

Genetic Variability and Divergence Studies in Maize (*Zea mays* L.)

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Abstract

An experiment was conducted to estimate the genetic variability and diversity for yield and yield related traits among the selected hundred maize germplasm lines along with four checks at ARS Arabhavi, during Rabi 2014-15 using RCBD design with two replications. The analysis of variance revealed existence of significant differences among the genotypes for the characters studied. Among the genetic parameters PCV was higher than GCV for all the traits indicates the role of environment in expression of the character. High heritability accompanied with high genetic advance was observed for grain yield per hectare and shelling percentage which indicate that these characters are under the control of additive gene effects and selection for these characters will be effective. Based on genetic diversity analysis all the germplasm were grouped into twelve clusters and genotypes with higher test weight was recorded in I, IV, VI and XI and cob length and cob girth in VIII and V respectively. Among the twelve quantitative characters studied, the most important character contributing to the divergence was days to maturity which is mainly responsible for increasing grain yield. The above results indicated the existence of sufficient genetic variability and diversity among the germplasm lines thus, these lines can be useful in crop improvement programme in terms of yield.

Keywords: Diversity; Genetic Advance Mean; Genotypic Correlation of Variation; Germplasm; Heritability; Phenotypic Correlation Variation and Grain Yield

Introduction

Maize (*Zea mays* L.) Maize is an important cereal crop after wheat and rice in the world and also in India. Maize is the only crop which meet the food, feed and fodder requirement having industrial application. The consumption of maize is increasing year after year in the world and hence, the demand for grain maize is also increasing. To meet this growing demand productivity of maize, yield has to increase for which efficient breeding programme have to be planned for which germplasm are the major source. Collection of germplasm, screening and assessing genetic variability, diversity is a continuous process in order to exploit maximum heterosis in the hybrid breeding programme. Grafius [1] suggested that selection based on component characters is more effective than on yield *per se*. The appropriate knowledge of interrelationships between grain yield and its contributing components can significantly improve the efficiency of breeding programmes through the use of appropriate selection indices as indicated by Mohammadia., *et al* [2]. Genetic divergence is an efficient tool for an effective choice of parents for hybridization programme. Such study also selects the genetically divergent parents to obtain desirable combinations in the segregating generations. Information on nature and degree of genetic divergence would help the plant breeder in choosing the right parents for the breeding programme. With this background the present study was undertaken with the objective of evaluation of the germplasm lines with respect to *per se*, variability and genetic diversity in terms of yield and its related traits.

Materials and Methods

The experimental material consisted of one hundred elite maize germplasm lines collected from Maize Winter Nursery at Indian Institute of Maize Research, Hyderabad and CIMMYT- India, Patancheru, Hyderabad which included advanced generation lines, CML lines, and exotic lines. The hundred germplasm lines along with four checks *viz.*, CM-111 (Flint), CM-202 (Dent), CI-4, and GH-0727 (hybrid check) were evaluated in randomized block design (RBD) with two replications at All India Co-ordinated Maize Improvement Project (AICMIP), Agricultural Research station (ARS), Arabhavi during *rabi*, 2014-15. Each entry was raised in two rows of 4 meter length following a spacing of 60 cm X 40 cm. The recommended package of practices was followed to raise the healthy crop that was compile from ten randomly selected plants. Observations were recorded on quantitative characters *viz.*, days to 50 per cent tasselling, days to 50 per cent silking, plant height (cm), ear height (cm), cob length (cm), cob girth (cm), number of kernel rows per ear, number of kernels per ear row, test weight (g), days to maturity, shelling percentage (%) and grain yield (q/ha). Data was compiled and analyzed using software for analyzing the variance component and estimating the genetic parameters. For estimating the genetic diversity the concept of Mahalanobi's generalized distance (D^2) statistics were used.

Results and Discussion

The Analysis of variance (ANOVA) revealed highly significant differences among the genotypes for all the characters studied (Table 1). Which indicated that the selected germplasm lines differed significantly and showed variation for different growth and yield related traits. Sufficient genetic variability existing among the experimental materials is a prerequisite of hybrid breeding programme. Genetic parameter *i.e.* GCV, PCV, h^2 and GAM were estimated for the twelve quantitative traits (Table 2), for most of the traits PCV was higher than GCV which may be due to higher degree of interaction of genotypes with environment.

