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RESEARCH PAPER

Character association studies for quantitative traits in maize (*Zea mays* L.)

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Abstract: The present investigation for studying correlations and path analysis estimates for grain yield and yield contributing characters in maize was carried out at Maize Research Centre and Seed Farm, Devihosur and analysis was carried out for eleven characters. Days to 50 per cent tasseling was significantly and positively correlated with days to 50 per cent silking and negatively correlated with plant height, ear height, cob length, shelling percentage, hundred grain weight and grain yield. Days to 50 per cent silking was significant and negatively correlated with plant height, ear height, shelling percentage and grain yield. Hundred grain weight exhibited significant positive association with plant height, ear height, cob length, cob girth, number of kernel rows per ear, number of kernels per row and grain yield. The character grain yield showed significant and negative correlation with days to 50 per cent tasseling, days to 50 per cent silking and positive correlation with plant height, ear height, cob length, cob girth, number of kernel rows per cob, number of kernels per row and hundred grain weight. Path analysis revealed that direct positive effects were shown by number of kernels per ear followed by cob length, days to fifty percent tasseling, ear height and cob girth. Negative direct effects were shown by days to fifty per cent silking, days to 75 per cent dry husk, plant height, number of kernels per row and shelling percentage.

Key words: Correlation, Maize, Path analysis

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. Globally, maize is known as queen of cereals because of its highest genetic yield potential, Maize is the only food crop that can be grown in diverse seasons and ecologies. Maize has become a staple food to many parts of the world with total production of maize surpassing that of wheat or rice in addition to being consumed directly by humans. Maize is also used for corn ethanol, animal feed and other maize products, such as corn starch and corn syrup. Determination of correlation and path coefficients between yield and yield traits is important for the selection of favorable plant types for effective maize breeding programs.

Maize grain yield is a complex quantitative trait that depends on a number of interacting factors: environmental conditions and various growth and physiological processes throughout the crop's life cycle. Interrelationships exist between yield and its contributing components. An insight into such interrelationships can significantly improve the efficiency of breeding program by providing appropriate selection indices. Direct selection for yield is often misleading as it is highly influenced by unpredictable environmental components. In this regard, correlation coefficient analysis is useful in providing knowledge for the selection of several traits simultaneously influencing yield.

Correlation coefficients show associations among independent characteristics and the degree of linear relation between these characteristics. It is not sufficient to describe this relationship when the causal association among characteristics is needed. Path analysis is used to determine the amount of direct and indirect effect of the causal components on the effect component. Keeping this in view, the present study was undertaken to study the extent of relationships among yield and its components for enhancing the usefulness of selection.

Material and methods

The present investigation for studying correlations and path analysis estimates for grain yield and yield contributing characters in maize was carried out during *kharif* 2022, *summer* 2023 at Maize Research Centre and Seed Farm, Devihosur. Phenotypic and genotypic correlations were worked out in 10 parental inbred lines and the pooled analysis over was carried out and presented in Table 1 and 2 respectively. In general, phenotypic correlations were of higher magnitude than the corresponding phenotypic values and hence only the genotypic correlations are discussed here under. Path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations (Wright, 1921). Hence, the path coefficient analysis was undertaken to know the direct and indirect effects in maize.

Results and discussion

Grafius (1959) revealed that there may not be genes controlling for yield as such but exhibit only through its components. Hence correlation analysis provides their liable information on natureand magnitude of the association of different component characters with grain yield, which is regarded as highly complex trait in which the breeder is ultimately interested. So, there is scope for the plant breeders

Table 1. Phenotypic (P) and genotypic (G) pooled correlations for twelve characters in maize

Source		Days to 50% Tasseling	Days to 50% silking	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	Shelling percentage (%)	100-grain weight (g)	Grain yield (q/ha)
Days to 50%	P	1.00	0.601**	0.015	-0.160*	-0.340*	-0.124*	-0.070	-0.045	0.063	-0.240*	-0.123*	-0.225*
tasseling	G	1.00	0.914**	0.079	-0.319*	-0.514*	-0.188*	-0.158*	-0.030	0.129*	-0.597*	-0.134*	-0.254*
Days to 50%	P		1.00	0.014	-0.215*	-0.356*	-0.094	-0.072	0.056	0.140*	-0.261*	-0.084	-0.187*
silking	G		1.00	-0.145*	-0.338*	-0.493*	-0.152*	-0.152*	0.088	0.195*	-0.436*	-0.120*	-0.245*
Days to maturity	P			1.00	0.076	0.120	0.138*	0.078	0.111*	0.064	0.080	0.111*	0.106*
	G			1.00	0.070	0.336*	0.145	-0.048	0.366*	0.100*	0.012	0.037	0.003
Plant height (cm)	P				1.00	0.662**	0.462*	0.258*	0.283*	0.266*	0.142*	0.321*	0.454*
	G				1.00	0.758**	0.580*	0.336*	0.382*	0.334*	0.243*	0.400*	0.580*
Ear height (cm)	P					1.00	0.499*	0.241*	0.333*	0.334*	0.193*	0.287*	0.482*
	G					1.00	0.659**	0.289*	0.387*	0.439*	0.346*	0.367*	0.550*
coblength (cm)	P						1.00	0.184*	0.173*	0.447*	0.161*	0.349*	0.544*
	G						1.00	0.242*	0.276*	0.580*	0.462*	0.419*	0.627*
cob girth (cm)	P							1.00	0.381*	0.011	0.329*	0.429*	0.443*
	G							1.00	0.518*	0.002	0.725**	0.558*	0.514*
Number of kernels	P								1.00	0.225*	0.240*	0.459*	0.569*
per ear	G								1.00	0.363*	0.522*	0.631*	0.690*
Number of kernels	P									1.00	-0.088	0.313*	0.413*
per row	G									1.00	-0.010	0.358*	0.452*
Shelling percentage	P											0.319*	0.394*
	G											0.733**	0.748**
100 seed weight	P											1.00	0.765**
(g)	G											1.00	0.829**

