



## Research Note

# Character association and path analysis of grain yield and yield components in Maize (*Zea Mays* L.)

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### Abstract

An investigation was carried out to assess the character association and path analysis for nine characters viz., days to 50% tasseling, days to 50% silking, days to maturity, plant height, cob length, kernel rows per cob, 100-seed weight, protein content and grain yield per plant in 29 genotypes (twenty one hybrids, their seven parents along with a check 30-V-92). Association studies revealed that, six out of nine characters exhibited highly significant positive correlation with grain yield per plant. However, the traits 100-seed weight, cob length, plant height, kernel rows per cob, days to 50% silking and days to 50% tasseling were found to possess significant association in desirable direction with grain yield per plant at both genotypic and phenotypic levels. Path analysis studies revealed that 100-seed weight, plant height and kernel rows per cob showed true relationship by establishing significant positive association and direct effect on grain yield per plant.

### Keywords

Maize, character association, path analysis, yield

Maize (*Zea mays* L.) is a diploid ( $2n = 20$ ) cross pollinated crop. It is the second most important cereal crop in the world's economy. It ranks first in both productivity and production among the cereals and is having worldwide significance due to its demand as food, feed and industrial utilization. It is a good source of carbohydrate, starch, fat, protein, oil in addition to some of the important minerals and vitamins. Maize is known as "Queen of cereals" because of its high production potential and wider adaptability. It is an allogamous crop endowed with the mechanism of protandry and monoecy which lent itself feasible for the exploitation of hybrid vigour. Yield in maize crop has increased substantially over the years as the breeders are successful in harnessing the heterosis or hybrid vigour than in other crop species. This indicates the importance of maize in the ever-increasing demand for food and warrants the continuous development of new high yielding hybrids.

Grain yield being a complex character is very difficult to improve by selecting the genotypes for yield *per se*. Therefore identifying the characters which are closely related and have contributed to yield becomes highly essential. The estimates of correlation coefficients mostly indicate the inter relationships of the characters whereas path analysis permits the understanding of the cause and effect of related characters (Wright, 1921). The path analysis reveals whether the association of characters with yield is due to their direct effect on yield or is a consequence of their indirect effects *via* other component characters. Therefore, the present study was

conducted in maize to study the correlation and path coefficients.

Seven inbred lines were mated in Diallel fashion without reciprocals at Agricultural College Farm, Bapatla during *kharif* 2013 to produce 21  $F_1$ s. All these 21  $F_1$ s, seven parents along with a check, 30-V-92 were evaluated during *rabi* 2013 at Agricultural College Farm, Bapatla in a Randomized Block Design with three replications. The experimental material were raised in three rows of three m length with the spacing of 60 x 30 cm. Observations were recorded on 10 randomly chosen plants for nine quantitative characters viz., days to 50% tasseling, days to 50% silking, days to maturity, plant height (cm), cob length (cm), kernel rows per cob, 100-seed weight (g), protein content (%) and grain yield per plant (g). The data were subjected to statistical analysis and estimates of correlation coefficients were worked out as per Falconer (1964). Direct and indirect effects of yield components on yield were calculated as suggested by Dewey and Lu (1959).

The correlation coefficients provide a reliable measure of association among the characters. In the present study, phenotypic correlation coefficients were lower than genotypic correlation coefficients indicating that the apparent associations are largely due to genetic reasons. The traits 100-seed weight, cob length, plant height, kernel rows per cob, days to 50% silking and days to 50% tasseling were found to possess significant association in desirable direction with grain yield per

plant at both genotypic and phenotypic levels (Table 1). Hence, selection for these characters will help in selecting genotypes with high grain yield per plant. These results were in accordance with findings of Reddy *et al.* (2013) and Kumar *et al.* (2014) for the traits 100-seed weight, days to 50% silking and days to 50% tasseling and with the results of Raghu *et al.* (2011), Rajitha (2013) and Kumar *et al.* (2014) for cob length and plant height and in accordance with the findings of Jawaharlal *et al.* (2011) and Rajitha (2013) for the character kernel rows per cob.

The trait protein content showed negative significant association with grain yield per plant while the trait days to maturity showed negative non-significant association with grain yield per plant (Table 1). Similar results were earlier reported by Parimala *et al.* (2011) for protein content and Kumar *et al.* (2011b) and Rajitha (2013) for days to maturity.

