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Research Article

GENETIC VARIABILITY AND ASSOCIATION PATH ANALYSIS IN MAIZE (*Zea mays* L.) GENOTYPES

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ABSTRACT

The present investigation was conducted with one ninty six maize (Zea mays L.) genotypes to evaluate their performance for genetic variability and association analysis. All the quantitative characters viz. days to 50% tasseling, days to 50% silking, days to 80% maturity, final plant stand, plant height, ear height, ear length, ear girth, number of cobs per plot, number of kernel rows per cob, number of kernels per row, test weight, shelling percentage and grain yield showed wide variation among the genotypes studied. High heritability coupled with high genetic advance as percentage of mean was recorded for grain yield, test weight, ear height, number of cobs per plot, number of kernels per row, number of kernel rows per cob, ear length, ear girth and plant height. Significant positive genotypic correlation with grain yield for traits days to 80% maturity, final plant stand, plant height, ear height, ear length, ear girth, number of cobs, number of kernels per row, test weight and shelling percentage. Maximum genotypic correlation coefficient with grain yield was recorded by number of cobs followed by final plant stand, test weight, ear girth, plant height, number of kernels per row, ear height, days to 80% maturity, ear length and shelling percentage. The genotypic path coefficient analysis of different yield contributing and associated traits on grain yield revealed that traits viz., number of cobs, recorded highest estimate of positive direct effect, while days to 50% tasseling recorded moderate positive direct effect, while ear girth recorded low value of positive direct effect on grain yield, while shelling percentage and plant height recorded negligible estimate of positive direct effect on grain yield.

INTRODUCTION

Maize (*Zea Mays* L.) belongs to family graminae (2n=2x=20) and is an important staple food of many countries, particularly in the tropics and subtropics. This cereal is referred as Miracle crop and Queen of the Cereals due to its high productivity potential compared to other poaceae family members. It is a cereal with a remarkable potential for production, it is the third most important grain crop after wheat and rice. It is a cereal with a remarkable potential for production, it is the third most important grain crop after wheat and rice. Maize (*Zea mays* L.) is an exciting and leading crop contributing significantly to world agriculture and more importantly to world's food basket of roughly 2000 million metric tons (Vasal, S.K., 2014). It contributes maximum among the food cereal crops i.e. 38% annually in the global food production as compared to 30% for wheat and 20% for rice. In India, presently it occupies about 8.69 million hectares area with the mean yield of 2.53 tons/hectare (ICAR-IIMR, 2016). The availability of genetic variability is the basic pre-requisite for genetic improvement through systematic breeding programme. Evaluation and cataloguing of this variability is of paramount importance of its efficient utilization. Also the knowledge about relationship between yield and its contributing characters is important for an efficient selection criterion. Correlation studies help to understand the relationship of yield with other traits. Yield being a complex quantitative trait is governed by a large number of genes and is greatly influenced by climatologically factors. Hence, direct selection for this character may often be misleading. Thus, simultaneous selection for the component traits combining superiority for each one of them becomes essential. Therefore, the knowledge of the selection criterion between the components and the yield is important to identify the component traits on which the selection pressure could most profitably be exercised in order to obtain an increase in yielding ability (Grafius, 1956). Path coefficients are standardized partial regression coefficients. It partition the observed correlation between dependable variable and independent variable in direct and indirect effects in such a manner that observed correlation between dependent trait and independent trait is equal to the sum of direct and all

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Table 1 Analysis of Variance for grain yield and its component in maize.

SN	Characters	Mean sum of squares			Standard Error of mean (SEm ±)	Coefficient of variation (%)
		Replication	Genotype	Error		
		1	195	195		
1.	Days to 50% tasseling	3.31	34.28**	0.57	0.75	1.46
2.	Days to 50% silking	2.87	32.36**	0.90	0.95	1.71
3.	Days to 80% maturity	1.00	63.00**	0.79	0.89	0.95
4.	Final plant stand	3.37	26.67**	1.21	1.10	7.42
5.	Plant height (cm)	63.00	1438.00**	99.78	9.98	6.05
6.	Ear height (cm)	1.56	408.70**	26.55	5.15	10.17
7.	Ear length (cm)	0.72	12.74**	1.47	1.21	10.71
8.	Ear girth (cm)	1.54	4.59**	0.54	0.74	6.45
9.	No. of Cobs per plot	3.24	27.35**	1.10	1.05	7.40
10.	No. of kernel rows per cob	0.01	4.25*	0.75	0.86	7.55
11.	No. of kernels per row	11.87	71.18**	8.83	2.97	13.44
12.	Test weight (100gm)	0.65	90.18**	2.04	1.43	5.90
13.	Shelling percentage (%)	0.12	70.80*	11.24	3.35	4.62
14.	Grain yield (kg per plot)	0.004	0.08**	0.002	0.05	11.01

