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TARGETING OF TRAITS THROUGH ASSESSMENT OF INTERRELATIONSHIP AND PATH ANALYSIS BETWEEN YIELD AND YIELD COMPONENTS FOR GRAIN YIELD IMPROVEMENT OF MAIZE (*ZEA MAYS* L.) GENOTYPES

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ABSTRACT

The present investigation was undertaken to study the correlation/character association and path analysis in twenty five genotypes of maize obtained from All India Co-ordinated Maize Improvement Project for their further utilization in breeding programme(s). The magnitude of genotypic correlations was higher than the phenotypic corrrelation in the same direction indicating a low influence of environmental factors and relative stability of the genotypes. Positive and strong association was shown by number of kernels per row with seed yield per plant (rp=0.829, rg=0.778), while, days to 50% tasseling (rp=-0.103, rg=-0.002) and days to 50% silking (rp=-0.155, rg=-0.087) were negatively correlated. Maximum positive direct effect was exerted by number of kernels per row (0.620), 100 seed weight (0.487) followed by number of kernel rows per cob (0.210). While days to 50% silking (-0.074), tassel length (-0.007) and ear height (-0.003) showed negative direct effect on seed yield per plant and remaining had very low value of direct effects on seed yield per plant. The maximum indirect effect was contributed via number of kernels per row, number of kernel rows per cob and 100 seed weight on seed yield per plant.

INTRODUCTION

Maize is one of the most important grown plants in the world. Superior position of maize is due to its very wide and variety utilisation. During the centuries maize plant was known for its multifariously use. Maize is used like a human food, livestock feed, for producing alcohol and no alcohol drinks, built material, like a fuel, and like medical and ornamental plant (Zorana *et al*., 2010). Because of very wide utilization of maize, the main goal of all maize breeding programmes is to obtain new inbreds and hybrids that will outperform the existing hybrids with respect to a number of traits. In working towards this goal, particular attention is paid to grain yield as the most important agronomic characteristic. (Zorana *et al*., 2010).

The study of correlation between plant characters is of great importance to a plant breeder as it provides a measure of the degree of association between yield and other yield attributes. The path coefficient analysis is partitioned the correlation into direct and indirect effects and thus may be useful in choosing the characters that have direct and indirect effects on yield. Hence, study of correlations (genotypic and phenotypic) and path coefficient analysis of yield would be of help in selection of yield component traits in the genetic improvement of quantitative traits, which are positively correlated. (Tarachand *et al*.,2014)

Knowing the correlations between the traits is a great importance for success in selections to be conduced in breeding programs, and analysis of correlation coefficient is the most widely used one among numerous methods that can be used (Yagdi and Sozen, 2009). Correlation measure the level of dependence traits and out of numerous correlation coefficients it is often difficult to determined the actual mutual effects among traits (Ikanovic *et al*., 2011). The estimates of correlations alone may be often misleading due to mutual cancellation of component traits and when the indirect associations become complex, path coefficient analysis is the most effective mean to find out direct and indirect causes of association among the different variables. So, it becomes necessary to study path coefficient analysis, which takes into account the casual relationship in addition to degree of relationship (Neelam *et al*., 2014). In such case, path coefficient analysis is an important technique for partitioning the correlation coefficient into direct and indirect effect of independent variables on dependent variable. Ikanovic *et al*. (2011) concluded that even if correlation values are similar for certain pairs of traits, direct effects for some of them and especially indirect effects via other traits can differ for some traits. It is therefore, correlation as well as path coefficient may be important tools for the breeder to enhancing the seed yield of maize crop.

Keeping the above facts in view, the present investigation aimed to assess the degree of association/interrelationship and to determine the direct and indirect influences of yield and its attributing characters.

