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Genetic variability, heritability and genetic advance of yield attributing traits in maize

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Abstract
The present experiment was conducted at Agricultural College Farm, Naira during kharif 2013-14 to estimate the genetic variability, heritability and genetic advance in 30 inbred lines. The genotypic coefficients of variation (GCV) for all the characters studied were lesser than the phenotypic coefficients of variation (PCV) indicating the effect of the environment. The high estimates of heritability with high genetic advance as per cent of mean and high PCV and GCV were recorded for grain yield per plant and 100 kernel weight followed by LAI 90 DAS. Whereas, low estimates of heritability with low genetic advance as per cent of mean and low PCV and GCV were recorded for RGR 60, 90 DAS followed by harvest index.

Keywords: Genetic variability, yield attributing, traits, PCV, GCV

Introduction

Maize (*Zea mays* L.; 2n=20), belonging to the family Poaceae and tribe Maydeae, is one of the most important cereal crops of the world and contributes to the food security in most of the developing countries. Its importance lies in the fact that it is not only used for human food and animal feed but it is also widely used for corn starch industry, oil production, baby corn *etc*. In India, maize is the third most important crop after rice and wheat. Maize is cultivated over an area of 9.21 mha with a production and productivity of 27.23 mt and 2727 kg ha^{-1}, respectively (Agricultural Statistics at a Glance, 2019) [1]. Of late, the crop has assumed a place of prominence owing to its varied uses *viz.*, human consumption, poultry feed, green fodder, value added products and industrial usage.

The amount of variability present in the population is a prerequisite for any plant breeding programme as it helps in selecting desirable genotypes, hence critical analysis of the genetic variability parameters *viz.*, genotypic coefficient of variability and phenotypic coefficient of variability is essential. Along with variability, the estimates of heritability help the plant breeder in determining the characters for which selection would be rewarding. The major function of heritability estimates is to provide information on transmission of characters from the parents to the progeny. Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. Therefore, this study was undertaken to study the genetic variability, heritability and genetic advance among the maize genotypes for yield and yield contributing traits.

Materials and Methods

Thirty genotypes of maize were sown in a Randomized Block Design with three replications at College Farm, Agricultural College, Naira, Srikakulam District, during *kharif*, 2013-14. Each genotype was represented by one row of four meter length in each replication with a spacing of 60 cm between rows and 20 cm within row. The recommended fertilizers of N, P and K were applied in the ratio of 120:80:60 kg ha^{-1}. The entire P, K and half dose of nitrogen were applied as basal, while remaining half dose of N was applied in two equal split doses at knee height and tasseling stages. Intercultural operations like weeding and irrigation schedules along with necessary plant protection measures were followed to protect the crop from pests and diseases as per the package and practices recommended by the university to raise a healthy crop. Genetic variability together with the heritability estimates would give a better idea on the amount of genetic gain expected out of selection (Burton, 1952 [4] and Swarup and Chaugle, 1962) [14].

Further, the magnitude of heritable variability is the most important aspect (Panse, 1957) [11], which has close relationship with response to selection. Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. However, it is not necessary that a character showing high heritability will always exhibit high genetic advance (Johnson *et al*., 1955) [5].

Results and Discussion

The analysis of variance revealed highly significant differences among thirty genotypes for seven characters (Table 1).

Heritability and variance

High heritability coupled with high PCV and GCV was observed for number of kernels per row, 100 kernel weight, grain yield and LAI 90 DAS. High heritability coupled with moderate PCV was observed for plant height, ear height, ear length, LAI 30 and 60 DAS, LAD 30-60 and 60-90 DAS, SCMR and stover yield and low GCV for ear girth, number of kernel rows per cob. Moderate heritability with moderate PCV and low GCA was reported for RGR 90 DAS and low GCV and PCV for harvest index. Low heritability with low PCV and GCV was noticed for RGR 60 DAS. High heritability coupled with low PCV and GCV was observed for days to 50% tasseling, days to 50% silking and days to maturity (Table 2.)

