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Variability, Heritability and Genetic advance Studies of Maize (*Zea mays* L.) Genotypes at Satna District of Vindhya Region.

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Abstract:

Twenty six diverse cultivars of maize in a Completely Randomized Block Design (CRBD) at AKS University, Satna, during *Rabi* season on November 2020. The twelve quantitative characters studied, data were collected and estimated for variance, genetic variability, heritability and genetic advance. The design of the experiment indicated highly significant differences for all the characters due to treatments. The analysis of variance of twenty six genotypes of maize and indicated the existence of sufficient amount of variability among genotypes for all the studied characters. PCV was higher than GCV for all the studied characters. The maximum GCV and PCV was observed for cob height and number of kernel per row. High heritability (h^2b) >80% were observed for Day to 50% pollen shedding (98.00%) and Day to maturity (94.50%) suggested that the characters are influenced by the environmental factors in very less amount and also indicates the dependency of phenotypic expression which reflect the genotypic ability of strains to transmit the gene to their progenies. High heritability coupled with high genetic advance was found for characters kernel per cob, cob height and grain yield/plant which indicated that these characters are governed by additive type of gene action.

Keywords: Maize, Variance, variability, heritability and genetic advance

Introduction:

Maize (*Zea mays* L.) belongs to the grass family. It is C4 plant belongs to the tribe Maydeae family, Poaceae (syn. Gramineae), subfamily, Panicoideae, which incorporates the majority of grasses in tropical and sub-tropical regions throughout the sector. Maize is a monoecious and vital cereal crop of the sector after wheat and rice. It is also known as queen of cereals because of its highest genetic yield potential among the cereals. Stebbins and Crampton, (1961) revised this category and put down *Zea* and *Tripsacum* in the Andropogoneae. It have female inflorescence, which turn into an ear (known as cob) nicely covered by means of husk

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leaves. This is the food material storage part of the plant. The plant is terminated with the male inflorescence, (known as the tassel). It is cultivated in nearly 201 m ha with a production of 1162 m tonnes and productivity of 5754.7 kg/ha all over the world, having wider diversity of soil, climate, biodiversity and management practices FAOSTAT, (2020).

Maize has been in cultivation for numerous thousand years in Mexico as indicated through unearthed grains and elements of ears pronounced from caves and rock- shelters supported via archeological excavations in New Mexico Berger, (1962). The oldest archaeological remains of maize, excavated inside the valley of Tchuacan in southern Mexico, abruptly regarded inside the archaeological facts around 5000 B.C. Flannery and MacNeish, (1997). Maize is said to be originated in Latin the USA, wherein maximum genetic diversity in Zea and their wild family exist Hallauer and Miranda, (1981).

Improvement of well adapted varieties /hybrids for focused environmental situations with various ecogeographic and environmental conditions is a mission and a persistent activity. Also, the vagaries of weather change/ variability desires to be addressed with suitable breeding methods to add new germplasm for the benefit of goal environments Cairns *et al*., (2012) and to increase extra weather resilient maize structures Cairns *et al*., (2013). The know-how of genetic variability, heritability, genetic advance and relationship between yield and its contributing characters in a given crop species is of paramount significance for the success of any plant breeding programme. Genetic variability is of greatest interest to the plant breeder as it performs a crucial role in framing a success breeding programme.

Material and method

The present investigation was conducted during *Rabi*, 2020-21 at Research farm, Genetics and Plant Breeding, AKS University, Sherganj, Satna, Madhya Pradesh. The material consists 26 varieties/strains of Maize (*Zea mays* L.) germplasm comprising indigenous genotypes, evaluated in Completely Randomized Block Design. The entire experimental field divided in 3 blocks of equal size and each block had 26 plots. Each plot was consisted of three rows 2 meters length, following row to row spacing of 60 cm. and plant to plant spacing of 20 cm. These genotypes exhibiting wide spectrum of variability for various agronomic and morphological characters were collected from different sources of M.P. and Bihar.

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Twelve observations on yield and yield contributing characters were recorded. In each plot, five competitive plants were randomly selected for recording observations for all the twelve quantitative characters, which were recorded on the plot basis.

The analysis of variance for the design of the experiment was carried out according to the procedure outlined by Panse and Sukhatme, (1967). The genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and environmental coefficient of variation (ECV) was estimated by the formula suggested by Burton and de Vane, (1953). Heritability in broad sense (h^2b) was estimated using the formula suggested by Burton and de Vane, (1953). Genetic advance was calculated by the method suggested by Johnson *et al*., (1955).