*= significant of p= 0.05 level, **= significant of p= 0.01 level

Table 2 Parameters of Genetic variability for different characters of maize genotypes

Character	Mean	Range		PCV %	GCV %	h^2	GA	GA as % of mean
		Minimum	Maximum					
Days to tasseling	51.48	41.50	64.50	8.11	7.97	96.70	8.32	16.16
Days to silking	55.74	47.00	66.50	7.32	7.11	94.50	7.94	14.25
Days to maturity	93.50	83.00	107.00	6.04	5.96	97.50	11.34	12.09
Final plant stand	14.82	10.00	21.50	25.19	24.07	91.30	7.02	46.98
Plant height	165.09	99.30	262.10	16.80	15.67	87.00	49.71	29.83
Ear height	50.66	19.20	94.80	29.12	27.29	87.80	26.68	51.93
Ear length	11.32	5.20	19.90	23.55	20.97	79.30	4.36	38.17
Ear girth	11.49	5.85	16.20	13.96	12.38	78.60	2.60	22.45
No. of cobs/plot	14.22	8.50	21.50	26.52	25.47	92.20	7.17	49.96
No .of kernel rows/cob	11.50	6.20	15.40	13.7	11.49	69.80	2.28	19.77
No. of kernels/row	22.10	9.70	43.40	28.61	25.26	77.90	10.15	45.19
Test weight	24.23	12.00	48.00	28.02	27.39	95.60	13.37	54.52
Shelling percentage	72.48	48.00	83.65	8.84	7.53	72.60	9.58	13.19
Grain yield (kg/plot)	0.45	0.16	2.44	46.44	32.55	70.09	0.40	81.63

Table 3 Genotypic correlation between yield and other characters

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1.0000	0.9629**	0.4759**	0.0521	-0.1449*	-0.1068	0.1001	0.0871	0.0698	0.0028	-0.2439**	0.1738**	-0.2769**	-0.0172
X2		1.0000	0.4660**	0.0161	-0.1660**	-0.1271*	0.0675	0.0496	0.0369	-0.0228	-0.2870**	0.1398*	-0.3029**	-0.0798
X3			1.0000	0.1784**	0.2607**	0.2572**	0.3841**	0.4053**	0.1920**	0.1302*	0.1902**	0.4568**	-0.0688	0.1943**
X4				1.0000	0.1523*	0.0964	0.0537	0.1912*	0.9884**	0.0530	0.1120	0.2182**	0.0662	0.7559**
X5					1.0000	0.7942**	0.5562**	0.4776**	0.1588*	0.2215**	0.5566**	0.3595**	0.1700**	0.3016**
X6						1.0000	0.5779**	0.5124**	0.1136	0.3253**	0.6058**	0.3650**	0.2204**	0.2280**
X7							1.0000	0.6670**	0.0819	0.2578**	0.7162**	0.4993**	0.2353**	0.1888**
X8								1.0000	0.2074**	0.5025**	0.6395**	0.6553**	0.2943**	0.3091**
X9									1.0000	0.0545	0.1218*	0.2402**	0.0847**	0.7632**
X10										1.0000	0.3040**	0.0874	0.1948**	0.0218
X11											1.0000	0.3579**	0.5089**	0.2796**
X12												1.0000	0.1746**	0.3141**
X13													1.0000	0.1705**
X14														1.0000

*= significant of p= 0.05 level, **= significant of p= 0.01 level

X1- Days to 50% tasseling, X2- Days to 50% silking, X3- Days to 80% maturity, X4- Final plant stand, X5- Plant height (cm), X6- Ear height (cm), X7- Ear length (cm), X8- Ear girth (cm), X9- Number of cobs per plot, X10- Number of kernel rows per cob, X11- Number of kernels per row, X12- Test weight (100gm), X13- Shelling