Table 2. Phenotypic(P) and genotypic (G) pooled path for twelve characters in maize

Source		Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant Height (cm)	Ear height (cm)	Cob length (cm)	Cob girth (cm)	Number of kernel rows per ear	Number of kernels per row	Shelling percentage (%)	100-seed weight (g)	Grain yield (q/ha)
Days to 50%	P	-0.046	-0.028	-0.001	0.007	0.016	0.006	0.003	0.002	-0.003	0.011	0.006	-0.226
tasseling	G	0.930	0.851	0.074	-0.297	-0.479	-0.176	-0.148	-0.029	0.120	-0.556	-0.126	-0.254
Days to 50%	P	-0.051	-0.084	-0.001	0.018	0.030	0.008	0.006	-0.005	-0.012	0.022	0.007	-0.188
silking	G	-1.903	-2.081	0.303	0.705	1.028	0.317	0.318	-0.184	-0.406	0.909	0.251	-0.245
Days to maturity	P	0.000	0.000	-0.026	-0.002	-0.003	-0.004	-0.002	-0.003	-0.002	-0.002	-0.003	0.107
	G	-0.097	0.178	-1.224	-0.086	-0.412	-0.178	0.059	-0.448	-0.122	-0.016	-0.045	0.004
Plant height(cm)	P	-0.007	-0.009	0.003	0.041	0.027	0.019	0.011	0.012	0.011	0.006	0.013	0.455
	G	0.385	0.408	-0.084	-1.206	-0.914	-0.700	-0.406	-0.461	-0.403	-0.293	-0.482	0.580
Ear height(cm)	P	-0.005	-0.005	0.002	0.010	0.015	0.008	0.004	0.005	0.005	0.003	0.004	0.483
	G	-0.052	-0.050	0.034	0.076	0.100	0.066	0.029	0.039	0.044	0.035	0.037	0.551
cob length(cm)	P	-0.028	-0.021	0.031	0.103	0.111	0.223	0.041	0.039	0.100	0.036	0.078	0.545
	G	-0.322	-0.259	0.248	0.988	1.122	1.703	0.414	0.471	0.988	0.788	0.714	0.628
cobgirth (cm)	P	-0.004	-0.004	0.005	0.016	0.015	0.011	0.061	0.023	0.001	0.020	0.026	0.444
	G	-0.015	-0.015	-0.005	0.033	0.028	0.023	0.097	0.050	0.000	0.070	0.054	0.515
Number of kernel	P	-0.011	0.013	0.026	0.066	0.078	0.041	0.089	0.233	0.053	0.056	0.107	0.569
rows per ear	G	-0.062	0.177	0.733	0.765	0.775	0.554	1.038	2.001	0.727	1.046	1.263	0.691
Number of kernels	P	0.008	0.018	0.008	0.034	0.043	0.058	0.002	0.029	0.129	-0.011	0.040	0.413
per row	G	-0.105	-0.158	-0.081	-0.270	-0.355	-0.469	-0.002	-0.294	-0.809	0.012	-0.290	0.452
Shelling percentage	P	-0.027	-0.029	0.009	0.016	0.021	0.018	0.036	0.026	-0.010	0.110	0.035	0.395
	G	1.092	0.799	-0.024	-0.445	-0.634	-0.846	-1.327	-0.956	0.028	-1.829	-1.341	0.748
100 seed	P	-0.056	-0.038	0.051	0.145	0.130	0.158	0.194	0.208	0.141	0.144	0.451	0.766
weight (g)	G	-0.107	-0.096	0.029	0.318	0.292	0.333	0.443	0.501	0.284	0.582	0.794	0.829

to identify which of the characters are correlated with yield and also the relationship among themselves, so that breeders can ultimately increase yield by selecting these component traits.

