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Genotype and Phenotype Coefficient of Variance in Maize (*Zea mays* L.)

G. Pranay [a*], Danam Shashibhushan [b], K. Jhansi Rani [c], D. Bhadru [d] and C. V. Sameer Kumar [e]

[a] Department of Genetics and Plant Breeding, College of Agriculture, PJTSAU, Hyderabad, Telangana, India.
[b] Department of Genetics and Plant Breeding, Agricultural College, PTJSAU, Palem, Telangana, India.
[c] Department of Genetics and Plant Breeding, Agricultural College, PJTSAU, Polasa, Jagitial, Telangana, India.
[d] Plant Breeding, Maize Research Centre, PTJSAU, Hyderabad, Telangana, India.
[e] Department of Genetics & Plant Breeding, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out with 30 maize inbred lines at Seed Research Technology Centre, Rajendranagar, PJTSAU. Analysis of variance revealed significant differences among the inbreds for all the traits studied. The phenotypic coefficient of variance (PCV) was slightly higher than the genotypic coefficient of variance (GCV) indicating the role of experimental variance in the total variance. High PCV and GCV were observed for SVI-2 whereas cob yield per plant and grain yield per plant showed high PCV and moderate GCV. It indicated the presence of a high degree of variability. Ear height, 100- grain weight, seed vigour index – I and speed of germination had moderate PCV and GCV. High heritability coupled with high genetic advance was observed in ear

**Corresponding author: E-mail: pranaygundala1406@gmail.com;*

height, 100-seed weight, cob yield per plant, seed vigour index-1, seed vigour index-2, speed of germination and grain yield per plant indicating the preponderant role additive gene action in inheritance and simple selection would be effective for yield improvement. Based on GCV, PCV, heritability and genetic advance over mean seven traits (ear height, ear length, cob yield per plant, grain yield per plant, SVI-1, SVI-2 and speed of germination) are given importance during the selection of inbred lines. The current study reveals the existence of proper genetic variability among the characters which can be applied to a maize improvement programme.

Keywords: Maize; inbreds; PCV; GCV; heritability; genetic advance; genetic variability.

1. INTRODUCTION

Maize (*Zea mays* L.) is the most important cereal crop next to wheat and rice, it is considered as "Queen of the cereals" and is also best known as the golden crop because every part of this crop is useful to man, animals and industries [1]. Maize is the third-largest cereal crop in the world with a production of 1148 million metric tonnes in 2019 (FAOSTAT). It is the third most important cereal in India, next to wheat and rice in terms of area (9.8 m.ha), production (31.6 million tonnes) and productivity (31.9 q ha^{-1}) (Indiastat, 2020-21). It also plays a key role in the Indian economy by contributing a significant share in global agricultural imports and exports.

The maize crop is majorly used as feed for animals and food for humans. Apart from food and feed it is also extensively used for corn oil, starch and biofuel production. It is processed into many food products such as tortillas, snacks, flour, flakes etc. [2]. It is enriched with an abundant amount of macronutrients like starch, fibre, protein and fat along with micronutrients like vitamin B complex, ß-carotene and essential minerals such as magnesium, zinc, phosphorus, copper, etc. [3]. Many hybrids or varieties are released by both public and private to cater to the various needs.

Development of high yielding maize varieties is the most fundamental goal of any maize breeder to increase yield. Grain yield is the collective product of inherited and environmental factors [4]. Genetic variability in maize genotypes plays a vital role in grain yield variation. Maize production could be increased through the development of improved genotypes capable of producing enhanced yield under different agro-climatic conditions [5]. Genetic variability among maize genotypes can be estimated based on qualitative and quantitative traits.

The major breeding approach for increasing productivity relies on the production of hybrids using heterosis breeding. In this context, the first step is to develop maize inbred lines and assess the extent of genetic variability. Genetic variability is the pre requisite for any crop improvement program. Genetic variability, which is a heritable difference among cultivars, is required at an appreciable level within a population to facilitate and sustain an effective long term plant breeding program [6]. Progress from selection has been reported to be directly related to the magnitude of genetic variance in the population. Improvement in any trait depends solely on the amount of variability present in the base material for that trait. Therefore, variability is a key to crop improvement according to [7].

