Madras Agric. J., 98 (1-3): 7-9, March 2011
https://doi.org/10.29321/MAJ.10.100229

Character Association and Path Analysis in Maize (*Zea mays* L.)

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An investigation was carried out on correlation and path analysis for 11 characters of maize on 45 F_1S generated through half diallel fashion, their 10 parents along with two standard checks raised during rabi, 2008-09. Plant height, ear height, ear girth, number of kernel rows per ear, number of kernels per row and 100 grain weight showed positive and significant correlation coefficients with grain yield at genotypic level . While days to 50% tasseling and days to 50% silking recorded negative and significant association with yield. All other possible correlations were positive and significant. Path analysis revealed that ear girth exerted maximum positive direct effect followed by 100 grain weight, number of kernels per row, plant height and number of kernel rows per ear on grain yield. Ear girth registered positive indirect effect on yield via ear girth, number of kernel rows per ear, number of kernels per row, 100 grain weight and plant height. Different yield related traits influenced the yield not only through their direct effects but also through indirect contributions.

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

Maize (*Zea mays* L.) is one of the three most important cereal crops in the world together with wheat and rice. Global production of maize reached 622 million metric tons in 2003-2004. It is estimated that about 68% of the global maize area is in the developing world, but the developing world accounts for only 46% of the world's maize production. Grain yield is the end product of interaction among yield contributing components. Selection based on this trait is usually not very useful but the one based on its component characters could be more effective. Knowledge of interrelationship serves many purposes from breeders point of view. Most importantly, these are highly useful in selection for characters which are not easily observed or genotypic values of which are modified by environmental effects. Significant phenotypic correlations without significant genotypic associations are of no value.

There is simple evidence to show that selection directly for grain yield or which make a significant contribution to yielding ability would be useful in improvement of yield. Partitioning the genotypic correlation coefficient of yield components with grain yield into direct and indirect effects will help to estimate the actual contribution of an attribute and its influence through other characters. Keeping this in view, the present investigation was undertaken to have knowledge on yield contributing characters which can be kept as the selection criteria.

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Materials and Methods

Forty five crosses generated by crossing 10 elite inbred lines in diallel excluding reciprocals during kharif, 2008 at Maize Research Centre, Rajendranagar along with 10 parents and two checks (BH 1576 and BH 40625) were grown in randomized black design replicated thrice with a spacing of 75 x 20 cm in plot size of 900m^2. Length of each row was 4 meters containing 20 plants in each row. The experiment was conducted at Research Farm, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad, Andhra Pradesh during rabi, 2008-09. Five plants were selected at random and biometrical observations like days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, plant height, ear height, ear girth, number of kernel rows per ear, number of kernels per row, 100 grain weight and grain yield per plant were recorded. Correlation coefficient and path analysis were calculated following methods of Dewey and Lu (1959).

Results and Discussion

The data (Table 1) revealed that genotypic correlations were slightly higher in magnitude than phenotypic ones. This indicated that though there was a strong inherent association between characters studied and its expression was lessened due to the influence of environment. But, there was a general agreement in both sign and magnitude

Table 1. Phenotypic (P) and Genotypic (G) correlation coefficient analysis of yield and yield contributing characters in maize.