MATERIALS AND METHODS

The present investigation was carried out in *Kharif*-2012 on Agricultural Research Farm, Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi with 25 genotypes of maize obtained from All India Co-ordinated Maize Improvement Project in a Randomized Block Design (RBD) with three replications. The detail of genotypes is given in Table 1. Each entry was sown with a three rows of 3m length with row to row spacing of 60 cm and plant to plant spacing of 20 cm. Initially two seeds per hill were planted and later on one plant was thinned to maintain single plant per hill. Two boarder rows were also planted to avoid the boarder effect. Recommended cultural practices were carried out to raise a healthy crop. The pre and post harvest observations were recorded on five plants selected at random from each genotype in each replication for eleven characters *viz.,* days to 50% flowering, days to 50% silking, plant height (cm), ear height (cm), tassel length (cm), cob length (cm), cob diameter (cm), number of kernel rows per cob, number of kernels per row, 100 grain weight (g) and grain yield per plant (g) measured from five cobs from random plants harvested and after shelling, grain was dried to get uniform moisture of 15% and weight was measured with pan balance. Mean of the data from the sampled plants of each plot in respect of different characters were used for various statistical analysis. Correlation coefficients were calculated for all the character combinations at genotypic and phenotypic levels as per the formula given by Miller *et al.* (1958). Path coefficient analysis was done by using correlation coefficients as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Selection for a character may lead to simultaneous improvement in associated characters from which understanding on interallelic relationship among different characters is essential to make any programme on improvement of character following appropriate method of plant breeding. (Sunil Diyali *et al.*, 2014)

The present investigation was carried out to study character association in maize both at phenotypic and genotypic levels. In general, genotypic correlation was higher than phenotypic correlation indicating a low influence of environmental factors and relative stability of the genotypes (Bhole and Patil.,1984). Grain yield per plant exhibited high significant positive association with number of kernels per row (rp = 0.829, rg = 0.778) followed by, tassel length, 100 seed weight, cob length, number of kernel rows per cob, indicating the importance of these traits in selection for yield. Similar results were reported by several workers on different characters *viz.,* for the association of grain yield with ear height (Kumar and Kumar, 2000 ; Moradi and Azarpour, 2011; Selvaraj and Nagarajan, 2011; Zarei *et al.,* 2012), cob diameter (Kumar and Satyanarayana, 2001; Mohan *et al.,* 2002; Selvaraj and Nagarajan, 2011; Moradi and Azarpour, 2011; Zarei *et al.*, 2012), number of kernels per row (Najeeb *et al.,* 2009; Rafiq *et al.*, 2010; Pavan *et al.*, 2011; Selvaraj and Nagarajan, 2011; Zarei *et al.,* 2012), number of kernel rows per ear (Mahajan *et al.,* 1995; Krishnan and Natarajan, 1995; Mohan *et al.*, 2002; Kabdal *et al.*, 2003; Tang Hua *et al.*, 2004; Moradi and Azarpour,2011)

Days to 50% tasseling had highest significant positive correlation with days to 50% silking. Cob length exhibited highly significant correlation in positive direction with cob diameter, number of kernel rows per cob and number of kernels per row. Plant height had positive and significant correlation with ear height at both phenotypic and genotypic level. Similar observations were reported by Bhole and Patil (1984). Number of kernel rows per cob has significant positive correlation with number of kernels per row. Similar observations were reported by Malik *et al.* (2005), Hemavathy *et al.* (2008) and Raghu *et al.* (2011).

From the present investigation, it is inferred that characters *viz.,* cob length, cob diameter, plant height, ear height, number of kernels per row and number of kernel rows per cob, 100 seed weight are highly correlated with grain yield per plant and need to be considered for selection. The results revealed that there is scope for simultaneous improvement of these traits through selection.

Path coefficient analysis

In the present investigation, direct and positive effect on yield was exhibited by 50% tasseling, number of kernels per row, 100 seed weight, number of kernel rows per cob, cob length, indicating the effectiveness of direct selection, while, direct and negative effects were exhibited by days to 50% silking ,tassel length, plant height and cob diameter indicating the

Table1: List of twenty five genotypes of maize

S. No.	Genotypes
1.	HUZM-185
2.	HUZM-121
3.	HUZM-60
4.	323
5.	HUZM-47
6.	HUZM-97.1.2
7.	HUZM-509
8.	1105
9.	HKI-287
10.	HKI-162
11.	HUZM-478
12.	HUZM-80.1
13.	HKI-164-4.1.3.2
14.	HUZM-88
15.	V-336
16.	V-341
17.	V-25
18.	V-388
19.	V-348
20.	V-351
21.	V-358
22.	CM-141
23.	V-386
24.	V-335
25.	CM-145