Source of variation	Degrees of freedom	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Ear height (cm)	Cob length (cm)	Cob girth (cm)	No. of Rows kernel rows per	No. of Kernels per ear row
Replication	1	0.30	4.04	773.85	2.79	1.09	0.16	0.09	5.46
Treatments	103	46.29**	38.10**	973.16**	341.77**	7.70**	0.46*	4.49*	35.03**
Error	103	9.19	8.89	416.42	30.82	3.07	0.21	1.92	9.46
CD @ 5%		9.19	5.91	40.47	11.01	3.47	0.90	2.75	6.10
SEm		3.26	2.10	14.36	3.91	1.23	0.32	0.97	2.16
CV (%)		12.50	8.65	9.34	20.29	1.40	15.80	10.38	9.66

Source of variation	Degrees of freedom	Test weight (g)	Days to maturity	Shelling percentage	Grain yield (q/ha)
Replication	1	4.50	5.24	25.90	145.44
Treatments	103	26.40**	7.40**	114.91**	93.19**
Error	103	21.65	0.70	15.24	26.99
CD @ 5%		9.23	1.66	7.74	10.29
SEm		3.30	0.59	2.74	3.66
CV (%)		18.91	13.49	10.30	9.00

Table 1: ANOVA for yield and yield contributing traits in maize germplasm lines.

The magnitude of PCV for days to maturity and days to silking were relatively close to the corresponding magnitudes of GCV which suggest that environment components had relatively less influence on these characters as presented in table 2 and figure 1. Similar result to the present were coined by Gyanendra (1995), Mani, *et al.* [3], Pradeepkumar and Satyanarayana [4], Sumati, *et al.* [5] and Omprakash, *et al.* [6].

Character	Genetic Parameters						
	GV	GCV	PV	PCV	h ² (%)	GA	GAM
Days to 50% tasselling	12.40	4.39	33.88	7.26	36.6	4.39	5.47
Days to 50% silking	14.61	4.64	23.49	5.89	62.00	6.21	7.54
Plant height (cm)	278.37	12.02	694.79	18.99	40.00	21.76	15.68
Ear height (cm)	155.47	17.83	186.29	19.52	84.00	23.47	33.55
Cob length (cm)	2.31	11.72	5.38	17.87	43.00	2.06	15.83
Cob girth (cm)	0.13	9.61	0.33	15.57	38.00	0.45	12.21
N0. of kernel rows per ear	1.29	8.68	3.20	13.71	40.00	1.48	11.33
N0. of kernels per ear row	12.79	13.01	22.24	17.16	57.00	5.58	20.33
Days to maturity	3.35	3.10	4.10	3.41	83.00	0.99	5.73
Test weight (g)	2.40	6.24	24.02	19.91	30.00	3.43	4.04
Shelling percentage	44.36	17.73	59.55	20.54	74.50	11.84	31.52
Grain yield (q/ha)	33.13	9.98	60.06	13.44	55.17	11.28	19.57

Table 2: Estimation of genetic parameters in maize germplasm lines.

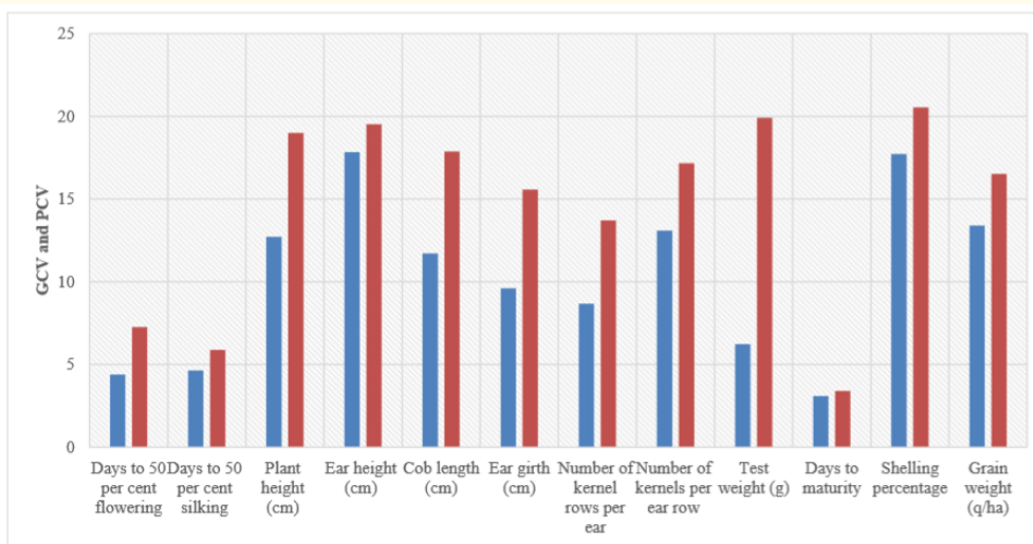


Figure 1: Genotypic and phenotypic coefficient of variation (GCV and PCV) in maize germplasm lines.