The study of variability and genetic advance in the germplasm will help to ascertain the real potential of the genotype as suggested by [8]. Whereas genetic advance shows the degree of gain obtained for the characters under a particular selection pressure [9]. Accordingly, a study of genetic parameters like genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as per cent of mean provides a clear cut idea about the extent of variability present in a plant population and a relative measure of efficiency of selection of genotypes based on phenotype in a highly variable population which was described by [10]. The estimates of genetic parameters like heritability and genetic advance helps in predicting the gain under selection. Therefore, this study was undertaken to study the genetic variability, heritability and genetic advance among the maize genotypes for yield and yield contributing traits.

2. MATERIALS AND METHODS

The present pursuit entails a study of genetic parameters and variability in a set of 30 inbred lines of maize developed by the Maize Research Centre, Rajendranagar for grain yield and yield contributing characters including seed vigour traits. The experiment was conducted with a standard agronomical package of practices at Seed Research Technology Centre, Rajendranagar, Professor Jayashankar Telangana State Agricultural University (PJTSAU) during the *Rabi* 2020 in Randomized Block Design with three replications and the plot size was 4 rows of 6 metres length for each inbred line. Statistical analysis was done by using INDOSTAT software. The estimates for variability treated as per the categorization proposed by [11], heritability and genetic advance as per cent of mean estimates according to criteria proposed by [12]. From the heritability estimates, the genetic advance was calculated by the following formula given by [13].

2.1 Estimation of Variance components

2.1.1 Genotypic and phenotypic coefficients of variance

According to the formula given by [14], the genotypic and phenotypic coefficients of variation were computed.

Genotypic coefficient of variation = Genotypic standard deviation/ Mean× 100

Phenotypic coefficient of variation = Phenotypic standard deviation/ Mean× 100

Classification of the range of variation was effected as proposed by [11].

<10%	:	Low
10-20%	:	Moderate
>20%	:	High

2.1.2 Heritability

Heritability in the broad sense refers to the proportion of genotypic variance to the total observed variance in the total population

In a broad sense, heritability states to the fraction of genotypic variation to the overall measured variance in a population. Heritability (h^2) was determined in the broad sense using [15].

$$h^2 = \frac{\sigma^2 g}{\sigma^2 p}$$

Where,

h^2 = Heritability in broad sense
σ^2_g = Genotypic variance
σ^2_p = Phenotypic variance (σ^2_g) + (σ^2_e)
σ^2_e = Environmental variance

2.1.3 Genetic advance (Expected)

Genetic advance states the expected gain or improvement in the next generation by selecting superior individuals under a certain amount of selection pressure. From the heritability estimates, the genetic advance was calculated by the following formula given by [15].

$$GA = K.\ h^2\ (b).\ \sigma_p$$

Where,

GA = expected genetic advance
K = selection differential, the value of which is 2.06 at 5% selection intensity
σ_p = phenotypic standard deviation
h^2 (b) = heritability in broad sense

To visualize the relative utility of genetic advance among the traits, genetic advance as per cent for mean was computed.

Genetic advance as per cent of mean = GA/ Grand mean× 100

3. RESULTS AND DISCUSSION

The major breeding approach for increasing productivity relies on the production of hybrids using heterosis breeding. In this context, the first step is to develop maize inbred lines and assess the extent of genetic variability. Selection of genetically superior genotypes, as well as inbred lines for hybrid breeding, requires sufficient genetic variability and high heritability in the base population. Analysis of variance (Table 1) revealed highly significant differences among maize inbred lines in respect of almost all the characters under studied at 1% and 5% levels. This indicates that a sufficient range of variability in all the traits exists among the populations. Significant differences among the maize inbreds for studied characters have also been reported by [16-22].

