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Character association for yield and quality traits in quality protein maize (*Zea mays* L.)

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Abstract
Correlation studies revealed that plant height, ear girth, ear length, number of kernel rows rep ear, number of kernels per row, shelling percentage, crude protein, tryptophan and lysine contents recorded significantly positive correlations with grain yield. Path coefficient analysis revealed that number of kernels per row, shelling percentage and 100-kernel weight exhibited the highest positive direct effects at both the genotypic and phenotypic levels on grain yield and hence these traits play an important role in generating the high yielding genotypes in the future breeding programmes.

Keywords: Yield, quality traits, quality protein maize, *Zea mays* L.

Introduction
Maize is considered as queen of cereals due to its high genetic potentiality and adaptability. Several people consume maize as staple food to meet their protein and calories requirement. However, net protein utilization and biological value of normal maize was less as the normal maize has the drawback of deficient in important amino acids like tryptophan and lysine. Mal nutritional problems were observed where maize was the staple food especially in young children, pregnant and lactating mothers, especially in tribal communities. Maize breeders strived hard to improve the nutritional aspects in maize by way of improving the amino acids i.e. tryptophan and lysine contents so that the digestability, biological value has been improved with the enhanced levels of lysine and tryptophan contents. However, main goal of the plant breeders is to develop high yielding hybrids coupled with high tryptophan and lysine contents to combat malnutrition problems especially in developing countries mostly in tribal communities. QPM has balance leucine: isoleucine ratio with the enhanced niacin levels helps in preventing pellagra. It is a better alternative to animal protein which is costly and plays a major role in meeting infant, lactating mothers food requirements. Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character (Srijan *et al*. 2016) [2]. 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 correlations. Path analysis is that, it permits the partitioning of the correlation coefficient into its components, one component being the path coefficient that measures the direct effect of a predictor variable upon its response variable; the second component being the indirect effect (s) of a predictor variable on the response variable through another predictor variable (Dewey and Lu, 1959) [1].

Material and Methods
During *Kharif*, 2015, a diallel set of 36 crosses along with 9 parents and two checks *viz*., DHM-117 and Vivek QPM 9 were sown in Randomized Block Design replicated thrice Student farm,Cillege of Agriculture, Hyderabad of Telangana state, India. Each entry was sown in two rows of four meters length with a spacing of 75 cm between rows and 20 cm between the plants. The recommended fertilizers of N, P and K were applied in the ratio of 120: 80: 60 kg ha^{-1}. The entire P and K and half dose of nitrogen was applied as basal, while remaining half dose of N in two equal split doses at knee height and tasseling stages. Weeding operations, necessary plant protection measures were taken up to protect the crop from pests and diseases as per the recommendations along with the timely irrigation schedules to raise a healthy crop. Observations were made on different characters i.e. days to 50 percent anthesis, days to 50 percent silking, anthesis silking interval, days to maturity, plant height (cm), ear

height (cm), ear length (cm), ear girth (cm), Number of kernel rows per ear, number of kernels per row, 100 kernel weight (g), Shelling percentage, Crude Protein (%), lysine content (%),Tryptophan content (%) and grain yield (g/plant). Genotypic and phenotypic correlations coefficient was worked out by adopting method described by Singh and Chaudhary (1977) [5]. Path coefficient analysis was done according to the procedure suggested by Dewey and Lu (1959) [1].

Result and Discussion

Grain yield is a complex character and is dependent on several contributing traits. Hence, character association was studied in the present investigation, to assess the relationships among yield, its components for enhancing the usefulness of selection. Genotypic correlations reveal the existence of real associations, whereas, the phenotypic correlations due to genotype x environment interactions. Significant phenotypic correlations without significant genotypic associations are of no value. If the genotypic correlation is significant and phenotypic is not, it means that the existing real association is masked by environmental effect. This indicates the importance of genotypic correlation compared to phenotypic correlation. Correlation coefficient is a statistical measure used to find out the degree and direction of relationship between two or more variables. The information on the interrelationship among the characters facilitates the choice of a suitable breeding method to be applied and selecting the parents for crop improvement. The genetic correlation coefficients between the characters at genotypic as well as phenotypic levels, as an important from breeding point of view have been presented in Table 1. In general, phenotypic correlations provide the information on phenotypic expression of the traits and hence the phenotypic correlations have been discussed hereunder.