Path coefficient analysis is done in order to study the direct and indirect effects of individual component characters on the dependant variable, grain yield per plant. Study of path coefficients enables breeder to concentrate on the variable which shows high direct effect on grain yield per plant. Ultimately we can reduce time in looking for more number of component traits by restricting selection to one or few important traits (Dewey and Lu, 1959). Path analysis revealed that 100-seed weight, plant height and kernel rows per cob showed true relationship by establishing significant positive association and positive direct effect on grain yield per plant (Table 2). 100-seed weight exhibited high positive direct effect coupled with significant positive correlation at both phenotypic and genotypic levels on grain yield per plant. Similar results of positive direct effect on grain yield per plant at both phenotypic and genotypic levels were reported by Raghu *et al.* (2011), Rajitha (2013), Reddy *et al.* (2013) and Kumar *et al.* (2014). As the direct effect of 100-seed weight on grain yield per plant at both genotypic and phenotypic level accounted for the major portion in the total correlation between them, direct selection on 100-seed weight will be rewarding in improving grain yield per plant.

The trait, plant height showed significant positive correlation on grain yield per plant at both phenotypic and genotypic levels coupled with positive direct effect at both phenotypic and genotypic levels. Similar results of positive direct effect of plant height on grain yield per plant were reported by Parimala *et al.* (2011), Kumar *et al.* (2011a), Raghu *et al.* (2011), Reddy *et al.* (2013) and Kumar *et al.* (2014) at both phenotypic and genotypic levels. This trait also recorded positive indirect effects on grain yield per plant *via* 100-seed weight, kernel

rows per cob, protein content and days to 50% silking. Hence, these traits along with plant height should be considered simultaneously for improving the grain yield per plant.

Kernel rows per cob also had positive direct effect and significant positive association with grain yield per plant at both phenotypic and genotypic levels. Similar results of positive direct effect of kernel rows per cob were reported by Reddy *et al.* (2013) at genotypic level and Raghu *et al.* (2011) and Rajitha (2013) at both phenotypic and genotypic levels. The positive indirect effects of this trait *via* plant height, 100-seed weight and protein content also contributed to the total correlation on grain yield per plant. This indicate that, direct selection on kernel rows per cob along with the other three indirect causal factors *via* plant height, 100-seed weight and protein content will be effective in selection.

The trait, days to 50% tasseling recorded positive direct effects and significant negative association with grain yield per plant at both phenotypic and genotypic levels. Similar result of positive direct effects on grain yield per plant was reported by Kumar *et al.* (2011a) and Reddy *et al.* (2013). Since, the direct effects are positive and the correlation coefficients are significantly negative, the indirect causal factors which are having positive effects *viz.*, cob length and kernel rows per cob along with days to 50% tasseling are to be considered simultaneously during selection.

The trait, cob length exhibited positive direct effect coupled with significant positive correlation at phenotypic level and negative direct effect coupled with significant positive correlation at genotypic level. Here the contribution of high positive indirect effects nullified the negative direct effect at genotypic level. In such situations, the above mentioned high positive indirect causal factors are to be considered during selection process. These results were in conformity with the findings of Parimala *et al.* (2011), Rajitha (2013), Reddy *et al.* (2013) and Kumar *et al.* (2014) at phenotypic level and Raghu *et al.* (2011) at genotypic level.

The trait, days to maturity showed low positive direct effect and non-significant negative association on grain yield per plant at phenotypic level and negative direct effect coupled with negative non-significant association with grain yield per plant at genotypic level. The results of negative direct effect on days to maturity were in agreement with Raghu *et al.* (2011) and Rajitha (2013) at genotypic level. At phenotypic level, the direct effects are low positive and even negative at genotypic level while the correlations are negative. In such situations, the casual factors which had positive indirect effects on

grain yield per plant may be considered during the process of selection.

Days to 50% silking showed negative direct effect coupled with negative association with grain yield per plant at both phenotypic and genotypic levels. Similar results were reported by Kumar and Kumar (2000) and Rajitha (2013) at both genotypic and phenotypic levels. Since both direct effects as well as correlation coefficients are negative both at phenotypic and genotypic levels, the causal factors which had positive indirect effects on grain yield per plant may be considered during the process of selection.

At both levels protein content showed negative significant association and negative direct effects on grain yield per plant. These results were in accordance with Parimala *et al.* (2011) and Kumar *et al.* (2011a) at both phenotypic and genotypic levels. Since both direct effects as well as correlation coefficients are negative both at phenotypic and genotypic levels, the causal factors which had positive indirect effects on grain yield per plant may be considered during the process of selection.

In plant breeding, it is very difficult to have complete knowledge of all component traits of yield. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield. In other words, residual effect measures the role of the possible independent variables which were not included in the study on the dependent variable. In the present study, the residual effect at phenotypic level is 0.3703 indicating that the characters included in present investigation are contributing more than 62 per cent of variability pertaining the dependent variable *i.e.*, yield. Considering the nature and magnitude of character association and their direct and indirect effects, it can be inferred that improvement of grain yield per plant is possible through simultaneous manifestation of 100-seed weight, plant height and kernel rows per cob.