Result and discussion

The analysis of variance for the design of the experiment involving 26 maize strains/varieties were evaluated in for the twelve quantitative characters. The design of the experiment (mean sum of squares) indicated highly significant differences for all the characters suggesting the presence of appreciable genetic variability among the experimental material under study. **Table 1**. Thus, there is enough of area and scope for advancement of different polygenic and oligogenic traits through selection. Similar finding of significant variability for various traits in the maize genotypes was also reported by Kumar *et al*., (2015); Kandel *et al*., (2018); and Tesfaye et al. (2021). Also similar results were reported by Asins, (2002).

The variances accomplished at genotypic, phenotypic and environmental levels of twelve characters are presented in **Table 1** The greatest magnitude genotypic variance were obtained for kernel per cob (3498.83), followed by plant height (401.11), grain yield/plant (283.30) and Cob Height (243.97) as compared to other traits. The lowest genotypic variance was obtained for cob diameter (0.65). Similar results for these variances were observed by Mohammadia *et al*., (2003); Viola *et al*., (2003); Naushad *et al*., (2007) and Najeeb *et al*., (2009) in their respective studies.

The mean performance, grand means, range, GCV, and PCV of 20 genotypes of maize for 12 quantitative characters are presented in **Table 2 and Table 3.** The magnitude of phenotypic coefficients of variation (PCV) was slightly higher than corresponding genotypic coefficients of variation for all the parameters due to the environmental influence. The magnitude of GCV ranged from no of kernel per row (15.55) to days to 50% silking (2.57). The

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magnitude of PCV ranged from cob height (16.63) to days to 50% silking (3.03). The high GCV and PCV were recorded for cob height and number of kernel per row. The values were also appreciably high for length of flag leaf, number of kernel per cob and grain yield/plant. This is an indicative of less amenability of these characters to environmental fluctuations and hence, greater emphasis should be given to these traits. The traits with high environmental coefficient of variation (ECV) indicated more influence of environmental factors. Therefore, caution has to be exercised during the selection programme because the environmental variations are unpredictable in nature and may mislead the results. Earlier researchers also observed high amount of PCV and GCV values Gangashetti *et al*., (2000); Vasic *et al*., (2001); Satyanarayan *et al*., (2003); Omprakash *et al*., (2006); Bello *et. al*., (2012); Kumar *et al*., (2014); Mohan and Dhirendra, (2014); Sharma *et al*., (2014) and Tesfaye *et al*., (2021) in their respective studies.

Heritability estimates are used to predict expected advance under selection so that breeders are able to anticipate improvement from different of selection intensity. Burton and De Vane (1953) suggested that the GCV along with heritability estimate could provide better picture of the genetic advance to be expected by phenotypic selection. Heritability h^2 (Broad Sense), h^2 (Broad Sense)%, Genetic Advancement @ 5%, Genetic Advancement @1%, Genetic Advance as % of Mean 5%, Genetic Advance as % of Mean 1%, and Variation was estimated for all the characters and has been presented in **Table: 4.**

Among the characters studied, Length of flag leaf had the highest heritability (>80%) estimates (98.10%) while Seed Index (gm.) showed the lowest heritability estimates (66.40%). The high heritability estimates were also observed for Day to 50% pollen shedding (98.00%) and Day to maturity (94.50%) suggested that the characters are influenced by the environmental factors in very less amount and also indicates the dependency of phenotypic expression which reflect the genotypic ability of strains to transmit the gene to their progenies. These results are accordance to higher heritability estimates were reported by Mani and Bisht (1996); Gangashetti *et al.* (2000); Saleh *et al.* (2002); Muhammad *et al.* (2006); Omprakash *et al.* (2006); Najeeb *et al.* (2009); which supports the present findings.

Genetic advance is a measure of genetic gain under selection which depends upon main factors viz., genetic variability, heritability, and selection index Allard RW, (1960). The expected

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genetic advance in percent of mean ranged from 113.58% at 5% and 145.56% at 1% for kernel per cob to 1.49% at 5% and 1.91% at 1% for cob diameter. High estimate of expected genetic advance were found for kernel per cob (113.58%) followed by plant height (34.10%), grain yield/plant (31.04%) and cob height (30.01%). High heritability and high genetic advance were found for characters kernel per cob, cob height and grain yield/plant which indicated that these characters are governed by additive type of gene action. So improvement can be possible by visual selection of these characters. These results are accordance to higher heritability estimates were reported by Johnson *et al.* (1955); Hallauer and Scobs (1973); Sleeper & Poehlmal (2006); Pavan *et al.* (2011); Maruthi & Rani (2015) and Tesfaye et al. (2021) which supports the present findings.