The mean values, genotypic and phenotypic variances, heritability, and the genetic advance of traits studied are some of the key parameters which determine the efficiency of a breeding program.

3.1 Mean Performance

The mean performance of the inbred lines for eighteen yield, yield contributing characters and seedling vigour traits are presented in Table 2.

Among the 30 maize inbreds, days to tasseling was recorded as highest in PFSR- 56 (66.0) and lowest in PFSR-12 (57.6), days to silking(68.0,59.6) and days to maturity (112.0,111.6) were highest in PFSR-12 and lowest in MGC- 137. Plant height was highest in PFSR- 104 (168.7) and lowest in GP-311 (116.3). Highest ear height was observed in PFSR-198 (93.60), while the lowest was observed in the inbred line PFSR-151 (61.76). Ear length was highest in PFSR-135 (14.63), and lowest in PFSR-56 (10.23). Ear diameter was highest in MGC- 137 (4.06) and lowest in PFSR-49 (3.03).

Number of kernel rows per ear and speed of germination were highest in PFSR-56 (14.6) and lowest in MGC-137 (9.3). MGC-137 (32) had the highest number of kernels per row and GP-170 (17.6) had the lowest. 100- Grain weight was highest in PFSR-29 (33.4) and lowest in MGC-7 (16.0). The shelling percentage was highest in MGC-7 (84.2%) and lowest in PFSR-204 (75.1%). Cob yield per plant was highest in MGC-137 (122.3) and lowest in GP-19 (46.0).

Grain yield per plant (98.6,38.3) and germination first count (100,78) were highest in PFSR-17 and lowest in MGC-137. Germination final count (100,84), seed vigour index-1 (3940.0,2127.6)and seed vigour index- 2 (102.0,30.2) were highest in GP-311 and lowest in MGC-137. In other words, the performances of the inbred lines for these characters were statistically different, suggesting scope for improvement. These results are in agreement with the results of [23-26].

3.2 Genetic Variability Parameters

In crop breeding, variability is very significant. The degree of variability present in crop species is critical because it serves as the basis for selection. Genetic and environmental influences contribute to the overall variation in a population. The presence of significant genetic variability in the breeding materials is critical for successful plant breeding program exploitation. The computed values of phenotypic, genotypic coefficient of variation, genetic advance and heritability are presented in Tables 3 and 4.

The traits studied were at three levels *i.e.,* high, medium, and low. PCV showed a wide range of variation from 2.72 to 23.10 per cent while the GCV ranged from 1.30 to 22.83 per cent for the different traits studied. Phenotypic Coefficient of variance is slightly higher than the Genotypic coefficient of variance which indicates the role of experimental variance to the total variance. Both PCV and GCV were high for SVI-2 (23.10, 22.83), whereas cob yield per plant (20.21, 19.10) and grain yield per plant (20.36, 19.23) had high PCV and moderate GCV. It implies the presence of high variability among the inbreds for this trait and the possibility of selection of these traits for improving maize yield. Ear height (12.03, 11.81), 100- grain weight (18.82, 18.48), seed vigour index – I (13.34, 12.86), speed of germination (18.49, 18.33) had the moderate PCV and GCV.

Moderate PCV and low GCV were noticed for plant height (12.87, 9.98), cob length (10.22, 8.56), number of kernels row per cob (12.40, 8.67), and number of kernels per row (13.50, 9.80). Low phenotypic coefficient of variation and genotypic coefficient of variation were observed for traits days to tasseling (3.92, 3.27), days to silking (3.76, 3.06), days to maturity (2.72, 1.30), ear diameter (6.65, 5.31), shelling % (3.48, 2.72), germination 1st count (5.26, 5.00) and germination 2nd count (3.28, 2.98) indicating the absence of variation for these traits in the inbred lines studied and improvement can’t be achieved through the traditional methods and new methods such as mutation breeding and DNA technologies can be used to create variation.

