	source	Replication	Genotypes	Error
	Degrees of freedom (df)	2	30	60
1	Days to 50% tasselling	7.11	16.321**	8.12
2	Days to 50% silking	3.18	49.645**	10.91
3	Plant height (cm)	29.345	119.954**	21.46
4	Ear height (cm)	7.295	4.676**	5.98
5	Tassel length (cm)	15.09	4.952**	0.48
6	Days to 75% maturity	100.18	71.34**	14.56
7	Cob weight (g)	7.29	22.109**	1.19
8	Cob length (cm)	9.325	3.339**	6.28
9	Number of grain rows per cob	28.145	23.485**	0.09

10	Number of Grains per row	24.3825	4.841**	0.24
11	100 grain weight (g)	32617.14	33.508**	0.34
12	Grain yield per plant (g)	7.0435	170.771**	24.78

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

Table 2: Genetic parameters for 12 quantitative characters in Maize genotypes

TRAITS	GCV	PCV	Heritability		
			(Broad sense) %	GA 5%	GAM 5%
Days to 50% tasselling	8.59	9.65	12.90	1.63	1.44
Days to 50% silking	3.59	6.23	40.90	2.26	1.94
Plant height (cm)	12.03	14.52	35.12	1.14	0.75
Ear height (cm)	21.02	22.91	61.00	17.11	28.81
Tassel length (cm)	3.98	7.90	20.69	0.38	1.17
Days to 75% maturity	1.96	2.36	16.50	1.23	0.80
Cob weight (gm)	23.72	31.00	58.50	22.86	37.38
Cob length (cm)	4.48	10.51	18.20	0.48	3.94
Number of grain rows per cob	8.02	12.02	44.50	1.31	11.02
Number of Grains per row	11.82	19.09	38.30	2.76	15.06
100 grain weight (gm)	3.30	15.34	14.58	0.46	1.46
Grain yield per plant (gm)	39.03	45.70	72.90	31.89	68.67

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

TRAITS		Days to 50% tasselling	Days to 50% silking	Plant height (cm)	Ear height (cm)	Tassel length (cm)	Days to 75% maturity	Cob weight (gm)	Cob length (cm)	Number of grain rows per cob	Number of Grains per row	100 grain weight (gm)	Grain yield per plant (gm)
Days to 50% tasselling	G	1.0000**	0.9856**	-0.0648	0.3388	-0.9617**	0.2822	-0.2691	-0.3652*	-0.7423**	-0.6445**	-0.4536**	-0.1616
	P	1.0000**	0.7382**	-0.1796	-0.1053	-0.4563**	0.0126	0.0787	-0.6453**	-0.238	-0.072	-0.3591*	-0.0126
Days to 50% silking	G		1.0000**	0.2559	-0.2348	-0.8691**	0.3085	-0.5547**	0.2336	-0.5852**	-0.6545**	-0.5731**	-0.3807**
	P		1.0000**	-0.1013	-0.1533	-0.4521**	0.2196	-0.3562*	-0.1001	-0.3863**	-0.1122	-0.18	-0.3126
Plant height (cm)	G			1.0000**	-0.8456**	-0.1349	0.9154**	-0.7196**	-0.4532**	-0.8419**	-0.6482**	-0.8921**	-0.6491**
	P			1.0000**	-0.5629**	0.0561	-0.1041	0.0219	0.1095	0.0726	0.1027	0.104	-0.5489**
Ear height (cm)	G				1.0000**	-0.9828**	-0.5407**	0.4649**	0.4816**	0.3151	0.6667**	0.7057**	0.4470**
	P				1.0000**	-0.4862**	-0.116	0.3232	0.3963**	0.188	0.2916	0.2551	0.3813**
Tassel length (cm)	G					1.0000**	-0.6457**	0.5694**	0.6562**	0.7518**	1.068	-0.8064**	0.0382
	P					1.0000**	-0.1609	-0.1141	0.3812**	0.1288	-0.0095	0.0068	-0.028
Days to 75% maturity	G						1.0000**	-0.4008**	0.064	-0.7317**	0.0916	-0.5062**	0.4896**
	P						1.0000**	-0.3128	0.0259	-0.1805	-0.0206	-0.0034	0.4129**
Cob weight (gm)	G							1.0000**	0.5321**	0.7145**	0.6522**	0.8660**	0.8958**
	P							1.0000**	0.3963**	0.4645**	0.2837	0.0881	0.6974**
Cob length (cm)	G								1.0000**	0.1938	0.5492**	0.7968**	0.6941**
	P								1.0000**	0.1118	0.0335	0.1568	0.5735**
Number of grain rows per cob	G									1.0000**	0.4415**	0.8193**	0.7338**
	P									1.0000**	0.2288	0.1434	0.6083**
Number of Grains per row	G										1.0000**	0.3769*	0.4672**
	P										1.0000**	0.0769	0.4638**
100 grain weight (gm)	G											1.0000**	0.3769*
	P											1.0000**	0.7183**
Grain yield per plant (gm)	G												1.000
	P												1.000