Conclusion

In the light of above findings it may be concluded that wide spectrum of exploitable variability in the material studied with respect to seed yield per plant and its component characters. As per mean performance the maximum yield was recorded by varieties/genotypes viz., Gagan, Laxmi 333, Pioneer P3522, Harita-VMH 150. The maximum GCV and PCV was observed viz., cob height, number of kernel per row, length of flag leaf, number of kernel per cob and grain yield/plant. Higher estimates (h^2b) >80% were observed for day to 50% pollen shedding and day to maturity. High heritability coupled with high genetic advance observed for kernel per cob, cob height and grain yield/plant indicating that these characters could be prominently governed by additive gene action. So the selection of these traits could be more effective for desired genetic improvement and will help in improving the seed yield in maize.

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Table 1 Analysis of variance, Genotypic, phenotypic and environmental variances among 12 characters of maize

Characters	Replication df.-2	Treatments df.-25	Error df.-50	Genotypic variances	Phenotypic variances	Environmental variances
Day to 50% pollen shedding	2.176	81.211**	1.636	26.53	27.07	0.55
Days to 50% silking	367.258	22.672**	6.398	5.42	7.56	2.13
Length of flag leaf	0.389	206.274**	3.868	67.47	68.76	1.29
Day to maturity	14.432	156.237**	8.609	49.21	52.08	2.87
Plant Height	8202.346	1761.324**	557.989	401.11	587.11	186.00
Cob Height	743.108	841.277**	109.369	243.97	280.43	36.46
Cob length	4.435	6.566**	1.063	1.83	2.19	0.36
Cob Diameter	0.402	2.396**	0.453	0.65	0.80	0.15
No. of Kernel per Cob	6762.838	12081.098**	1584.614	3498.83	4027.03	528.21
No of kernel per row	62.401	85.142**	10.267	24.96	28.38	3.42
Seed Index	169.846	27.985**	9.416	6.19	9.33	3.14
Grain Yield/Plant	365.632	1060.315**	210.424	283.30	353.44	70.14

***Significant at 5% probability level.**

****Significant at 1% probability level.**

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Table 2 Mean performance of 12 characters of 26 maize genotypes.

Characters	Ch-1	Ch-2	Ch-3	Ch-4	Ch-5	Ch-6	Ch-7	Ch-8	Ch-9	Ch-10	Ch-11	Ch-12
DKC 7044	62.33	85.53	42.67	106.17	188.93	81.37	15.07	12.83	396.50	37.07	25.10	100.97
DKC 9144	54.00	85.90	48.57	105.50	177.17	90.20	15.50	14.20	434.93	31.30	25.30	104.20
P 3377	53.33	85.67	44.07	108.17	178.30	75.77	15.87	13.67	336.80	29.30	28.03	107.53
PAC 751	68.17	87.93	52.50	92.83	211.90	105.87	15.90	13.17	410.80	31.97	32.40	123.23
MRM 4080W	70.67	90.57	62.70	94.17	189.43	94.23	14.40	13.73	351.93	27.47	26.80	109.40
SX 38	58.33	88.80	40.53	95.67	178.97	77.43	14.63	14.20	357.23	31.67	27.57	112.03
R 4118	62.33	90.87	59.97	96.17	221.67	101.47	13.63	14.00	315.33	22.40	29.07	96.30
DMH 1301	58.33	90.23	62.10	94.50	227.83	119.93	16.20	14.17	432.33	31.70	29.00	139.83
R 4794	57.83	88.60	65.40	108.83	241.60	112.37	16.20	14.80	415.77	33.90	31.03	129.63
MOTI SUPER	62.17	90.73	44.17	113.17	234.93	126.40	16.53	15.07	495.30	35.87	26.37	139.93
REAL NANO	62.17	89.70	46.30	116.83	234.13	112.00	15.33	15.70	415.47	31.20	30.47	134.63
LAXMI 108	71.50	91.50	55.97	110.67	214.30	95.30	17.60	14.57	471.87	33.80	27.97	138.60
REAL SUMO	58.50	90.43	53.67	117.17	212.80	96.70	15.50	14.70	375.07	28.30	27.13	111.40
POP CORN	61.83	90.90	61.40	100.17	235.40	105.90	16.87	16.27	384.53	32.70	33.47	140.20
LAXMI 333	62.50	90.10	62.70	98.17	210.33	92.60	18.30	15.23	455.50	34.43	37.07	159.90
GAGAN	68.83	91.13	47.10	102.67	213.30	117.40	19.23	15.93	552.90	45.60	29.87	160.53
RASHI 4118	60.50	96.57	42.20	101.17	185.27	64.53	15.73	14.37	290.30	22.53	28.37	95.33
KARANTI	61.50	94.90	56.83	94.17	221.87	114.87	18.07	14.63	424.13	31.40	33.77	137.60
HARITA-VMH 150	71.83	91.57	51.07	108.83	221.90	104.23	17.27	15.83	440.77	32.67	34.13	141.93
HARITA-VMH 152	65.67	93.43	46.30	109.83	233.30	99.23	17.13	15.67	422.97	30.53	29.33	128.50
LAXMI 999	67.17	94.43	40.23	98.17	227.63	84.17	13.40	14.63	316.73	26.50	28.13	99.93
K 25	64.50	94.47	62.90	103.33	246.90	107.53	14.37	15.27	396.20	29.97	27.73	112.07
LG 802	64.33	90.50	52.80	99.17	248.63	127.20	15.50	15.53	535.23	40.33	26.77	133.43
PIONEER P3522	59.50	93.00	56.60	96.83	244.10	126.67	18.57	15.80	447.13	43.30	34.27	145.23
LAXMI GOLD	69.00	92.13	60.53	110.00	265.43	81.87	16.07	13.93	449.30	30.60	27.53	129.37
HARITA VMH 55	70.50	90.67	64.70	103.17	240.30	103.70	16.63	14.17	434.80	28.83	29.50	128.83