Heritability and genetic advance

High heritability coupled with high genetic advance as per cent of mean was observed for plant height, ear height, ear length, number of kernels per row, 100 kernel weight, grain yield, LAI 60 and 90 DAS, LAD 30-60 and 60-90 DAS, SCMR and stover yield per plant. High heritability (96.43) coupled with high genetic advance as per cent of mean (93.31) was observed for grain yield per plant indicating the operation of additive gene action. The high heritability is being exhibited due to favourable influence of environment rather than genotype indicating the possibility of improvement of this trait through heterosis breeding rather than simple selection. Similar results were reported by Malathesha *et al.* (2015) [7], Kumar *et al.* (2015) [6], Maruthi and Jhansi (2015) [8], Begum *et al.* (2016) [3] and Mukti Ram *et al.* (2016) [9] in maize. High heritability coupled with moderate genetic advance as percent of mean was observed for days to 50% tasseling, days to 50% silking, ear girth, number of kernel rows per cob, LAI 30 DAS indicating the operation of non additive and additive gene action for this trait. The high heritability is being exhibited due to favourable influence of environment rather than genotype and indicating the possibility of improvement of the trait through heterosis breeding rather than simple selection. These results are in accordance with the findings of Shanthi *et al.* (2011) [13], Nataraj *et al*. (2014) [10] and Maruti and Jhansi (2015) [8] in maize.

High heritability (72.39) coupled with low genetic advance as per cent of mean (6.84) was observed for days to maturity indicating the operation of non –additive gene action. The high heritability is being exhibited due to favorable influence of environment rather than genotype hence, selection for such trait may not be effective. Similar findings were reported by Reddy *et al.* (2013) [12].

Moderate heritability (44.34) coupled with moderate genetic advance as per cent of mean (11.17) was observed for RGR 90 DAS and low genetic advance for harvest index indicating the character is highly influenced by the environmental effects and selection would be ineffective. Low heritability (25.73) coupled with low genetic advance as per cent of mean (3.94) was observed for RGR 60 DAS indicating the character is highly influenced by the environmental effects and selection would be ineffective.

Heritability, genetic advance and variability

High heritability coupled with high genetic advance as per cent of mean and high PCV and GCV was observed for number of kernels per row, 100 kernel weight, grain yield per plant and LAI at 90 DAS. High heritability coupled with high genetic advance as per cent of mean and moderate PCV and GCV was observed for plant height, ear height, ear length, LAI 60 DAS, LAD 30-60 and 60-90 DAS, SCMR and stover yield. High heritability coupled with moderate genetic advance as per cent of mean and moderate PCV and GCV was observed for LAI 30 DAS and low GCV for ear girth, number of kernel rows per cob. High heritability coupled with moderate genetic advance as per cent of mean and low PCV and GCV was observed days to 50% tasseling, days to silking. High heritability coupled with low genetic advance as per cent of mean and low PCV and GCV was observed for days to maturity.

Medium heritability coupled with medium genetic advance as per cent of mean and medium PCV and low GCV was observed for RGR 90 DAS. Medium heritability coupled with low genetic advance as per cent of mean and low PCV and low GCV was observed for harvest index. Low heritability coupled with low genetic advance as per cent of mean and low PCV and GCV was observed for RGR at 60 DAS.

Table 1: Analysis of variance for twenty one quantitative characters for 30 maize genotypes

S. No.	Characters	Mean sum of squares		
		Replications (df =2)	Genotypes (df = 29)	Error (df = 58)
1	Days to 50% Flowering	0.48	35.19**	2.21
2	Days to 50% Silking	0.93	33.78**	1.92
3	Days to Maturity	3.38	42.78**	4.83
4	Plant height (cm)	2.88	966.59**	95.14
5	Ear height (cm)	0.41	245.33**	15.26
6	Ear length (cm)	0.07	16.05**	1.22
7	Ear girth (cm)	0.02	3.95**	0.49
8	No of kernel rows per cob	0.08	4.58**	0.48
9	No of kernels/ row	0.07	101.69**	2.21
10	100 kernel weight (g)	0.06	49.44**	1.29
11	Grain yield/ plant (g)	1.71	1637.43**	19.96
12	Leaf area index 30 DAS	0.0000	0.0009**	0.0001