Table 2: Phenotypic (p) and genotypic (g) correlation coefficient among yield and yield attributes in twenty five genotypes of maize

Characters		Days to 50% tasseling	Days to 50% silking	Tassel length (cm)	Plant height (cm)	Ear height (cm)	Cob length (cm)	Cob diameter (cm)	Number of kernel rows per cob	Number of kernels per row	100 seed weight (g)	Grain yield per plant (g)
Day to 50% tasseling	p	1	0.858**	-0.192	-0.128	-0.223	-0.114	-0.243	-0.158	0.02	-0.144	-0.103
	g	1	0.862**	-0.169	0.058	-0.173	-0.14	-0.208	-0.206	0.218	-0.094	-0.002
Day to 50% silking	p		1	-0.309	-0.18	-0.26	-0.058	-0.155	-0.013	0.03	-0.29	-0.155
	g		1	-0.26	0.012	-0.202	-0.028	-0.165	0.031	0.145	-0.269	-0.087
Tassel length (cm)	p			1	0.728**	0.615**	0.459*	0.346*	0.401*	0.452*	0.633**	0.699**
	g			1	0.781**	0.708**	0.388*	0.543**	0.329	0.532**	0.709**	0.767**
Plant height (cm)	p				1	0.744**	0.28	0.291	0.307	0.303	0.387*	0.465**
	g				1	0.812**	0.394*	0.338*	0.264	0.476**	0.435*	0.580**
Ear height (cm)	p					1	0.447*	0.319	0.448*	0.389*	0.281	0.495**
	g					1	0.550**	0.298	0.459*	0.559**	0.291	0.575**
Cob length (cm)	p						1	0.462**	0.515**	0.636**	0.189	0.611**
	g						1	0.605**	0.483**	0.756**	0.181	0.587**
Cob diameter (cm)	p							1	0.563**	0.25	0.358*	0.461
	g							1	0.681**	0.450*	0.488**	0.692**
Number of kernel rows per cob	p								1	0.411*	0.179	0.557**
	g								1	0.502**	0.231	0.595**
Number of kernels per row	p									1	0.229	0.829**
	g									1	0.367*	0.778**
100 seed weight (g)	p										1	0.687**
	g										1	0.838**
Grain yield per plant (g)	p											1
	g											1

*Significant at 5 percent level: **Significant at 1 percent level

Table 3 : Phenotypic (p) and genotypic (g) path coefficient analysis indicating direct and indirect effects of component characters on grain yield in 25 genotype of maize