High heritability (h^2) with high genetic advance indicates the predominance of additive gene action and greater response to phenotypic selection and improvements of such traits could be anticipated. Accordingly, in the present study high h^2 and high GAM was observed by ear height followed by shelling (%), number of kernels per ear row and grain yield (q/ha) as shown in table 2 and figure 2.

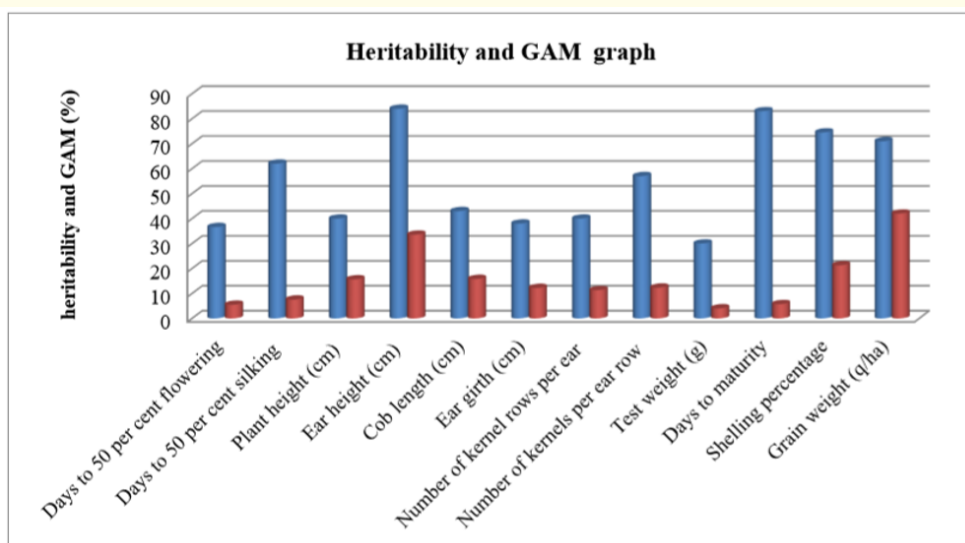


Figure 2: Heritability in broad sense and genetic advance as per cent of mean (GAM) in maize germplasm lines.

Low heritability and low GCV indicates that less influence of environment for expression of this character and influence of non-additive gene action which was observed in test weight followed by days to 50 per cent tasselling which was also reported by Burton., *et al* [7].

Days to 50 per cent tasselling was found early among genotype of cluster XIII. Similarly, plant height was minimum in cluster IX. Highest test weight was recorded in cluster I, IV, VI and XI. Cob length and cob girth were high in the clusters VIII and V respectively as presented in table 3. Based on D^2 statistics value of 104 genotypes were grouped into thirteen clusters with variable number of entries revealing the presence of considerable amount of genetic diversity in the material. Ninety-two genotypes were present in cluster I. And other twelve clusters were with single genotype indicating very considerable diversity among lines. This indicates that the amount of genetic diversity in the selected hundred germplasm lines is very low and additional germplasm material/sources should be collected/augmented to harness the genetic diversity. Similar results is in conformity with the findings of Singh., *et al.* [8] and Lu Yu., *et al.* [9] in maize and also by Masud., *et al.* [10] in pumpkin.

Cluster	Characters											
	DFT	DFS	PHT	EHT	CLN	CGR	KRP	KPR	TWT	GYD	DTM	SP
I	80.40	82.13	139.98	70.11	12.96	3.76	13.23	27.34	59.72	24.52	88.73	80.82
II	76.50	80.50	149.00	72.50	11.36	3.77	12.00	26.50	64.00	28.00	87.50	81.78
II	83.00	86.00	101.10	42.50	13.15	2.75	10.40	22.50	60.00	29.50	86.50	79.29
IV	83.00	86.50	133.30	81.50	12.38	3.89	13.60	30.30	64.00	22.00	88.50	80.16
V	83.50	86.00	154.90	91.00	14.34	4.14	12.80	26.10	56.00	27.00	88.00	90.12
VI	83.00	88.00	128.90	68.90	13.25	2.84	8.40	25.00	64.00	27.00	93.50	81.58
VII	76.00	76.50	162.20	90.20	13.92	4.04	14.00	28.80	56.00	24.00	89.50	79.16
VIII	86.50	90.00	127.10	81.50	14.85	3.33	10.70	36.75	61.50	29.00	93.50	82.95
IX	85.00	85.00	65.70	29.50	12.45	2.66	9.55	25.50	61.00	24.50	90.50	77.61
X	75.50	76.00	132.00	91.50	13.40	2.85	12.60	33.75	61.00	21.50	91.50	81.24
XI	84.50	89.50	96.50	38.50	13.05	3.04	9.10	27.00	64.00	26.00	91.00	84.47
XII	80.00	80.00	174.50	80.20	14.93	3.17	13.40	34.00	59.00	30.00	94.33	82.86
XIII	70.00	74.00	126.50	55.00	11.23	3.87	14.20	26.00	56.00	22.60	89.00	79.22

Table 3: Cluster means of maize germplasm lines for yield and yield related traits.