These findings are in agreement with the findings of [17,18], [27-30]. Thus, indicating the presence of sufficient inherent genetic variance over which selection could be effective. These characters with a low magnitude of genetic variability may have limited utility in a programme of selection for their improvement.

3.3 Heritability and Genetic Advance

High heritability coupled with high genetic advance was noticed for ear height (96.4%, 23.9), 100-seed weight (96.4%, 37.4), cob yield per plant (89.3%, 37.18), seed vigour index-1(93.1%, 25.6), seed vigour index-2 (97.7%, 46.50), speed of germination (98.2%,37.42) and grain yield per plant (89.2%, 37.4) which suggest that these characters are controlled by the additive type of gene action in the inheritance and simple selection for these traits would be fruitful. Thus, heritability estimates coupled with high genetic advance would be more reliable (Reddy et al. 2012).

Table 1. Analysis of variance for yield, yield components and seed vigour traits in Maize

S. No.	Character	Mean sum of squares		
		Replications (d.f.=2)	**Treatments (d.f.=29)**	**Error (d.f.=58)**
1	Days to 50% tasseling	1.944	14.10**	1.784
2	Days to 50% silking	3.033	13.295**	1.953
3	Days to maturity	24.044	14.619*	7.757
4	Plant height (cm)	428.796	787.911**	142.840
5	Ear height (cm)	5.097	251.797**	3.105
6	Ear length (cm)	0.558	4.393**	0.546
7	Ear diameter (cm)	0.014	0.123**	0.020
8	No of rows per cob	1.111	3.617**	0.927
9	No of seeds per row	12.878	22.684**	5.234
10	100-grain weight (g)	0.417	73.240**	0.898
11	Shelling %	3.830	17.504**	3.060
12	Cob yield per plant (g)	13.253	649.217**	24.868
13	Germination 1st count	6.011	71.396**	2.425
14	Germination 2nd count	5.700	27.318**	1.815
15	Seed vigour index-I	33527.04	465850.0**	11284.29
16	Seed vigour index-II (g)	17.359	723.044**	5.666
17	Speed of germination	0.139	7.401**	0.045
18	Grain yield per plant (g)	7.286	428.998**	16.562

*** Significant at 1 per cent level * Significant at 5 per cent level*

Table 2. Mean performance of maize inbreds for grain yield, yield components and seed vigour traits

S. No.	Inbreds	Days to (50%) tasseling	Days to (50%) silking	Days to Maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows per cob	No. of kernel per rows
1	PFSR-9	64.0	66.0	119.0	124.7	64.76	13.6	3.4	10.0	23.3
2	PFSR-12	66.0	68.0	121.0	127.5	63.03	14.0	3.2	10.0	27.0
3	PFSR-17	58.0	60.0	113.0	134.5	65.0	10.6	3.5	12.0	22.3
4	PFSR-19	62.3	64.0	117.3	152.4	77.0	12.3	3.4	10.6	25.6
5	PFSR-29	61.3	63.0	115.6	163.5	77.4	13.4	3.4	10.6	23.0
6	PFSR-30	60.3	62.3	115.3	155.6	78.2	13.9	3.4	10.0	22.6
7	PFSR-32	62.0	63.6	116.6	147.4	78.0	13.2	3.5	10.6	21.6
8	PFSR-46	62.0	62.6	115.3	150.0	78.2	13.8	3.4	11.3	26.0
9	PFSR-49	60.6	62.6	115.6	125.4	66.8	13.8	3.0	10.0	23.6
10	PFSR-56	57.6	60.3	113.3	121.0	79.4	14.6	3.1	9.3	27.3
11	PFSR-70	59.6	61.3	114.3	144.4	80.2	11.9	3.6	11.3	21.6
12	PFSR-71	61.3	63.0	116.3	138.2	66.0	11.9	3.3	11.3	23.0
13	PFSR-84	63.6	65.3	118.3	157.5	82.0	13.2	3.5	10.6	25.0
14	PFSR-90	63.3	65.0	118.0	161.6	78.6	14.1	3.6	10.0	25.0
15	PFSR-92	62.6	64.3	117.3	165.1	83.6	14.6	3.5	10.0	26.6
16	PFSR-95	62.0	63.0	116.0	166.5	86.8	13.7	3.6	10.6	25.3
17	PFSR-104	61.3	63.3	116.3	168.7	91.4	14.2	3.6	10.0	26.3
18	PFSR-127	61.0	63.0	116.0	157.8	92.0	14.2	3.5	11.3	23.0
19	PFSR-130	62.0	63.3	116.3	163.0	89.2	14.2	3.6	10.0	25.6
20	PFSR-132	61.6	63.6	116.6	159.8	66.0	12.9	3.4	10.6	27.6
21	PFSR-135	58.6	61.0	113.6	119.2	80.2	10.2	3.7	11.3	23.3