Characters		Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No of kernel rows/ ear	No of kernels/ row	100 grain weight (g)	Grain yield/ plant(g)
Days to 50% tasseling	P	1.0000	0.8026 **	0.5076 **	-0.0635	0.1325	-0.0728	-0.1333	-0.0904	-0.2445 **	-0.1163	-0.2426 **
	G	1.0000	0.9374 **	0.5749 **	-0.0348	0.1864*	-0.1168	-0.2260 **	-0.1264	-0.3219 **	-0.1226	-0.2909 **
Days to 50% silking	P		1.0000	0.3997 **	0.0018	0.1898*	-0.0351	-0.0866	-0.0608	-0.2313 **	-0.0335	-0.1867 *
	G		1.0000	0.4748 **	0.0319	0.2536**	-0.0616	-0.1703	-0.0642	-0.2369 **	0.0024	-0.214 **
Days to maturity	P			1.0000	0.0813	0.1265	0.0778	-0.0437	-0.0681	-0.0844	-0.0133	-0.1209
	G			1.0000	0.0850	0.1353	0.0721	-0.0391	-0.0237	-0.1042	-0.0349	-0.1234
Plant height (cm)	P				1.0000	0.8729**	0.6700 **	0.6588 **	0.2703 **	0.5435 **	0.4776 **	0.6528 **
	G				1.0000	0.9077**	0.8114**	0.8316 **	0.3733 **	0.6676 **	0.5806 **	0.7139 **
Ear height (cm)	P					1.0000	0.5866 **	0.6224 **	0.2948 **	0.4699 **	0.4833 **	0.5936 *
	G					1.0000	0.7342 **	0.8042 **	0.4427 **	0.6035 **	0.5843 **	0.6523 **
Cob length (cm)	P						1.0000	0.7231 **	0.3561 **	0.7100 **	0.4278 **	0.6432 **
	G						1.0000	0.7550 **	0.4418 **	0.8048 **	0.5483 **	0.7342 **
Cob girth (cm)	P							1.0000	0.4533 **	0.5700 **	0.4458 **	0.7215 **
	G							1.0000	0.5110**	0.6967 **	0.5446 **	0.8594 **
No of kernel rows/ear	P								1.0000	0.3768 **	0.0328	0.3714 **
	G								1.0000	0.4687 **	0.0468	0.4294 **
No of kernels/ row	P									1.0000	0.2842 **	0.6376 **
	G									1.0000	0.4118**	0.7600 **
100 grain weight (g)	P										1.0000	0.5680 **
	G										1.0000	0.6640 **
Grain yield / plant (g)	P											1.0000
	G											1.0000

*Significant at 5 per cent level; ** Significant at 1 per cent level.
P represents Phenotypic correlation coefficient **G** represents Genotypic correlation coefficient

between the estimates of genotypic and phenotypic correlations. This type of magnitudinal difference occurred due to conduction of experiment in one location/ season only, where genotype x environment (GxE) component was not included.

Grain yield per plant had significant and positive relationship with plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row and 100 grain weight. Similar results were earlier reported by Krishnan and Natarajan (1995) and Kumar (1997). Strong positive correlation of yield with plant height by Malik *et al.,* 2005 and Sadek *et al.,* 2006; and with ear length, 100 grain weight and ear height by Kumar and Satyanarayana, 2001.

Ear girth exhibited highest positive correlation with grain yield per plant followed by plant height, ear length, number of kernels per row, ear height and 100 grain weight. All possible correlations among the characters were significant and positive except days to 50 per cent tasseling and days to 50 per cent silking. Ear girth exhibited significant positive correlation with plant height, ear length, number of kernels per row, ear height and 100 grain weight.

Path coefficient analysis allows separating direct effect and their indirect effects through other attributes by partitioning correlation (Wright, 1921). Path coefficient analysis (Table 2) revealed that the characters ear girth, 100 grain weight, number of kernels per row, plant height and number of kernel rows per ear had high positive direct effects towards grain yield. Direct negative effects on grain yield were attributed by days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, ear length and ear height which indicates that selection for longer interval of anthesis and silking result in less grain yield. This was in concurrence with the earlier reports of Mohan *et al.* (2002), Singh *et al.*(2003) and Sofi and Rather (2007).

Ear girth had exhibited the largest direct effect on grain yield followed by 100 grain weight and number of kernels per row. These findings were similar to Sharma and Kumar (1987), who reported that 100 grain weight had direct effect on grain yield. In general, characters exhibiting high direct effects for grain yield also exhibited high degree of positive correlation with grain yield. Ear girth had high positive indirect effect on grain yield through number of kernels per row, number of kernel rows per ear, 100 grain weight, plant height, days to 50 per cent silking and days to maturity. Hundred grain weight had indirect contribution on yield through plant height and ear girth. Number of kernels per row had indirect effect through days to 50 per cent silking, plant

Table 2. Phenotypic (P) and Genotypic (G) path coefficient analysis of yield and yield contributing characters in maize.