DFF: Days to 50% tasseling, DFS: Days to 50% silking, PHT: Plant Height, CLN: Cob Length, CGR: Cob Girth, KRP: No. kernel rows per ear, KPR: No. kernels per ear row, GYD: Grain yield, TWT: Test weight, DTM: Days to maturity, SP: Shelling percentage.

Among the twelve quantitative characters contributing to the total divergence 56% is contributed by plant height, days to maturity and grain yield traits, while test weight gave the lowest contribution of 0.99% followed by ear girth with 1.30% to the total genetic divergence. Very narrow contribution was recorded for days to 50 per cent flowering followed by days to 50 per cent silking and the present result are in agreement with that of Tan., *et al.* [11] and Alom., *et al.* [12] who also identified the above said characters as the principle components contributing to variation in maize. More., *et al.* [13] reported that plant height and days to maturity were the major contributors towards divergence as presented in table 4 and figure 3.

Sl. No.	Characters	Per cent Contribution
1	Days to 50 per cent tasseling	1.96
2	Days to 50 per cent silking	2.00
3	Plant height (cm)	20.16
4	Ear height (cm)	18.22
5	Cob length (cm)	3.26
6	Cob girth (cm)	1.30
7	Number of kernel rows per ear	1.98
8	Number of kernels per ear row	3.51
9	Days to maturity	22.72
10	Test weight (g)	0.99
11	Shelling percentage	6.91
12	Grain yield (q/ha)	17.00

Table 4: Per cent contribution of character towards total divergence in maize germplasm lines.

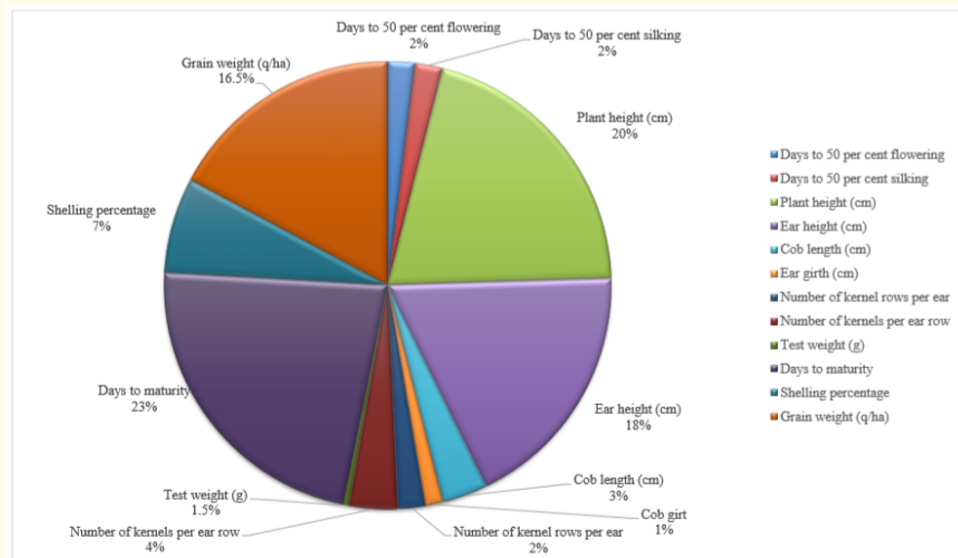


Figure 3: Per cent contribution of character towards total divergence in maize germplasm lines.

Conclusion

This study has revealed the existence of adequate genetic variability in the material studied. Indicating that genetic diversity and the strong genetic association between grain yield and others traits would aid in indirect selection thus helping the breeders in the development of maize germplasm for future breeding programme. In addition, genetic parameters that having highly heritable traits with complex ones could help determine whether selection for one trait has any effect on another. Ear height and shelling (%) traits which showed the highest coefficient of genotypic variability, high broad sense heritability estimates, and had strong positive association with grain yield could be used as effective selection indices for grain yield improvement.

In general, coefficients of variation at genotypic levels was lesser than phenotypic coefficient variation for most of the inter character associations. This suggested the preponderance of environmental factors which might have suppressed the expression of character.

The characters like ear height, days to 50 per cent silking, days to maturity and shelling % recorded high heritability estimates indicating the involvement of additive gene action in the inheritance of these characters. Hence selection of these components will simultaneously improve the grain yield.

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