Table 2. (Contd.) Mean performance of maize inbreds for grain yield, yield components and seed vigour traits

S.No.	Inbreds	Days to (50%) tasseling	Days to (50%) silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of kernels per row	No. of kernel rows
22	PFSR-151	61.0	62.6	115.3	160.7	61.7	13.5	3.6	11.3	22.3
23	PFSR-198	62.3	63.6	116.6	146.9	93.6	12.9	3.3	12.0	28.6
24	PFSR-204	62.6	63.6	116.6	167.8	84.7	13.9	3.3	10.0	25.6
25	GP-16	63.0	64.3	117.3	156.1	77.8	13.8	3.3	10.0	24.0
26	GP-19	65.0	66.6	119.6	149.1	84.6	14.4	3.3	10.6	24.0
27	GP-170	63.0	64.3	117.3	141.0	67.4	10.6	3.5	10.6	17.6
28	GP-311	65.6	67.6	120.6	116.3	68.5	11.8	3.9	12.6	21.3
29	MGC-7	65.3	67.3	120.3	128.4	71.4	12.6	3.5	12.6	27.6
30	MGC-137	58.0	59.6	111.6	136.1	78.4	14.1	4.0	14.6	32.0
General Mean		61.92	63.63	116.57	146.9	77.08	13.22	3.49	10.8	24.62
C. V. %		2.15	2.19	2.38	8.13	2.28	5.58	3.9	8.84	9.29
Highest Range		66.0	68.0	112.0	168.7	93.60	14.63	4.06	14.6	32.0
Lowest Range		57.6	59.6	111.6	116.3	61.76	10.23	3.03	9.3	17.6
Standard Error		0.7	0.80	1.60	6.90	1.01	0.42	0.08	0.5	1.32
C.D 5%		2.18	2.28	4.5	19.5	2.8	1.20	0.2	1.57	3.73
C.D 1%		2.90	3.03	6.05	25.9	3.83	1.60	0.30	2.09	4.97

Table 2. (Contd.) Mean performance of maize inbreds for grain yield, yield components and seed vigour traits