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

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	Plant height (cm)	Ear height (cm)	Tassel length (cm)	Days to 75% maturity	Cob weight (gm)	Cob length (cm)	Number of grain rows per cob	Number of Grains per row	100 grain weight (gm)	Grain yield per plant (gm)
Days to 50% tasselling	G	-0.96	-1.1677	0.0622	-0.3253	0.9232	-0.2709	0.2583	-0.3506	1.0686	0.6187	0.4354	-0.1616
	P	-0.0224	-0.005	0.004	0.0024	0.0061	-0.0003	-0.0018	0.0039	0.0053	0.0016	0.0012	-0.0126
Days to 50% silking	G	-1.4444	-1.1874	-0.3039	0.2788	1.032	-0.3663	0.6586	-0.2774	0.6949	0.7772	0.6805	-0.3807**
	P	0.0191	0.0857	-0.0087	-0.0131	0.0044	0.0188	-0.0249	-0.0086	-0.0245	-0.0096	-0.0154	-0.3126
Plant height (cm)	G	-0.0224	0.0884	0.3456	-0.4601	-0.0466	0.3164	-0.2487	-0.9067	-0.2909	-0.7429	-1.7881	-0.6491**
	P	-0.0167	-0.0094	0.0932	0.0305	0.0052	-0.0097	0.002	0.0102	0.0068	0.0096	0.0097	-0.5489**
Ear height (cm)	G	0.4192	-0.2905	-1.6471	1.2371	-1.2159	-0.6689	0.5751	0.5958	0.3899	0.8247	0.873	0.4470**
	P	0.0081	0.0118	-0.0252	-0.0769	-0.0063	0.0089	-0.0249	-0.0169	-0.0145	-0.0224	-0.0196	0.3813**
Tassel length (cm)	G	-0.0363	-0.0328	-0.0051	-0.0371	0.0377	-0.0244	0.0215	0.0247	0.0284	0.0403	-0.0304	0.0382
	P	0.0018	-0.0001	-0.0001	-0.0002	-0.0024	0.0004	0.0003	-0.0002	-0.0003	0.0048	0.0045	-0.028
Days to 75% maturity	G	-0.1625	-0.1776	-0.527	0.3113	0.3717	-0.5757	0.2307	-0.0368	0.4212	-0.0527	0.8984	0.4896**
	P	-0.0019	-0.033	0.0156	0.0174	0.0242	-0.1503	0.0081	-0.0039	0.0271	0.0031	0.0005	0.4129**
Cob weight (gm)	G	-0.2318	-0.4779	-0.62	0.4005	0.4905	-0.3453	0.8615	0.4584	0.6155	0.5619	0.746	0.8958**
	P	0.0511	-0.1891	0.0142	0.2099	-0.0741	-0.035	0.6494	0.0811	0.3017	0.1842	0.0572	0.6974**
Cob length (cm)	G	-0.802	0.5131	-5.7618	1.0577	1.441	0.1406	1.1685	2.1961	0.4256	1.2062	2.3212	0.6941**
	P	-0.0087	-0.005	0.0055	0.0109	0.0043	0.0013	0.0062	0.0499	0.0056	0.0017	0.0078	0.5735**
Number of grain rows per cob	G	1.653	0.869	1.2501	-0.468	-1.1164	1.0866	-1.061	-0.2878	-1.485	-0.6557	-1.2166	0.7338**
	P	-0.0298	-0.0359	0.0091	0.0236	0.0161	-0.0226	0.0582	0.014	0.1253	0.0287	0.018	0.6083**
Number of Grains per row	G	1.2848	1.3048	4.2858	-1.329	-2.1292	-0.1825	-1.3002	-1.0949	-0.8802	-1.9935	-0.7513	0.4672**
	P	-0.0028	-0.0043	0.0039	0.0111	-0.0004	-0.0008	0.0108	0.0013	0.0087	0.0382	0.0029	0.4638**
100 grain weight (gm)	G	0.1407	0.1778	1.605	-0.2189	0.2502	0.4841	-0.2686	-0.3279	-0.2542	-0.1169	-0.3102	0.8496**
	P	-0.0028	-0.0043	0.0039	0.0111	-0.0004	-0.0008	0.0108	0.0013	0.0087	0.0382	0.0029	0.4638**

UNDER PEER REVIEW

