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RESEARCH ARTICLE

Correlation and path analysis in maize (*zea mays* L.)

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Abstract

A field experiment involving 18 genotypes of maize was carried out at Agricultural Research Station, Madhira during *kharif* 2015 to study the association of yield contributing characters among themselves along with direct and indirect effects on seed yield per plant. The results of the study revealed that days to 50% tasseling and days to 50% silking showed negative significant association with ear length, ear girth, number of kernel rows, number of kernels per row, test weight and seed yield per plant both at genotypic and phenotypic levels. Plant height showed positive significant association with ear height, ear length, ear girth, number of kernel rows, number of kernels per row, test weight and seed yield per plant. Days to 50% tasselling exhibited negative direct effect coupled with negative significant association while days to 50% silking exhibited positive direct effect on seed yield per plant. Ear height and ear length showed positive direct effects and positive indirect effect through ear girth, number of kernel rows, number of kernels per row and test weight resulting in significant positive association with seed yield per plant. For improvement of seed yield, attention should be given for traits such as ear length, ear girth, number of kernel rows and number of kernels per row which showed high positive correlation coefficients with a considerable direct and indirect effect on seed yield.

Key words: Maize, correlation, path analysis, yield, effect

Introduction

Maize (*Zea mays* L.) is the third important cereal crop (both for food and feed purpose) globally after wheat and rice. It is grown on more than 120 million hectares and is called the “king of grain crops”. Despite of staple food of many countries the average yield of maize around the world is less than to meet the food requirements of increasing world population. At present grain yield of maize in India is much lower than world average. It is mainly due to the poor genetic composition of the cultivars, non availability of good quality seed of varieties/hybrids with high yield potential and less acclimatization of exotic hybrids due to biotic and abiotic stresses. Therefore, the development of improved cultivars/hybrids of maize is the need of the day.
Grain yield is a complex quantitative trait that depends on plant genetics and its interaction with environmental conditions. To determine such relationships, correlation analyses are used such that the values of two characters are analyzed on a paired basis, results of which may be either positive or negative. The result of correlation is of great value in the evaluation of

the most effective procedures for selection of superior genotypes. When there is positive association of major yield characters, component breeding would be very effective but when these characters are negatively associated, it would be difficult to exercise simultaneous selection for such characters in varietal development. Phenotypic correlation indicates the extent of the observation having relation between two traits while genotypic correlation provides an estimate of inherent association between the genes controlling any two traits.

For formulating selection indices for genetic improvement of yield, the cause and effect of the trait is very essential and can be done by path analysis. Path analysis shows direct and indirect effects of cause variables on effect variables. In this method, the correlation coefficient between two traits is separated into the components which measure the direct and indirect effects. Generally, this method provides more information among variables than do correlation coefficients since this analysis provides the direct effects of specific yield components on yield, and indirect effects via other yield components.In order to develop promising maize genotypes with higher yield potential, it is essential to know the correlation among different traits, especially with grain yield, which is the most important ultimate objective in any breeding program. It is necessary to have a good knowledge of those characters that have significant correlation with yield because those characters can be used as indirect selection criteria to enhance the mean performance of varieties in a new plant population. Keeping this in view, the present study was therefore, designed to genetic basis of grain yield components and to develop suitable selection criteria for future maize breeding program.

Material and methods

The study of genetic potential and genetic variability of various parameters in maize was conducted at Agricultural Research Station, Madhira during *kharif* 2015. Eighteen maize genotypes *viz*., 15 lines and 3 testers possessing a wide genetic background were obtained from Maize Research Station, Rajendranagar. The genotypes were evaluated in randomized block design with three replications. Each plot consisted of four rows of five-meter length with row spacing and plant spacing of 75 and 25 cm, respectively. A basal fertilizer dose of 120 kg N and 50 kg P_2O_5 was applied in the form of DAP and urea. A full dose of P_2O_5 and half of N was applied at the time of sowing. The remaining half of the N was given when the plants reached knee-height. Thinning was carried out when plants were 10-15 cm tall. Standard cultural practices were adopted from sowing till harvest to raise a healthy crop.

Data collection and statistical analysis

Data were recorded on days to 50% tasselling, days to 50% silking, days to maturity, plant height (cm), ear height (cm), ear length (cm), ear girth (cm), number of kernel rows, number of kernel per row, test weight (gm), seed yield per plant. All the data were subjected to statistical analysis to test the differences among maize genotypes for various traits. Analysis of variance was done for partitioning the total variation due to treatments and replications according to procedure given by Panse and Sukhatme (1985). Correlation coefficients between different traits were determined as described by Singh and Chaudhary (1979). Path coefficients were determined following the method suggested by Dewey and Lu (1957). Data were analyzed using Indostat software (Indostat Inc. Hyderabad, India).