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**Table 1. Phenotypic and genotypic correlations among yield and yield contributing characters in maize (*Zea mays* L.)**

Character	Correlation	Days to 50% silking	Days to maturity	Plant height (cm)	Cob length (cm)	Kernel rows per cob	100-seed weight (g)	Protein content (%)	Grain yield per plant(g)
Days to 50% tasseling	G	0.8650**	0.9068**	-0.0798	-0.1816	0.0810	-0.2725*	0.0170	-0.2585*
Days to 50% silking	P	0.8545**	0.6716**	-0.0738	-0.1455	0.0519	-0.2648*	0.0230	-0.2224*
Days to maturity	G		0.9371**	-0.1337	-0.2872*	0.0326	-0.1813	0.1307	-0.2914**
Plant height (cm)	P		0.7318**	-0.1054	-0.2328*	-0.0062	-0.1760	0.1279	-0.2529*
Cob length (cm)	G			0.1009	-0.0141	0.4742**	-0.1176	0.0016	-0.0266
Kernel rows per cob	P			0.0846	-0.0005	0.1978	-0.0816	0.0196	-0.0631
100-seed weight (g)	G				0.9366**	0.5906**	0.5921**	-0.1546	0.8032**
Protein content (%)	P				0.7257**	0.4365**	0.5055**	-0.1092	0.6141**
Grain yield per plant(g)	G					0.6229**	0.6024**	-0.2697*	0.8189**
	P					0.4755**	0.5362**	-0.2492*	0.6497**
	G						0.4552**	-0.1738	0.6786**
	P						0.3583**	-0.1407	0.4913**
	G							0.0043	0.8313**
	P							0.0094	0.7366**
	G								-0.2411*
	P								-0.2150*

G: Genotypic correlation  
P: Phenotypic correlation

\*Significant at 5% level  
\*\* Significant at 1% level



**Table 2. Direct and indirect effects of different traits on grain yield per plant in maize (*Zea mays* L.)**

Character		Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height(cm)	Cob length (cm)	Kernel rows per cob	100-seed weight(g)	Protein content(%)
Days to 50% tasseling	P	<b>0.0967</b>	0.0827	0.0650	-0.0071	-0.0141	0.0050	-0.0256	0.0022
	G	<b>0.1375</b>	0.1189	0.1247	-0.0110	-0.0250	0.0111	-0.0375	0.0623
Days to 50% silking	P	-0.1645	<b>-0.1925</b>	-0.1408	0.0203	0.0448	0.0012	0.0339	-0.0246
	G	-0.1123	<b>-0.1299</b>	-0.1217	0.0174	0.0373	-0.0042	0.0235	-0.0170
Days to maturity	P	0.0101	0.0110	<b>0.0150</b>	0.0013	0.0001	0.0030	-0.0012	0.0003
	G	-0.1746	-0.1804	<b>-0.1926</b>	-0.0194	0.0027	-0.0913	0.0226	-0.0003
Plant height (cm)	P	-0.0132	-0.0188	0.0151	<b>0.1785</b>	0.1295	0.0799	0.0902	-0.0195
	G	-0.0401	-0.0672	0.0507	<b>0.5024</b>	0.4706	0.2967	0.2975	-0.0777
Cob length(cm)	P	-0.0146	-0.0233	-0.0001	0.0726	<b>0.1001</b>	0.0476	0.0537	-0.0249
	G	0.0423	0.0669	0.0033	-0.2181	<b>-0.2328</b>	-0.1450	-0.1403	0.0628
Kernel rows per cob	P	0.0076	-0.0009	0.0290	0.0639	0.0696	<b>0.1464</b>	0.0525	-0.0206
	G	0.0288	0.0116	0.1686	0.2099	0.2214	<b>0.3555</b>	0.1618	-0.0618
100-seed weight(g)	P	-0.1415	-0.0941	-0.0436	0.2702	0.2866	0.1915	<b>0.5344</b>	0.0050
	G	-0.1374	-0.0914	-0.0593	0.2985	0.3038	0.2295	<b>0.5043</b>	0.0022
Protein content(%)	P	-0.0030	-0.0170	-0.0026	0.0145	0.0331	0.0187	-0.0012	<b>-0.1329</b>
	G	-0.0026	-0.0198	-0.0002	0.0235	0.0409	0.0264	-0.0007	<b>-0.1517</b>
Grain yield per plant(g)	P	-0.2224*	-0.2529*	-0.0631	0.6141**	0.6497**	0.4913**	0.7366**	-0.2150*
	G	-0.2585*	-0.2914**	-0.0266	0.8032**	0.8189**	0.6786**	0.8313**	-0.2411*

\* Significant at 5% level

\*\* Significant at 1% level

Diagonal values indicate direct effects

Residual effect at phenotypic level = 0.3703

P: at phenotypic level

G: at genotypic level