Days to 50 percent anthesis was significantly and positively correlated with days to 50% silking and days to maturity while, it had negatively significant association with ear length, ear girth, shelling percentage, crude protein, tryptophan and lysine contents whereas, negative and non-significant association was observed with grain yield.

Days to 50 percent silking exhibited significantly positive association with days to maturity while, it had significantly negative significant association with ear length, ear girth, shelling percentage, crude protein, tryptophan and lysine content and grain yield whereas, 100-kernel weight exhibited significantly negative association.

Significantly negative associations were observed with shelling percentage and crude protein content while, its association was positive and non-significant with days to maturity and a negative and non-significant associations were recorded with the remaining traits *i.e.* ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100-kernel weight, tryptophan and lysine contents.

Days to maturity exhibited significantly negative association with 100-kernel weight while, a non-significant negative association was recorded with shelling percentage, crude protein, tryptophan and grain yield.

The association of plant height was significant and positive with days to anthesis, days to silking, ear height, ear girth and number of kernel rows per ear while, it exhibited significantly negative association with tryptophan and lysine contents. It exhibited positive but non-significant association with grain yield.

Ear height exhibited significantly positive association with ear length, ear girth, number of kernel rows per ear, number of kernels per row at all the three locations. None of the traits exhibited significantly negative association with ear height. It also exhibited significantly positive association with shelling percentage while, it exhibited significantly positive association with grain yield.

Ear girth registered significant and positive associations were recorded with number of kernel rows per ear, number of kernels per row, 100 kernel weight, shelling percentage, crude protein and grain yield while the association was non-significant and positive with tryptophan content.

Ear length exhibited positive and significant associations with ear girth, number of kernel rows per ear, number of kernels per row, 100- kernel weight, shelling percentage, crude protein, tryptophan and grain yield at all the three locations. It also exhibited a significantly positive association with lysine content at Hyderabad.

Number of kernel rows per ear exhibited significantly positive association of number of kernel rows per ear was with number of kernels per row, 100- kernel weight, shelling percentage and grain yield whereas, its association with crude protein content was non-significant. It also exhibited significantly negative association with days to maturity and lysine.

Number of kernels per row exhibited positive and significant association with 100-kernel weight, shelling percentage and grain yield whereas, its association with tryptophan content was positive but non-significant. Days to maturity and lysine contents were significantly and negatively associated with the character.

Significant and positive associations were observed with shelling percentage, crude protein and grain yield while, it exhibited negative but non- significant association with lysine. Crude protein, lysine and grain yield exhibited significantly positive association with shelling percentage.

Tryptophan and grain yield were associated significantly and positively with crude protein content. Significantly positive association was recorded with lysine content. It exhibited significantly positive association with lysine content. Lysine content was significantly and positively associated with grain yield.

Path Coefficient Analysis

The genetic architecture of seed yield is based on the balance or overall net effect produced by various yield components interacting with one another. The association of different component characters among themselves and with yield is quite important for devising an efficient selection criterion for yield. The total correlation between yield and its component characters may be some times misleading, as it might be an over-estimate or under-estimate because of its association with other characters. If relationship is due to multiple effects of gene(s) it is difficult to separate these effects by selecting a particular character. Hence, indirect selection by correlated response may not be some times fruitful. Path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations. Hence, the path coefficient analysis was undertaken to know the direct and indirect effects.

Direct effect (-0.0606) of days to 50 percent anthesis was negative. This trait showed significantly negative correlation (-0.4435) with the grain yield was mainly due to indirect negative contribution exhibited through plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, days to maturity, 100-kernel weight, shelling percentage and lysine while, it had positive effects through days to 50 percent silking, anthesis silking interval, crude protein and tryptophan contents.

Days to 50 percent silking exhibited positive direct effect (0.0046) on grain yield was recorded with significantly negative correlation (-0.4846) which was mainly attributed to indirect negative influence through plant height, days to 50 Percent anthesis, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, days to maturity, 100 kernel weight, shelling percentage and lysine.Positive indirect effect was exhibited through anthesis silking interval, crude protein and tryptophan contents.

Anthesis silking interval registered direct effect was positive (0.0109) on grain yield with negative correlation (-0.1046) mainly attributed to the indirect negative influence through days to 50 percent anthesis, ear height, ear length, ear girth, number of kernels per row, days to maturity,100 kernel weight, shelling percentage and lysine. Indirect positive effects exhibited through plant height, days to 50 percent silking, number of kernel rows per ear, crude protein and tryptophan contents.