Results and discussion

The correlation studies were made for seed yield per plant and other yield attributing traits. The association between two variables which can be directly observed is termed as phenotypic correlation, whereas the inherent or heritable association is known as genotypic correlation and in the present study in general the genotypic correlation coefficients (Table1) were higher than phenotypic (Table2) value indicating that strong intrinsic association is reduced at phenotypic level due to environmental effects. 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 therefore, designed to understand genetic basis of grain yield components and to develop suitable selection criteria for future maize breeding program.

Days to 50% tasseling showed positive significant association with days to 50% silking and negative significant association with ear length, ear girth, number of kernel rows, number of kernels per row, test weight and seed yield per plant both at genotypic and phenotypic levels. Days to 50% silking also followed the same trend for yield attributing traits and seed yield per plant ay both genotypic and phenotypic levels. This clearly indicates that as the number days taken for tasselling and silking increase, most of the assimilates are diverted towards vegetative growth of the plant as a result of which the ear characters, kernel number, test weight and ultimately seed yield are reduced significantly. Similar results were also reported by earlier workers *viz*., Nagabhushanam *et al*., (2011), Pavan *et al*., (2011), Praveen *et al*., (2014) and Nataraj *et al*., (2014).

In the present study, plant height showed positive significant association with ear height, ear length, ear girth, number of kernel rows, number of kernels per row, test weight and seed yield per plant at genotypic level as well as at phenotypic level. In the present material under study, increased plant height contributed for increase in the length of ear thereby accommodating more kernel rows and more number of kernels per row ultimately resulting in more seed yield per plant. Similar influences of plant height at both genotypic and phenotypic levels indicate negligible influence of environment on the expression of these characters in the material under study.

Positive significant association of ear characters with number of kernel rows, number of kernels per row, test weight and seed yield per plant were observed at both genotypic and phenotypic levels indicating that increase in length and girth of ears will lead to simultaneous increase in kernel rows as longer and broader kernels can accommodate more number of kernel rows and consequently more number of kernels per row. These are the important yield attributing traits which can be aimed for simultaneous improvement in yield. Similar results were reported by earlier workers *viz.*, Jaghav *et al*., (2009), Selvaraj and Nagarajan (2011) and Muneeb *et al*., (2013).

The results of path analysis (Table3) in the present study revealed that days to 50% tasselling exhibited negative direct effect coupled with negative significant association with seed yield per plant. On the other hand, days to 50% silking exhibited positive direct effect on seed yield per plant. However, negative indirect effects of this trait were manifested through many of the yield contributing traits like ear length, ear girth, number of kernel rows per ear, number of kernels per row and test weight resulting in negative significant correlation with seed yield per plant. Days to maturity and plant height showed negative direct effect on seed yield per plant and negative indirect effects through many of the yield traits viz., ear length, ear girth, number of kernel rows and test weight. Pavan *et al.,* (2011), Sandeep *et al.,* (2011), Bullo (2014) and Hailegebrial *et al*., (2015) also reported similar observations for these traits in their study on several genotypes of maize.

Ear height and ear length showed positive direct effects and positive indirect effect through ear girth, number of kernel rows, number of kernels per row and test weight resulting in significant positive association with seed yield per plant. These results are in accordance with the earlier findings of Jadhav *et al*., (2009), Selvaraj and Nagarajan (2011), Nataraj *et al.*, (2014) and Hailegebrial *et al*., (2015). Positive direct effects on seed yield per plant were manifested by number of kernel rows, number of kernels per row and test weight. These traits also showed positive indirect effects through test weight, ear length, ear girth, ear height and plant height resulting in positive significant association with seed yield per plant. Test weight also exhibited positive direct and positive indirect effects resulting in positive significant relation with seed yield. Similar results were reported by earlier workers viz., Pavan *et al.,* (2011), Nataraj *et al*., (2015) and Praveen *et al.,* (2014).

According to the results, in order to bring an effective improvement of seed yield, more attention should be given for traits such as ear length, ear girth, number of kernel rows and number of kernels per row which showed high positive phenotypic and genotypic correlation coefficients with a considerable direct and indirect effect on seed yield. This study showed the existence of positive and significant association of yield with number of kernels per row and test weight and identified the existence of positive direct effect of desirable yield related traits with seed yield per plant. However, further evaluation of these genotypes at more locations and over years is advisable to confirm the promising results observed in present study. In general, it may be concluded that the information from this study could be valuable for researchers who intend to develop high yielding varieties of maize.