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Ch-1= Day to 50% pollen shedding, Ch-2= Days to 50% silking, Ch-3= Length of flag leaf, Ch-4= Day to maturity, Ch-5= Plant Height, Ch-6= Cob Height, Ch-7= Cob length, Ch-8= Cob Diameter, Ch-9= No. of Kernel per Cob, Ch-10= No of kernel per row, Ch-11= Seed Index, Ch-12= Grain Yield/Plant

Table 3 Mean, Range, Genotypic, Phenotypic and environmental variances, and coefficient of variation for 12 quantitative characters in maize.

S.N.	Characters	Grand mean	Range		GCV	PCV	ECV	C.V. @ 1%	C.V. @ 5%
			Min.	Max.					
1	Day to 50% pollen shedding	63.36	53.33	71.83	8.13	8.21	2.02	2.80	2.10
2	Days to 50% silking	90.78	85.53	96.57	2.57	3.03	2.79	5.53	4.15
3	Length of flag leaf	53.23	40.23	65.40	15.43	15.58	3.70	4.30	3.23
4	Day to maturity	103.29	92.83	117.17	6.79	6.99	2.84	6.42	4.81
5	Plant Height	219.47	177.17	265.43	9.13	11.04	10.76	51.65	38.74
6	Cob Height	100.73	64.53	127.20	15.51	16.63	10.38	22.87	17.15
7	Cob length	16.13	13.40	19.23	8.39	9.17	6.39	2.26	1.69
8	Cob Diameter	14.69	12.83	16.27	5.48	6.08	4.58	1.47	1.10
9	No. of Kernel per Cob	413.84	290.30	552.90	14.29	15.33	9.62	87.03	65.28
10	No of kernel per row	32.13	22.40	45.60	15.55	16.58	9.97	7.01	5.25
11	Seed Index	29.47	25.10	37.07	8.44	10.37	10.41	6.71	5.03
12	Grain Yield/Plant	125.41	95.33	160.53	13.42	14.99	11.57	31.72	23.79

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Table 4 Heritability (%) in broad sense, Genetic advance and genetic advance as percent of mean (5%) for 12 quantitative characters in maize.

S.N.	Characters	Heritability (h^2b)	Heritability (h^2b %)	Genetic Advancement 5%	Genetic Advancement 1%	Gen. Adv. as % of Mean 5%	Gen. Adv. as % of Mean 1%
1	Day to 50% pollen shedding	0.980	98.00	10.50	13.46	16.58	21.24
2	Days to 50% silking	0.718	71.80	4.07	5.21	4.48	5.74
3	Length of flag leaf	0.981	98.10	16.76	21.48	31.49	40.35
4	Day to maturity	0.945	94.50	14.05	18.00	13.60	17.43
5	Plant Height	0.683	68.30	34.10	43.70	15.54	19.91
6	Cob Height	0.870	87.00	30.01	38.46	29.80	38.18
7	Cob length	0.838	83.80	2.55	3.27	15.83	20.29
8	Cob Diameter	0.811	81.10	1.49	1.91	10.16	13.02
9	Kernel per Cob	0.869	86.90	113.58	145.56	27.45	35.17
10	No of kernel per row	0.879	87.90	9.65	12.37	30.04	38.50
11	Seed Index	0.664	66.40	4.18	5.35	14.17	18.16
12	Grain Yield/Plant	0.802	80.20	31.04	39.78	24.75	31.72

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