Days to maturity exhibited negative direct effect (-0.0196) with negative correlation with grain yield (-0.1604) was mainly due to the indirect negative effects through days to 50 percent anthesis, ear height, ear length, ear girth, number of kernels per row, 100 kernel weight, shelling percentage and lysine contents whereas, it had indirect positive influence through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein and tryptophan contents.

Direct effect of plant height was negative (-0.1362) while, correlation was positive with grain yield (0.0793) was due to indirect positive influence through days to 50 percent silking, ear height, ear length, ear girth, number of kernels per row, days to maturity,100-kernel weight, shelling percentage, crude protein and tryptophan. Indirect negative contribution observed through days to 50 percent anthesis, anthesis silking interval, number of kernel rows per ear and lysine contents.

Direct positive effect was recorded (0.1385) for ear height and the correlation was significantly positive with grain yield (0.2123) was mainly attributed to the indirect positive contribution on grain yield through days to 50 percent anthesis, ear length, ear girth, number of kernels per row, days to maturity, 100-kernel weight, shelling percentage, crude protein and tryptophan while, it had indirect negative influence through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear and lysine contents.

For ear girth, direct positive effect was observed (0.1193) and the correlation was significantly positive (0.5650) with grain yield was due to the indirect positive influence through days to 50 percent anthesis, ear height, ear length, number of kernels per row, days to maturity, 100-kernel weight and shelling percentage whereas, it had indirect negative contribution exhibited through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein, tryptophan and lysine contents.

Ear length showed positive direct effect (0.1109) on grain yield with the significantly positive correlation (0.5701) was due to indirect positive effects through days to 50 percent anthesis, ear height, ear girth, number of kernels per row, days to maturity, 100-kernel weight, shelling percentage and lysine whereas, it had indirect negative contribution through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein and tryptophan contents.

Number of kernel rows per ear had direct negative effect (-0.4377 on grain yield and the correlation was significantly positive (0.2318) was due to indirect positive contribution through days to 50 percent silking, ear height, ear length, ear girth, number of kernels per row, days to maturity,100-kernel weight, shelling percentage and tryptophan while, indirect negative influence on grain yield exhibited through plant height, days to 50 percent anthesis, anthesis silking interval, crude protein and lysine contents.

Number of kernels per row had direct positive influence (0.4353) on grain yield and the correlation was significantly positive (0.4668) was due to the indirect positive influence through days to 50 percent anthesis, ear height, ear length, ear girth, days to maturity, 100-kernel weight and shelling percentage whereas, it had indirect negative contribution through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein, tryptophan and lysine contents.

Hundred kernel weight exhibited direct positive effect (0.2568) on grain yield and the correlation was significantly positive (0.5445) was due to the indirect positive influence through days to 50 percent anthesis, ear height, ear length, ear girth, number of kernels per row, days to maturity, shelling percentage and tryptophan while, it had indirect negative influence on grain yield through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein and lysine contents.

Shelling percentage had direct positive effect (0.3642) on grain yield and the correlation was significantly positive (0.7374) was due to the indirect positive influence through days to 50 percent anthesis, ear height, ear length, ear girth, number of kernels per row, days to maturity, 100-kernel weight and lysine. Indirect negative influence observed through plant height, days to 50 percent silking, anthesis silking interval, number of kernel rows per ear, crude protein and tryptophan contents.

For crude protein, direct negative effect (-0-0270) was observed on grain yield and the correlation was significantly positive (0.1697) was due to indirect positive influence through plant height, days to 50 percent anthesis, ear length, ear girth, number of kernels per row, days to maturity, 100-kernel weight, shelling percentage and lysine while, it had indirect negative influence through days to 50 percent silking, anthesis silking interval, ear height, number of kernel rows per ear and tryptophan contents.

Direct negative effect (-0.3608) was observed for tryptophan with on grain yield and the correlation was negative (-0.1201) was attributed to the indirect negative influence through days to 50 percent silking, anthesis silking interval, ear height, 100 kernel weight and crude protein while, it had indirect positive influence through plant height, days to 50 percent anthesis, ear length, ear girth, number of kernel rows per ear, number of kernels per row, days to maturity, shelling percentage and lysine contents.