Characters		Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No of kernel rows/ ear	No of kernels/ row	100 grain weight (g)	Correlated grain yield/ plant(g)
Days to 50% tasseling	P	**-0.0279**	-0.0224	-0.0142	0.0018	-0.0037	0.0020	0.0037	0.0025	0.0068	0.0032	-0.2426**
	G	**0.4926**	0.4618	0.2832	-0.0171	0.0918	-0.0576	-0.1114	-0.0623	-0.1586	-0.0604	-0.2909**
Days to 50% silking	P	-0.0385	**-0.0480**	-0.0192	-0.0001	-0.0091	0.0017	0.0042	0.0029	0.0111	0.0016	-0.1867*
	G	-0.1935	**-0.2064**	-0.0980	-0.0066	-0.0523	0.0127	0.0352	0.0132	0.0489	-0.0005	-0.2140**
Days to maturity	P	-0.0297	-0.0234	**-0.0586**	-0.0048	-0.0074	-0.0046	0.0026	0.0040	0.0049	0.0008	-0.1209
	G	-0.0732	-0.0605	**-0.1274**	-0.0108	-0.0172	-0.0092	0.0050	0.0030	0.0133	0.0045	-0.1234
Plant height (cm)	P	-0.0102	0.0003	0.0131	**0.1612**	0.1407	0.1080	0.1062	0.0436	0.0876	0.0770	0.6528**
	G	-0.0097	0.0088	0.0236	**0.2776**	0.2520	0.2252	0.2308	0.1036	0.1853	0.1612	0.7139**
Ear height (cm)	P	0.0029	0.0042	0.0028	0.0192	**0.0220**	0.0129	0.0137	0.0065	0.0104	0.0107	0.5936*
	G	-0.1347	-0.1833	-0.0978	-0.6562	**-0.7229**	-0.5307	-0.5814	-0.3200	-0.4362	-0.4224	0.6523**
Ear length (cm)	P	0.0015	0.0007	-0.0016	-0.0136	-0.0119	**-0.0203**	-0.0147	-0.0072	-0.0144	-0.0087	0.6432**
	G	0.0184	0.0097	-0.0114	-0.1281	-0.1159	**-0.1579**	-0.1192	-0.0697	-0.1271	-0.0866	0.7342**
Ear girth (cm)	P	-0.0409	-0.0266	-0.0134	0.2021	0.1909	0.2218	**0.3068**	0.1391	0.1749	0.1368	0.7215**
	G	-0.1741	-0.1312	-0.0301	0.6406	0.6195	0.5816	**0.7703**	0.3941	0.5367	0.4195	0.8594**
No of kernel rows/ ear	P	-0.0070	-0.0047	-0.0052	0.0208	0.0227	0.0274	0.0349	**0.0770**	0.0290	0.0025	0.3714**
	G	-0.0174	-0.0088	-0.0033	0.0515	0.0610	0.0609	0.0705	**0.1379**	0.0646	0.0065	0.4294**
No of kernels/ row	P	-0.0610	0.0577	-0.0211	0.1357	0.1173	0.1772	0.1423	0.0941	**0.2496**	0.0709	0.6376**
	G	-0.1429	-0.1052	-0.0463	0.2963	0.2679	0.3573	0.3093	0.2081	**0.4439**	0.1828	0.7600**
100 grain weight (g)	P	-0.0318	-0.0092	-0.0036	0.1304	0.1320	0.1168	0.1218	0.0090	0.0776	**0.2731**	0.5680**
	G	-0.0563	0.0011	-0.0161	0.2667	0.2684	0.2519	0.2502	0.0215	0.1892	**0.4594**	0.6640**

Phenotypic residual effect=0.5547 Genotypic residual effect=0.3302
P represents Phenotypic correlationcoefficient **G** represents Genotypic correlation coefficient
Bold values are direct effects

height, ear girth, number of kernels per row and 100 grain weight on grain yield per plant.

Phenotypic and genotypic residual effects were 0.5547 and 0.3302 respectively indicating that some characters which had due weightage in selection for yield improvement are to be included.

To conclude, the investigation clearly indicated that direct selection for ear girth, 100 grain weight, number of kernels per row and indirect selection of plant height, ear girth, number of kernel rows per ear through other characters are highly rewarding. In the view of negative correlation observed between grain yield and days to 50% tasseling, days to 50% silking and days to maturity, these characters should be considered for reliable results for getting higher yield in maize in addition to yield contributing traits.

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Received: April 5, 2010; Accepted: January 23, 2011