Characters		Day to 50% tasseling	Day to 50% silking	Tassel length (cm)	Plant height (cm)	Ear height (cm)	Cob length (cm)	Cob diameter (cm)	Number of kernel rows per cob	Number of kernels per row	100 seed weight (g)	Correlation coefficient
Day to 50% tasseling	p	0.055	0.047	-0.011	-0.007	-0.012	-0.006	-0.013	-0.009	0.001	-0.008	-0.103
	g	0.207	0.178	-0.035	0.012	-0.036	-0.029	-0.043	-0.043	0.045	-0.019	-0.002
Day to 50% silking	p	-0.063	-0.074	0.023	0.013	0.019	0.004	0.011	0.001	-0.002	0.021	-0.155
	g	-0.102	-0.118	0.031	-0.001	0.024	0.003	0.02	-0.004	-0.017	0.032	-0.087
Tassel length (cm)	p	0.001	0.002	-0.007	-0.005	-0.004	-0.003	-0.002	-0.002	-0.003	-0.004	0.699**
	g	-0.008	-0.012	0.046	0.036	0.033	0.018	0.025	0.015	0.023	0.033	0.767**
Plant height (cm)	p	-0.002	-0.003	0.014	0.019	0.014	0.005	0.006	0.006	0.006	0.007	0.465**
	g	-0.0002	0	-0.002	-0.003	-0.003	-0.001	-0.001	0	-0.001	-0.001	0.580**
Ear height (cm)	p	0.0006	0.0007	-0.001	-0.002	-0.003	-0.001	-0.0009	-0.001	-0.001	-0.0008	0.495**
	g	-0.006	-0.007	0.025	0.028	0.035	0.019	0.01	0.016	0.019	0.01	0.575**
Cob length (cm)	p	-0.002	-0.0009	0.007	0.004	0.007	0.015	0.007	0.008	0.009	0.003	0.611**
	g	-0.025	-0.005	0.069	0.07	0.098	0.178	0.107	0.086	0.134	0.032	0.587**
Cob diameter (cm)	p	-0.001	-0.0009	0.002	0.002	0.002	0.003	0.006	0.003	0.001	0.002	0.461
	g	0.004	0.003	-0.01	-0.006	-0.006	-0.011	-0.019	-0.013	-0.008	-0.009	0.692**
Number of kernel rows per cob	p	-0.033	-0.003	0.084	0.064	0.094	0.108	0.118	0.21	0.086	0.038	0.557**
	g	-0.06	0.009	0.095	0.077	0.133	0.14	0.198	0.29	0.146	0.067	0.595**
Number of kernels per row	p	0.013	0.018	0.28	0.188	0.241	0.394	0.155	0.255	0.62	0.142	0.829**
	g	0.046	0.03	0.111	0.1	0.117	0.158	0.094	0.105	0.209	0.077	0.778**
100 seed weight (g)	p	-0.07	-0.14	0.308	0.188	0.137	0.092	0.174	0.087	0.112	0.487	0.687**
	g	-0.058	-0.166	0.437	0.268	0.18	0.112	0.301	0.143	0.227	0.617	0.838**

Phenotypic Residual effect = 0.1224 ; Genotypic Residual effect = SQRT (1-1.0072) ; Diagonal values indicate direct effects

effectiveness of indirect selection. Similar findings were reported earlier by Devi *et al.* (2001), Viola *et al.* (2003).

Among these, plant height, ear height and cob diameter have recorded negligible direct effects, while cob length showed low positive direct effects. The character number of kernel row per cob exhibited moderate positive direct effect. Number of kernels per row exhibited high positive direct effect. Days to 50% tasseling recorded positive direct effects and days to 50% silking recorded negative direct effects. Similar findings were reported earlier by Saidaiah *et al.* (2008) and Selvaraj and Nagarajan (2011).

Number of kernels per row recorded maximum positive phenotypic direct effect on yield. Similar findings were reported earlier by Kumar and Kumar (2000). Similarly, Devi *et al.* (1998) also mentioned that grain yield of maize was directly influenced by number of kernels per row. The high direct effect of these traits appeared to be the main factor for their strong association with grain yield. Hence, direct selection for these traits would be effective. Swarnalatha Devi (1990) also indicated maximum direct effect of number of kernels per row on grain yield. These findings are in consonance with earlier reports (Mahajan *et al.*, 1995; , 2001; Mohan *et al.*, 2002); Geetha and Jayaraman (2000). Raghu et *al.* (2011) also reported that number of kernels per row had direct affect on grain yield. However, the path coefficient analysis of Devi *et al*. (2001), Viola *et al*. (2003), Saidaiah *et al*. (2008) and Selvaraj and Nagarajan (2011) revealed the positive direct effect of ear height on grain yield. The present findings are in consonance with above reports. The results thus emphasized the need for selection based on plant type with greater number of kernels per row, number of kernel rows per ear, cob diameter, cob length, ear height, and 100 grain weight, since these were important contributors for grain yield.

Maximum positive direct effect was exerted by number of kernels per row, 100 seed weight (g) followed by number of kernel rows per cob. While days to 50% silking, Tassel length and Ear height showed negative direct effect on seed yield per plant (g) and remaining had very low value of direct effects on seed yield per plant. The maximum indirect effect was contributed *via* number of kernels per row, number of kernel row per cob and 100 seed weight on seed yield per plant. Path coefficient analysis showed that number of kernels per row exhibited high direct effect, while days to days to 50% silking recorded low negative direct effects.

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