For lysine content, direct positive effect (0.2181) was observed on grain yield and the correlation was positive (0.2628) was due to indirect positive influence through plant height, days to 50 percent anthesis, ear length, number of kernel rows per ear, days to maturity and shelling percentage. Indirect negative influence observed through days to 50 percent silking, anthesis silking interval, ear height, ear girth, number of kernels per row, 100 kernel weight, crude protein and tryptophan contents. Similar kinds of studies were reported earlier by Srinivasu (2004) [3], Sofi and Rather (2007) [6], Muhammad Rafiq *et al*. (2010) [7].

Table 1: Phenotypic (P) and Genotypic (G) Correlations for 16 characters at Hyderabad

Character		PH	DA	DS	ASI	EH	EL	EG	KRE	KPR	DM	100KW	SP	CP	TRY	LYS	GY
PH	P	1.0000	0.1848*	0.1756*	-0.0950	0.7169***	0.1483	0.2407**	0.2706**	0.1451	-0.0334	0.1529	0.1158	-0.0575	-0.3584***	-0.3451***	0.0793
	G	1.0000	0.1917	0.1802	0.4883	0.7400	0.1563	0.2499	0.2921	0.1423	-0.0439	0.1573	0.1364	-0.0579	-0.3878	-0.3681	0.0817
DA	P		1.0000	0.9944***	0.0956	-0.0322	-0.3075***	-0.2111*	0.0589	-0.1360	0.3441***	-0.1889*	-0.5494***	-0.4981***	-0.3128***	-0.3926***	-0.4435***
	G		1.0000	1.0011	-0.5565	-0.0330	-0.3126	-0.2186	0.0588	-0.1404	0.3805	-0.1958	-0.5897	-0.5459	-0.3263	-0.4020	-0.4478
DS	P			1.0000	0.1653	-0.0402	-0.3076***	-0.2156*	0.0543	-0.1429	0.3530***	-0.1916*	-0.5590***	-0.5041***	-0.3138***	-0.3966***	-0.4486***
	G			1.0000	-0.5748	-0.0447	-0.3133	-0.2235	0.0535	-0.1447	0.3867	-0.1996	-0.5985	-0.5519	-0.3268	-0.4050	-0.4518
ASI	P				1.0000	-0.1206	-0.0347	-0.0807	-0.0427	-0.0731	0.0456	-0.0492	-0.2183**	-0.1657*	-0.0546	-0.0516	-0.1046
	G				1.0000	0.5986	0.2335	0.3885	0.2628	0.3714	-0.8259	0.3318	0.7204	0.5476	0.2043	0.5067	0.4963
EH	P					1.0000	0.2990***	0.3349***	0.2983***	0.2395**	-0.1410	0.0539	0.2188**	-0.0690	-0.1354	-0.1046	0.2123***
	G					1.0000	0.2990	0.3419	0.3161	0.2448	-0.1734	0.0529	0.2314	-0.0726	-0.1410	-0.1071	0.2178
EL	P						1.0000	0.8006***	0.5462***	0.6271***	-0.2432**	0.4885***	0.5888***	0.2561**	0.2346**	0.1770*	0.5701***
	G						1.0000	0.8250	0.5811	0.6362	-0.2785	0.5029	0.6406	0.2831	0.2501	0.1789	0.5758
EG	P							1.0000	0.7535***	0.7496***	-0.2040*	0.6734***	0.5579***	0.1765*	0.0483	-0.1009	0.5650***
	G							1.0000	0.7940	0.7928	-0.2370	0.7057	0.5806	0.1774	0.0544	-0.0904	0.5736
KRE	P								1.0000	0.7708***	-0.2382**	0.6066***	0.2251**	0.0787	-0.0318	-0.3161***	0.2318***
	G								1.0000	0.8413	-0.2822	0.6360	0.2296	0.0572	-0.0162	-0.3252	0.2503
KPR	P									1.0000	-0.2112*	0.5490***	0.4037***	0.1649	0.1438	-0.2114*	0.4668***
	G									1.0000	-0.2690	0.5847	0.4786	0.1809	0.1462	-0.2362	0.4782
DM	P										1.0000	-0.2573**	-0.0366	-0.1184	-0.1352	-0.1866*	-0.1604
	G										1.0000	-0.2566	-0.0363	-0.1830	-0.1397	-0.1953	-0.1678
100KW	P											1.0000	0.4591***	0.1937*	-0.1134	-0.1143	0.5445***
	G											1.0000	0.4967	0.2260	-0.1130	-0.1288	0.5632
SP	P												1.0000	0.3888***	0.1179	0.2553**	0.7374***
	G												1.0000	0.4240	0.1423	0.3048	0.7885
CP	P													1.0000	0.3311***	0.0523	0.1697***
	G													1.0000	0.3641	0.0771	0.1809
TRY	P														1.0000	0.3577***	-0.1201
	G														1.0000	0.3842	-0.1267
LYS	P															1.0000	0.2628***
	G															1.0000	0.2768