S. No.	Inbreds	100 seed weight (g)	Shelling (%)	Cob yield per plant (g)	Germination 1st count	Germination 2nd count	SVI -1	SVI-2	Speed of germination	Grain yield per plant (g)
1	PFSR-9	26.4	82.2	76.0	92.0	96.0	3278.3	68.9	6.8	62.5
2	PFSR-12	24.7	78.1	73.0	99.0	100.0	2920.0	64.3	8.1	57.0
3	PFSR-17	17.6	80.1	47.8	99.6	100.0	3380.0	61.6	8.7	38.3
4	PFSR-19	22.0	80.5	72.6	98.0	98.6	3536.6	71.3	8.1	58.5
5	PFSR-29	33.4	80.6	76.3	98.0	98.0	2861.6	58.8	8.5	61.5
6	PFSR-30	31.9	83.4	72.3	98.0	98.0	2702.3	58.8	6.9	60.3
7	PFSR-32	29.9	79.0	71.3	92.0	97.6	2628.6	82.0	11.5	56.3
8	PFSR-46	27.2	81.5	77.6	98.0	99.0	2677.0	75.2	8.4	63.3
9	PFSR-49	23.8	83.0	59.6	94.0	98.0	2996.3	78.4	8.4	49.5
10	PFSR-56	22.3	84.1	65.3	97.6	99.0	3396.6	77.2	5.5	55.0
11	PFSR-70	25.4	82.1	70.0	99.3	100.0	2676.6	64.0	7.1	47.5
12	PFSR-71	24.9	81.4	59.0	86.0	97.6	2204.3	70.3	7.9	48.0
13	PFSR-84	29.2	81.3	72.3	94.3	94.0	3235.0	75.2	7.8	59.0
14	PFSR-90	31.1	82.6	90.0	99.6	99.6	3020.0	65.7	8.5	74.3
15	PFSR-92	28.9	81.4	91.3	90.3	96.3	2829.3	69.0	9.4	74.3
16	PFSR-95	30.7	80.1	84.0	92.0	98.0	2982.6	74.1	8.8	67.1
17	PFSR-104	30.3	81.4	88.0	94.0	96.0	3027.6	74.8	6.3	71.6
18	PFSR-127	30.3	80.2	80.3	99.6	100.0	3200.0	58.0	8.4	64.5
19	PFSR-130	29.8	78.6	90.3	100.0	100.0	3153.3	82.0	8.5	71.0
20	PFSR-132	24.5	82.7	83.0	100.0	100.0	3023.3	61.6	8.0	68.6
21	PFSR-135	31.5	81.3	75.3	98.0	100.0	2806.3	49.6	6.7	61.3

Table 2. (Contd.) Mean performance of maize inbreds for grain yield, yield components and seed vigour traits

S.No.	Inbreds	100 seed weight (g)	Shelling (%)	Cob yield per plant (g)	Germination 1st count	Germination 2nd count	SVI -1	SVI-2	Speed of germination	Grain yield per plant (g)
22	PFSR-151	32.1	77.5	88.3	98.0	99.6	2787.6	71.4	11.3	68.5
23	PFSR-198	16.5	79.2	58.0	94.0	98.0	3287.3	64.3	9.6	46.0
24	PFSR-204	32.5	84.2	87.0	98.0	98.3	3499.6	89.8	10.0	73.3
25	GP-16	29.0	79.3	77.3	92.0	98.0	3215.3	68.6	6.6	61.3
26	GP-19	18.1	83.4	46.0	99.0	99.0	3627.3	88.7	11.1	38.5
27	GP-170	27.4	80.1	72.0	98.0	98.0	2672.6	43.1	7.6	57.6
28	GP-311	25.3	75.5	75.0	78.0	84.0	2127.6	30.2	8.8	56.6
29	MGC-7	16.0	75.1	64.3	98.0	98.0	3074.0	31.3	10.1	48.3
30	MGC-137	23.4	75.8	122.3	100.0	100.0	3940.0	102.0	11.8	98.6
General Mean		26.56	80.56	75.53	95.82	97.96	3025.60	67.71	8.54	60.96
C. V. %		3.56	2.17	6.60	1.62	1.37	3.51	3.51.	2.27	6.67
Highest Range		33.43	84.26	122.33	100.0	100.0	3940.0	102.0	11.82	98.6
Lowest Range		16.03	75.16	46.0	78.0	84.0	2127.6	30.28	5.50	38.3
Standard Error		0.54	1.01	2.87	0.89	0.7	61.3	1.37	0.12	2.34
C.D 5%		1.54	2.85	8.15	2.54	2.20	173.61	3.89	0.34	6.65
C.D 1%		2.06	3.80	10.84	3.38	2.92	230.9	5.17	0.45	8.84

Table 3. Magnitude of variability, heritability and genetic advance for grain yield, yield components and seed vigour traits in Maize