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Table 1: Genotypic correlation coefficient values for yield attributes with seed yield per plant in eighteen genotypes of maize

Character	Days to 50% tasselling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows	Number of kernels per row	Test weight (g)	Seed yield per plant (g)
Days to 50% tasselling	1.0000	0.9854**	0.1960	-0.2086	-0.0931	-0.4671*	-0.5454*	-0.5598*	-0.5029*	-0.4207*	-0.6009**
Days to 50% silking		1.0000	0.2017	-0.2064	-0.1313	-0.4510*	-0.5391*	-0.5995*	-0.5182*	-0.4216*	-0.6098**
Days to maturity			1.0000	0.0175	0.0263	0.0797	0.0353	0.1655	-0.0014	0.1234	0.0333
Plant height (cm)				1.0000	0.7930**	0.6742**	0.6015**	0.3310	0.6381**	0.6280**	0.6092**
Ear height (cm)					1.0000	0.5017*	0.5119*	0.2289	0.5788*	0.5192*	0.5413*
Ear length (cm)						1.0000	0.6819**	0.4368*	0.7939**	0.7121**	0.8078**
Ear girth (cm)							1.0000	0.6112**	0.7292**	0.6320**	0.7382**
Number of kernel rows								1.0000	0.5680*	0.4318*	0.7283**
Number of kernels/ row									1.0000	0.6131**	0.8989**
Test weight (g)										1.0000	0.7868**
Seed yield per plant (g)											1.0000

**: Significant at 1%, *: Significant at 5%

Table 2: Phenotypic correlation coefficient values for yield attributes with seed yield per plant in eighteen genotypes of maize

Character	Days to 50% tasselling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows	Number of kernels per row	Test weight (g)	Seed yield per plant (g)
Days to 50% tasselling	1.0000	0.9617**	0.1861	-0.1767	-0.0869	-0.4295*	-0.4969*	-0.5281*	-0.4618*	-0.3806	-0.5582*
Days to 50% silking		1.0000	0.1849	-0.1815	-0.1142	-0.4123*	-0.4897*	-0.5596*	-0.4803*	-0.3844	-0.5707*
Days to maturity			1.0000	0.0494	0.0329	0.0622	0.0540	0.1338	-0.0186	0.1128	0.0331
Plant height (cm)				1.0000	0.7466**	0.6058**	0.5379*	0.2879	0.5709*	0.5754*	0.5704*
Ear height (cm)					1.0000	0.4741*	0.4608*	0.1928	0.5130*	0.4770*	0.5055*
Ear length (cm)						1.0000	0.6152**	0.3835	0.7173**	0.6577**	0.7595**
Ear girth (cm)							1.0000	0.5725*	0.6579**	0.5775*	0.6853**
Number of kernel rows								1.0000	0.5207*	0.3882	0.6775**
Number of kernels / row									1.0000	0.5867*	0.8481**
Test weight (g)										1.0000	0.7439**
Seed yield per plant (g)											1.0000

**: Significant at 1%, *: Significant at 5%

Table 3: Direct and indirect effects of yield attributes on seed yield per plant in eighteen genotypes of maize

Character	Days to 50% tasselling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows	Number of kernels per row	Test weight (g)	Seed yield / plant (g)
Days to 50% tasselling	**-0.7464**	-0.7355	-0.1463	0.1557	0.0695	0.3486	0.4071	0.4178	0.3753	0.3140	**-0.6009****
Days to 50% silking	0.7399	**0.7509**	0.1514	-0.1550	-0.0986	-0.3387	-0.4048	-0.4502	-0.3891	-0.3166	**-0.6098****
Days to maturity	-0.0173	-0.0178	**-0.0880**	-0.0015	-0.0023	-0.0070	-0.0031	-0.0146	0.0001	-0.0109	**0.0333**
Plant height (cm)	0.0434	0.0429	-0.0036	**-0.2080**	-0.1649	-0.1402	-0.1251	-0.0688	-0.1327	-0.1306	**0.6092****
Ear height (cm)	-0.0170	-0.0240	0.0048	0.1450	**0.1829**	0.0918	0.0936	0.0419	0.1059	0.0950	**0.5413***
Ear length (cm)	-0.0601	-0.0580	0.0103	0.0867	0.0645	**0.1286**	0.0877	0.0562	0.1021	0.0916	**0.8078****
Ear girth (cm)	0.0858	0.0848	-0.0056	-0.0946	-0.0806	-0.1073	**-0.1573**	-0.0962	-0.1147	-0.0994	**0.7382****
Number of kernel rows	-0.2240	-0.2399	0.0662	0.1324	0.0916	0.1748	0.2446	**0.4001**	0.2273	0.1728	**0.7283****
Number of kernels / row	-0.2525	-0.2602	-0.0007	0.3204	0.2907	0.3987	0.3661	0.2852	**0.5021**	0.3078	**0.8989****
Test weight (g)	-0.1528	-0.1531	0.0448	0.2280	0.1885	0.2586	0.2295	0.1568	0.2226	**0.3631**	**0.7868****

Residual effect = 0.1540