Table 2: Phenotypic (P) and Genotypic (G) Path coefficients for various characters in QPM maize at Hyderabad

Character		PH	DA	DS	ASI	EH	EL	EG	KRE	KPR	DM	100KW	SP	CP	TRY	LYS	GY
PH	P	-0.1362	-0.0112	0.0008	-0.0010	0.0993	0.0165	0.0287	-0.1184	0.0632	0.0007	0.0393	0.0422	0.0016	0.1293	-0.0753	0.0793
	G	-0.1416	-0.0271	0.0112	0.0053	0.1451	0.0331	0.0080	-0.1907	0.0942	-0.0022	0.0577	0.0269	0.0021	0.1617	-0.1021	0.0817
DA	P	-0.0252	-0.0606	0.0046	0.0010	-0.0045	-0.0341	-0.0252	-0.0258	-0.0592	-0.0067	-0.0485	-0.2001	0.0135	0.1129	-0.0856	-0.4435***
	G	-0.0272	-0.1413	0.0624	-0.0060	-0.0065	-0.0662	-0.0070	-0.0384	-0.0930	0.0188	-0.0718	-0.1164	0.0202	0.1360	-0.1115	-0.4478
DS	P	-0.0239	-0.0603	0.0046	0.0018	-0.0056	-0.0341	-0.0257	-0.0238	-0.0622	-0.0069	-0.0492	-0.2036	0.0136	0.1132	-0.0865	-0.4486***
	G	-0.0255	-0.1414	0.0623	-0.0062	-0.0088	-0.0663	-0.0072	-0.0349	-0.0958	0.0191	-0.0732	-0.1182	0.0204	0.1362	-0.1124	-0.4518
ASI	P	0.0129	-0.0058	0.0008	0.0109	-0.0167	-0.0038	-0.0096	0.0187	-0.0318	-0.0009	-0.0126	-0.0795	0.0045	0.0197	-0.0113	-0.1046
	G	-0.0692	0.0786	-0.0358	0.0108	0.1174	0.0494	0.0125	-0.1715	0.2459	-0.0409	0.1217	0.1423	-0.0203	-0.0852	0.1406	0.4963
EH	P	-0.0976	0.0020	-0.0002	-0.0013	0.1385	0.0332	0.0399	-0.1306	0.1043	0.0028	0.0138	0.0797	0.0019	0.0489	-0.0228	0.2123***
	G	-0.1048	0.0047	-0.0028	0.0065	0.1961	0.0633	0.0110	-0.2063	0.1621	-0.0086	0.0194	0.0457	0.0027	0.0588	-0.0297	0.2178
EL	P	-0.0202	0.0186	-0.0014	-0.0004	0.0414	0.1109	0.0955	-0.2391	0.2730	0.0048	0.1255	0.2144	-0.0069	-0.0846	0.0386	0.5701***
	G	-0.0221	0.0442	-0.0195	0.0025	0.0586	0.2117	0.0265	-0.3794	0.4213	-0.0138	0.1845	0.1265	-0.0105	-0.1043	0.0497	0.5758
EG	P	-0.0328	0.0128	-0.0010	-0.0009	0.0464	0.0888	0.1193	-0.3299	0.3263	0.0040	0.1730	0.2032	-0.0048	-0.0174	-0.0220	0.5650***
	G	-0.0354	0.0309	-0.0139	0.0042	0.0670	0.1746	0.0321	-0.5183	0.5249	-0.0117	0.2589	0.1146	-0.0066	-0.0227	-0.0251	0.5736
KRE	P	-0.0368	-0.0036	0.0003	-0.0005	0.0413	0.0606	0.0899	-0.4377	0.3356	0.0047	0.1558	0.0820	-0.0021	0.0115	-0.0689	0.2318***
	G	-0.0414	-0.0083	0.0033	0.0028	0.0620	0.1230	0.0255	-0.6528	0.5571	-0.0140	0.2333	0.0453	-0.0021	0.0068	-0.0902	0.2503
KPR	P	-0.0198	0.0082	-0.0007	-0.0008	0.0332	0.0696	0.0894	-0.3374	0.4353	0.0041	0.1410	0.1470	-0.0045	-0.0519	-0.0461	0.4668***
	G	-0.0202	0.0198	-0.0090	0.0040	0.0480	0.1347	0.0255	-0.5492	0.6621	-0.0133	0.2145	0.0945	-0.0067	-0.0609	-0.0655	0.4782