S. No	Character	General Mean	Range		Phenotypic Coefficient of Variation (PCV)	Genotypic Coefficient of Variation (GCV)	Heritability in broad sense (%) (H_{bs})	Genetic Advance as per cent of mean (5%) (GAM)
			Maximum	Minimum				
1	Days to 50% tasseling	61.9	66.0	57.66	3.92	3.27	69.7	5.63
2	Days to 50% silking	63.63	68.0	59.66	3.76	3.06	65.9	5.11
3	Days to maturity	116.57	121.0	111.66	2.72	1.30	22.8	1.27
4	Plant height (m)	146.9	168.67	116.3	12.87	9.98	60.1	15.94
5	Ear height(cm)	77.08	93.6	61.76	12.03	11.8	96.4	23.89
6	Cob length	13.23	14.63	10.23	10.22	8.56	70.1	14.77
7	Cob diameter	3.49	4.06	3.03	6.65	5.31	63.9	8.75
8	No of rows per cob	10.88	14.0	9.33	12.40	8.67	49.2	12.56
9	No of seeds per row	24.62	32.0	17.66	13.50	9.80	52.6	14.64
10	100-grain weight (g)	26.56	33.43	16.03	18.82	18.48	96.4	37.39
11	Shelling %	80.56	84.26	75.16	3.48	2.72	61.1	4.39
12	Cob yield per plant (g)	75.53	122.33	46.0	20.21	19.10	89.3	37.18
13	Germination 1st count	95.82	100.0	78.0	5.26	5.00	90.5	9.80
14	Germination 2nd count	97.96	100.0	84.0	3.28	2.98	82.4	5.57
15	Seed vigour index-I	3025.60	3940.0	2127.66	13.34	12.86	93.1	25.57
16	Seed vigour index-II (g)	67.71	102.0	30.28	23.10	22.83	97.7	46.50
17	Speed of germination	8.54	11.82	5.05	18.49	18.33	98.2	37.42
18	Grain yield per plant (g)	60.96	98.66	38.33	20.36	19.23	89.2	37.43

Table 4. Estimates of genetic parameters for grain yield, yield components and seed vigour traits in Maize

S. No	Character	Genetic Parameter	Gene effects	Influence of environment
1	Ear height 100-seed weight Cob yield per plant Seed vigour index-1 Seed vigour index-2 Speed of germination Grain yield per plant	High heritability with high GAM	Additive	Low
2	Plant height Cob length	High heritability with moderate GAM	Additive	Low
3	Days to tasseling Days to silking Ear diameter Shelling percentage Germination 1st count Germination 2nd count	Moderate heritability with low GAM	Additive and non-additive	Low
4	Number of rows per ear Number of kernels per row	Moderate heritability with moderate GAM	Additive and non-additive	Medium
5	Days to maturity	Low heritability with low GAM	Non-additive	High

High heritability coupled with low genetic advance was observed for days to 50% tasseling (69.7%, 5.63), days to 50% silking (65.9%, 5.11), ear diameter (63.9%, 8.75), shelling percentage (61.1%, 4.39), germination 1st count (90.5%, 9.80), germination 2nd count (82.4%, 5.57) indicating that they are controlled by the non-additive type of gene action which is influenced by the environment. The traits number of rows per ear and number of kernels per row which showed moderate heritability and moderate genetic advance suggested that these characters are controlled by joint action of genetic and non genetic factors.

High heritability and moderate genetic advance for plant height (60.1%, 15.9) and cob length (70.1%, 14.8) suggested that these traits are highly heritable and selection based on this trait will be effective. Low heritability and genetic advance for days to maturity (22.8%, 1.27) indicated the need for the creation of variability either by hybridization or mutation followed by selection.

The findings of this study are in broad agreement with the findings of [27-31]. The characters that showed high heritability coupled with high genetic advance could be improved through simple selection.

4. CONCLUSION

Based on PCV, GCV, heritability, along with high genetic advance as per cent of mean traits namely ear height, ear length, cob yield per plant, grain yield per plant, SVI-1, SVI-2 and speed of germination) were found to be crucial in the selection process for the improvement of yield on maize.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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