Table 4 Path coefficient based on genotypic correlation coefficient

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	0.286	-0.312	-0.023	-0.012	-0.004	0.003	-0.001	0.023	0.092	0.000	0.023	-0.023	-0.012	-0.0172
X2	0.278	-0.321	-0.023	-0.008	-0.004	0.003	-0.001	0.018	0.071	0.003	0.025	-0.022	-0.012	-0.0798
X3	0.145	-0.165	-0.045	-0.028	0.007	-0.008	-0.002	0.066	0.174	-0.014	-0.013	-0.043	-0.005	0.1943**
X4	0.018	-0.013	-0.007	-0.193	0.002	-0.001	0.000	0.023	1.104	-0.004	-0.004	-0.015	0.001	0.7559**
X5	-0.033	0.038	-0.010	-0.011	0.032	-0.030	-0.003	0.072	0.609	-0.022	-0.045	-0.028	0.004	0.3016**
X6	-0.023	0.028	-0.010	-0.003	0.025	-0.038	-0.003	0.083	0.035	-0.033	-0.053	-0.031	0.007	0.2280**
X7	0.039	-0.038	-0.017	0.001	0.017	-0.022	-0.005	0.116	0.023	-0.027	-0.063	-0.048	0.008	0.1888**
X8	0.038	-0.034	-0.018	-0.026	0.013	-0.018	-0.003	0.171	0.163	-0.053	-0.058	-0.067	0.010	0.3091**
X9	0.024	-0.020	-0.007	-0.192	0.002	-0.001	0.000	0.025	1.110	-0.005	-0.005	-0.017	0.002	0.7632**
X10	0.000	0.009	-0.007	-0.009	0.008	-0.013	-0.002	0.099	0.056	-0.092	-0.034	-0.011	0.009	0.0218
X11	-0.071	0.089	-0.006	-0.009	0.016	-0.022	-0.004	0.108	0.056	-0.035	-0.091	-0.028	0.021	0.2796**
X12	0.064	-0.068	-0.109	-0.029	0.009	-0.011	-0.002	0.112	0.188	-0.010	-0.025	-0.102	0.005	0.3141**
X13	-0.084	0.099	0.005	-0.006	0.003	-0.007	-0.001	0.044	0.062	-0.020	-0.048	-0.013	0.039	0.1705**

Residual = 0.1447

X1- Days to 50% tasseling, X2- Days to 50% silking, X3- Days to 80% maturity, X4- Final plant stand, X5- Plant height (cm), X6- Ear height (cm), X7- Ear length (cm), X8- Ear girth (cm), X9- Number of cobs per plot, X10- Number of kernel rows per cob, X11- Number of kernels per row, X12- Test weight (100gm), X13- Shelling percentage (%), X14- Grain yield (kg/plot).

possible indirect effects. Path coefficient analysis, which measures the direct and indirect effect of one variable through another on the end product, was carried out using genotypic as well as phenotypic correlation considering grain yield per plant as a dependable variable.

MATERIAL AND METHODS

A field experiment was conducted with standard agronomical package of practices at IGKV, RMD CARS, Research and Instructional Farm, Ajirma, Ambikapur (C.G.) during Kharif 2016 which is located at a latitude of $20^0$8'N, longitude of $83^0$15'E and altitude of 592.62 m MSL (mean sea level). A field trial was conducted using 191 germplasms (95 inbreds & population received from WNC, Hyderabad; 82 inbred lines developed at RMD CARS Ambikapur and 14 local germplasm) and five checks. These varieties were sown during *Kharif*, 2016 in a Randomized Block Design replicated twice. Each variety was sown in double rows of 4 m row length adopting a spacing of 75 cm between rows and 20 cm between the plants. All the recommended agronomic package of practices was adopted during the entire crop growth period. In each replication, five plants were taken at random and the following 14 biometrical observations *viz*., days to 50 % tasselling, days to 50 % silking, days to 80 % brown husk maturity, plant height (cm), plant population per plot, ear height (cm), ear length (cm), ear girth (cm), no. of kernel rows per cob, no. of kernels per row, no. of cobs per plot, test weight (gm), shelling percentage, grain yield were recorded.

RESULTS AND DISCUSSION

Genetic Variability

The analysis of variance for 14 characters viz., days to 50% tasseling, days to 50% silking, days to 80% maturity, final plant stand, plant height, ear height, ear length, ear girth, number of cobs per plot, number of kernel rows per cob, number of kernels per row, test weight, shelling percentage and grain yield per plot was carried out to partition the total variance due to genotypes and other sources. Analysis of variance revealed highly significant differences among genotypes in respect of almost all the characters under studied at 1% and 5% level. Similar result was also reported by Bhusal *et al.,* (2016). This indicated presence of substantial amount of genetic variability among the genotypes under study. The mean sum of squares of the genotypes for 14 characters is presented in table-1. The character wise variability i.e., estimates of coefficient of variation, range, mean, phenotypic and genotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as percent of mean for all 14 characters studied are summarized in table-2.