DM	P	0.0046	-0.0209	0.0016	0.0005	-0.0195	-0.0270	-0.0243	0.1043	-0.0920	-0.0196	-0.0661	-0.0133	0.0032	0.0488	-0.0407	-0.1604
	G	0.0062	-0.0538	0.0241	-0.0089	-0.0340	-0.0590	-0.0076	0.1842	-0.1781	0.0495	-0.0941	-0.0072	0.0068	0.0582	-0.0542	-0.1678
100KW	P	-0.0208	0.0115	-0.0009	-0.0005	0.0075	0.0542	0.0803	-0.2656	0.2390	0.0050	0.2568	0.1672	-0.0052	0.0409	-0.0249	0.5445***
	G	-0.0223	0.0277	-0.0124	0.0036	0.0104	0.1065	0.0227	-0.4152	0.3872	-0.0127	0.3668	0.0981	-0.0084	0.0471	-0.0357	0.5632
SP	P	-0.0158	0.0333	-0.0026	-0.0024	0.0303	0.0653	0.0665	-0.0985	0.1758	0.0007	0.1179	0.3642	-0.0105	-0.0425	0.0557	0.7374***
	G	-0.0193	0.0833	-0.0373	0.0078	0.0454	0.1356	0.0186	-0.1499	0.3169	-0.0018	0.1822	0.1975	-0.0157	-0.0593	0.0846	0.7885
CP	P	0.0078	0.0302	-0.0023	-0.0018	-0.0096	0.0284	0.0210	-0.0344	0.0718	0.0023	0.0497	0.1416	-0.0270	-0.1195	0.0114	0.1697***
	G	0.0082	0.0771	-0.0344	0.0059	-0.0142	0.0599	0.0057	-0.0373	0.1198	-0.0091	0.0829	0.0837	-0.0370	-0.1518	0.0214	0.1809
Character		PH	DA	DS	ASI	EH	EL	EG	KRE	KPR	DM	100KW	SP	CP	TRY	LYS	GY
TRY	P	0.0488	0.0190	-0.0014	-0.0006	-0.0188	0.0260	0.0058	0.0139	0.0626	0.0026	-0.0291	0.0429	-0.0089	-0.3608	0.0780	-0.1201
	G	0.0549	0.0461	-0.0204	0.0022	-0.0276	0.0530	0.0017	0.0106	0.0968	-0.0069	-0.0414	0.0281	-0.0135	-0.4168	0.1066	-0.1267
Lysine (%)	P	0.0470	0.0238	-0.0018	-0.0006	-0.0145	0.0196	-0.0120	0.1384	-0.0920	0.0037	-0.0294	0.0930	-0.0014	-0.1291	0.2181	0.2628
	G	0.0521	0.0568	-0.0252	0.0055	-0.0210	0.0379	-0.0029	0.2123	-0.1564	-0.0097	-0.0472	0.0602	-0.0029	-0.1602	0.2775	0.2768

DA: Days to 50 percent anthesis	KRE: Number of kernel rows per ear
DS: Days to 50 percent silking	KPR: Number of kernels per row
ASI: Anthesis silking interval	100-KW: 100-Kernel weight (g)
DM: Days to maturity (cm)	SP: Shelling percentage
PH: Plant height (cm)	CP: Crude protein (%)
EH: Ear height (cm)	TRY: Tryptophan (%)
EG: Ear girth (cm)	LY: Lysine (%)
EL: Ear length (cm)	GY: Grain yield (g/plant)

Path coefficient analysis revealed that number of kernels per row, shelling percentage and 100-kernel weight exhibited the highest positive direct effects at both the genotypic and phenotypic levels on grain yield and hence these traits play an important role in generating the high yielding genotypes in the future breeding programmes.

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