Original Research Article

Studies on genetic association and path coefficient analysis for yield and yield attributing characters in maize (*Zea mays* L.)

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] and SHAKTIMAN-5 [64.87] 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 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.

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

INTRODUCTION

Maize (*Zea mays* L.), the "Queen of cereals" is an important cereal crop which belongs to the tribe *Maydeae* of the grass family Poaceae (Graminacea). In India, it is the third most important food crop after rice and wheat. 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 **(Dowswell *et al.*, 1996).** 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 **(Shikha *et al.*, 2019).** Currently, 1147.7 million MT of maize is being produced together by over 170countries from an area of 193.7 million ha with an average productivity of 5.75 t/ha **(FAOSTAT, 2020).** 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 withan 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 **(Wright, 1921),** 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 **(Bhutia *et al.* 2016)**. Therefore, present study was conducted to assess correlation and path analysis to identify component traits for developing high yielding varieties of maize.

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**, heritability **Burton and Devane** and genetic advance **Johnson *et al.*, Ai Jibouri *et 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.**

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 (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.* (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** 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), 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.* (2019) and Mohammedali *et al.* (2020)**.

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*. (2019) and Khulbe *et al*. (2020).**

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*. (2018), Supraja *et al*. (2019) and Khulbe *et 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 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) **(Sharma, 1988)**. 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.* (2018), Barrtaula *et al.* (2019) and Dash *et al.* (2020).**

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.*** 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 at.*, (1987), Kumar S *et al.*, (2006) Hemavathy AT *et al.*, (2008) Gazal A *et al.*, (2018)**

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 at.*, (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:

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.

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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.