In general the values of phenotypic coefficient of variation were higher than that of genotypic coefficient of variation for all characters. The phenotypic coefficient of variation was estimated to be high for grain yield (46.44%), ear height (29.12%), number of kernels per row (28.61%) , test weight (28.02%), number of cobs per plot (26.52%), final plant stand (25.19%) and ear length (23.55%), while, it was moderate for plant height (16.80%), ear girth (13.96%) , number of kernel rows per cob (13.7%), and low for shelling percentage (8.84%) , days to 50% tasseling (8.11%) , days to 50% silking (7.32%) and days to 80% maturity (6.04%). This was confirmed by earlier reports of Pradeep and Satyanarayana (2001) and Akbar *et al.,* (2008). These characters with low magnitude of genetic variability may have limited utility in a programme of selection for their improvement. Genotypic coefficient of variation observed higher for grain yield (32.55%), test weight (27.39%), ear height (27.29%), number of cobs per plot (25.47%), number of kernels per row (25.26%), final plant stand (24.07%) and ear length (20.97%), while it was moderate for plant height (15.67%), ear girth (12.38%) and number of kernels rows per cob (11.49%), and low for days to 50% tasseling (7.97%), shelling percentage (7.53%), days to 50% silking (7.11%) and days to 80% maturity (5.96%). Higher PCV and GCV were reported previously for grain yield per plant by Yusuf (2010) and Sumathi *et al.,* (2005) and by Shakoor *et al.,* (2007) for 100 grain weight.

The heritability estimates are high for all the traits *viz.,* days to 80% maturity (97.50%), days to 50% tasseling (96.70%), test weight (95.60%), days to 50% silking (94.50%), number of cobs per plot (92.20%), final plant stand (91.30%), ear height (87.80%), plant height (87.00%), ear length (79.30%), ear girth (78.60%), number of kernels per row (77.90%), shelling percentage (72.60%), grain yield (70.09%), and number of kernel rows per cob (69.80%). High heritability estimate was also reported by Sumathi *et al.,* (2005) for days to 50 percent tasseling, days to 50 percent silking, and grain yield per plant, Akbar *et al.,* (2008) for days to 50 percent tasseling, days to 50 per cent silking, and plant height and by Pradeep and Satyanarayana, (2001) for plant height, ear length, ear girth, and 100-grain weight.

The higher estimate of genetic advance as percent of mean was exhibited by grain yield (81.63%), test weight (54.52%), ear height (51.93%), number of cobs per plot (49.96%), number of kernels per row (45.19%), ear length (38.17%), plant height (29.83%), ear girth (22.45%) and number of kernel rows per cob (19.77%). However medium estimate of genetic advance as per cent of mean was exhibited by days to 50% tasseling (16.16%), days to 50% silking (14.25%), shelling percentage (13.19%) and days to 80% maturity (12.09%). These results were in consonance with the findings of Alvi *et al.,*(2003) and Shakoor *et al.,* (2007) for 100-grain weight, grain yield per plant and cob diameter, Prakash *et al.,* (2006) for plant height and ear length and by Hefny (2011) for ear weight.

Association Analysis

Among the 14 characters studied under this category, ten characters *viz*., days to 80% maturity, final plant stand, plant height, ear height, ear length, ear girth, number of cobs per plot, number of kernels per row, test weight and shelling percentage recorded significant positive genotypic correlation with grain yield. Maximum genotypic correlation coefficient with grain yield was recorded by number of cobs per plot (0.7632) followed by final plant stand (0.7559), test weight (0.3141), ear girth (0.3091), plant height (0.3016), number of kernels per row (0.2796), ear height (0.2280), days to 80% maturity (0.1943), ear length (0.1888) and shelling percentage (0.1705). Rest traits recorded non significant correlation with grain yield per plot. Similar results were reported earlier in maize by several workers on different characters *viz*., Sharma and Kumar, (1987), Tyagi *et al.,* (1988), Kumar and Kumar, (1997), Umakanth and Sunil, (2000), Jha and Ghosh, (2001), Mohan *et al.,* (2002), Malik *et al.* (2005) and Sadek *et al.,* (2006) for the association of grain yield with plant height.

The genotypic path coefficient analysis of different yield contributing and associated traits on grain yield revealed that traits *viz.,* number of cobs per plot (1.110), recorded highest estimate of positive direct effect, while days to 50% tasseling (0.286) recorded moderate positive direct effect, while ear girth (0.171) recorded low value of positive direct effect on grain yield and shelling percentage (0.039) & plant height (0.032) recorded negligible estimate of positive direct effect on grain yield. These results were in consonance with the findings of Rupak *et al.,* (1979) for plant height, ear girth, ear length and 100 grain weight, Sharma and Kumar (1987) for number of grains per row, plant height, ear girth and 100 grain weight, Chandramohan (1999) for number of kernels per row, 100 grain weight and ear girth and by Brar *et al.,* (2008) for number of ears per plot, ear height, ear girth, ear length and plant height. The high negative direct effect on grain yield due to days to 50% silking (-0.321) was recorded, while final plant stand (-0.193) and test weight (-0.102) recorded moderate and low values respectively. While other negative direct effect such as number of kernel rows per cob (-0.092), number of kernels per row (-0.091), days to 80% maturity (-0.045), ear height (-0.038) and ear length (-0.005) on grain yield per plot were found to be of negligible magnitude.

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