13	Leaf area index 60 DAS	0.0097	0.5298**	0.0263
14	Leaf area index 90 DAS	0.0033	0.2305**	0.0098
15	LAD 30-60 DAS	0.32	103.04**	9.61
16	LAD 60-90 DAS	1.90	847.16**	62.39
17	SCMR	1.04	104.81**	13.62
18	RGR 30-60 DAS	0.000	0.000006*	0.000003
19	RGR 60-90 DAS	0.000	0.000001*	0.0000001
20	Harvest Index (%)	0.34	17.38**	3.79
21	Stover yield/ plant (g)	0.16	33.07**	2.31

Table 2: Estimates of genetic variability parameters for grain yield and its attributes in 30 maize inbred lines

S. No	Characters	Mean + S.E$_{(m)}$	Minimum	Maximum	Genotypic variance	Phenotypic variance	GCV %	PCV %	Heritability in broad sense (%)	Genetic advance	Genetic advance as per cent of mean
1	Days to 50% tasseling	56.16 + 0.86	48.33	63.33	10.99	13.21	5.90	6.47	83.24	6.23	11.10
2	Days to 50% silking	59.30 + 0.80	51.67	66.33	10.62	12.54	5.50	5.97	84.68	6.18	10.42
3	Days to maturity	91.09 + 1.27	83.33	99	12.65	17.48	3.90	4.59	72.39	6.23	6.84
4	Plant height (cm)	137.14 + 5.63	102.67	168.67	290.48	385.62	12.43	14.32	75.33	30.47	22.22
5	Ear height (cm)	49.48 + 2.26	33	67.33	76.69	91.95	17.70	19.38	83.40	16.47	33.30
6	Ear length (cm)	13.29 + 0.64	9.00	17.58	4.94	6.16	16.73	18.68	80.19	4.10	30.86
7	Ear girth (cm)	11.26 + 0.40	8.75	13	1.15	1.64	9.54	11.38	70.30	1.86	16.48
8	No of kernel rows per cob	12.91 + 0.40	11.17	15.83	1.37	1.85	9.05	10.52	74.00	2.07	16.04
9	No of kernels per row	24.75 + 0.86	11.75	36.92	33.16	35.37	23.26	24.03	93.75	11.49	46.40
10	100 kernel weight (g)	15.98 + 0.65	10.03	23.25	16.05	17.34	25.08	26.06	92.58	7.94	49.70
11	Grain yield per plant (g)	50.34 + 2.58	19.61	91.31	539.15	559.12	46.13	46.97	96.43	46.97	93.31
12	Leaf area index 30 DAS	0.15 + 0.01	0.12	0.18	0.00025	0.00037	10.51	12.64	69.18	0.03	18.01
13	Leaf area index 60 DAS	2.38 + 0.09	1.95	3.10	0.17	0.19	17.22	18.52	86.46	0.78	32.99
14	Leaf area index 90 DAS	1.33 + 0.06	1.01	1.83	0.07	0.08	20.32	21.63	88.24	0.52	39.31
15	LAD 30-60 DAS	40.50 + 1.79	33.02	50.16	31.14	40.76	13.78	15.76	76.42	10.05	24.82
16	LAD 60-90 DAS	90.33 + 4.56	71.89	118.98	261.59	323.98	17.90	19.93	80.74	29.94	33.14
17	SCMR	44.40 + 2.13	29.27	57.60	30.40	44.02	12.42	14.94	69.06	9.44	21.26
18	RGR 60 DAS	0.0256 + 0.0009	0.0235	0.0284	0.0000009	0.0000036	3.77	7.44	25.73	0.00	3.94
19	RGR 90 DAS	0.0042 + 0.0002	0.0033	0.0050	0.0000001	0.0000003	8.14	12.23	44.34	0.00	11.17
20	Harvest index (%)	36.06 + 1.12	31.28	40.55	4.53	8.32	5.90	8.00	54.57	3.24	8.98
21	Stover yield per plant (g)	28.59 + 0.88	21.98	38.72	10.25	12.56	11.20	12.40	81.61	5.96	20.84

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