Association of days to 50 per cent tasseling was highly significant positive correlation with days to 50 per cent silking (0.601) and significant negative association for days to 50 per cent tasseling was observed with plant height (-0.160), ear height (-0.340), cob length (-0.124), shelling percentage (- 0.240), hundred grain weight (-0.123) and grain yield (-0.225) at phenotypic level. Similar results for association of grain yield per plant with days to 50 percent tasseling were also reported by Raghu *et al.* (2011), Ravi *et al*. (2012) and Sharma *et al.* (2014). Days to 50 per cent tasseling in pooled analysis showed

highly significant positive correlation with days to 50 per cent silking (0.914) and number of kernels per row (0.129). Significant negative association for days to 50 percent tasseling was observed with plant height (-0.319), ear height (-0.514), cob length (-0.188), Cob girth (-0.158), shelling percentage (-0.597), hundred grain weight (-0.134) and grain yield (-0.254).

Pooled analysis revealed that association of days to 50 percent tasseling was significant positive correlation with number of kernels per row (0.140) and significant negative association for days to 50 per cent silking was observed with plant height (-0.215), ear height (-0.356), shelling percentage (- 0.261) and grain yield (-0.187). Whereas days to 75 per cent dry husk (0.014) and number of kernels per cob (0.056) had a non-significant positive association with this trait. Such finding was also observed by Reddy and Jabeen (2016) and Jodage *et al.* (2017) [2]. days to 50 per cent silking was a significant positive correlation with number of kernels perrow (0.195) and a significant negative association for days to 50 per cent silking was observed with days to 75 per cent dry husk (-0.145), plant height (-0.338), ear height (-0.493), cob length (-0.152), cob girth (-0.152), shelling percentage (- 0.436), hundred-grain weight (-0.120) and grain yield.

The association of number of kernel rows per cob was significant and positive with plant height, ear height, cob length, cob girth, number of kernels per cob, number of kernels per row, hundred-grain weight and grain yield in the pooled analysis. Hundred seed weight exhibited significant positive association with plant height, ear height, cob length and cob girth, number of kernel rows per cob, number of kernels per row, shelling percentage and grain yield. The character grain yield per plant showed significant and negative correlation with days to 50 per cent tasseling, days to 50 per cent silking and positive correlation with plant height, ear height, cob length, cob girth, number of kernel rows per cob, number of kernels per row and hundred-grain weight in the pooled analysis. Similar results were reported by Nataraj *et al*. (2014) and Sharma *et al.* (2014) .

Path analysis revealed that direct positive effects were shown by number of kernels per ear (2.000),cob length (1.702), days to fifty per cent tasseling (0.930), ear height (0.100) and cob girth (0.096). Negative direct effects were shown by days to fifty percent silking, days to 75 percent dry husk, plant height, number of kernels per row and shelling percentage. Positive indirect effect of days to fifty per cent tasseling on grain yield was observed *via* days to fifty per cent silking, days to 75 per cent dry husk and number of kernels per row. A highly negative indirect effect was shown by shelling percentage (-0.555) followed by ear height (-0.478) and plant height (-0.297). Days to fifty per cent silking showed highly positive indirect on grain yield through shelling percentage (0.908) followed by plant height (0.705). It was negative for the characters *viz*., days to fifty per cent tasseling (-1.903), number of kernels per row (-0.405) and number of kernels per ear (-0.183).

Days to 75 per cent dry husk showed a high positive indirect effect on grain yield via days to fifty per cent silking and a high negative indirect effect through number of kernels per ear. Ear height showed a positive indirect effect on grain yield through all most all the characters except days to fifty per cent tasseling and days to fifty per cent silking. Cob length showed a highly positive indirect effect on grain yield via ear height (1.122) followed by number of kernels per ear. Negative indirect effect was shown by days to fifty per cent tasseling and days to fifty per cent silking. Cob girth showed the highest positive indirect effect through shelling percentage (0.070) followed by number of kernels per ear (0.050). Number of kernels per ear showed positive indirect effect on grain yield with all the characters studied except days to fifty per cent tasseling. Number of kernels per row showed negative indirect effect through all the traits under study except shelling percentage (0.012). Shelling percentage showed positive indirect effect on grain yield through days to fifty per cent tasseling (1.092), days to fifty per cent silking (0.798) and number of kernels per row (0.027). Highest negative indirect effect was shown by cob girth (-1.327) followed by cob length (-0.845).

The present investigation clearly revealed that the characters number of kernels per ear, cob length and cob girth had a strong association with grain weight and positive highest direct and an indirect effect through other component traits. Vaezi*et al.* (2000) reported that the bulk of indirect effect on grain yield understudy was exerted by the traits like ear length and ear girth. This indicated direct selection for these characters will enhance the breeding efficiency for grain yield in maize. Mohamadi *et al*. (2003); Kumar *et al*. (1999) reported that number of kernels per ear had a maximum positive direct effect on yield followed by cob length, plant height, cob girth and days to fifty per cent silking. Sofi and Rather (2006), Najeeb *et al*. (2009) also reported the importance of these characters in path analysis.

Conclusion

The results obtained in this investigation revealed the occurrence of considerable positive as well as negative direct and indirect effects by various characters on the yield of Maize through one or other characters. Thus, it can be concluded that the characters mentioned above should be duly considered at the time of formulation of selection strategy to develop high yielding hybrids in Maize.

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