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Genetic variability for grain yield and its component in maize (*Zea mays* L.) Inbred lines

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Abstract
In the present investigation, study of genetic variability for grain yield & its component in maize was carried out based on 15 traits during the *rabi-summer* 2021-2022 at the Farm of Raj Mohini Devi College of Agriculture & Research Station, Ambikapur. The material used under the research comprises of 14 maize inbred line (9 lines and 5 testers). During the *kharif* 2021, 45 crosses were made by adopting crossing design 'Line x Tester' & in the *Rabi* 2022, these 45 crosses along with the parents (14) and 3 commercial checks *viz*. NK 30, CGASM 1 & COH (M) 8 were planted in RBD with 3 replication each, with 3 rows of each having row length of 4m and the plant to plant and row to row distance was 20 cm & 60 cm respectively. Analysis of Variance (ANOVA) revealed that except for ear diameter, MSS of all the genotype was highly significant @ 1% level which showed that the genotypes differ significantly for specific traits under observation. GCV & PCV of high magnitude was found for 2 traits *viz*., grain yield (23.30% & 26.73%) & ear weight without husk (21.93% & 25.15%). GCV & PCV of moderate magnitude was recorded for plant population (11.73% & 15.33%) & no. of cobs (11.12% & 15.15%). High heritability with high GA was found for the characters *viz*. ear weight without husk (76.08%) having GA 39.42, grain yield (75.98%) with GA 41.85 & high heritability was found for days to 50% tasseling (86.30%) and days to 50% silking (85.04%) with low GA of 8.21 & 7.86 respectively, whereas the characters including days to 80% maturity (71.17%) having GA of 4.71, ear height (62.09%) with GA 14.62, ear length (70.79%) with GA 19.00, plant height (71.47%) with GA 17.18,, no. of kernels/row (63.33%) with GA 15.38 showed high heritability. The present study implicate that the genotypes tested, possess considerable amount of variability and can be manipulated for further breeding program.

Keywords: Line x tester, maize, genetic variability, GCV, PCV, heritability & genetic advance

Introduction

Maize (*Zea mays* L.) is an important cereal crop which belongs to the Poaceae family and is believed to be originated in Southern Mexico or Northern Guatemala (Weather wax, 1955) [9]. from teosinte (*Zea mays* L. spp. Mexicana) about 7000-10000 years ago. It is also called Queen of cereals or Miracle crop because of the high potential of productivity it possesses as when compared to other cereals of the Poaceae family. Maize occupies an important place as a source of human food (25%), animal feed (12%), poultry feed (49%), industrial products mainly as starch (12%) and 1% each in beverages and seed (Sinha S.K. *et al*., 2019) [4]. The genetic variability present in maize makes it able to survive in broad environmental and climatic conditions of tropical, subtropical, and temperate climates. Maize due to its wider adaptability is grown from sea level to up to 3000 m above mean sea level. It is cultivated on 188 million ha area in more than 170 countries across the globe with 1423 million MT of production (ICAR-IIMR, 2022). China possesses highest area under maize followed by USA, both of them together represents 39% of world maize area. Since 2005, India ranks 4th in terms of area (9.89 million ha) under maize and currently ranks 6th in terms of production with annual output of 31.65 million MT. Currently India has a productivity of about 3.19 t/ha, which is slightly more than the half of world's average (5.6 t/ha) (ICAR-IIMR, 2022).

Currently peninsular India represents over 40% of maize area and 50% of total maize production. Simultaneously Rabi or winter maize has also made significant impact in nontraditional belts like coastal Andhra Pradesh, Bihar, Telangana, West Bengal and others. Karnataka (1.3 million ha), Madhya Pradesh (1.3 million ha), Maharashtra (1.0 million ha), Telangana and Andhra Pradesh (0.9 million ha), Rajasthan (0.8 million ha) are the principal maize growing states of the country (ICAR-IIMR, 2022).

In Chhattisgarh maize occupies 130.44 thousand hectare land with the production of 406.84 thousand metric ton and productivity of 3119 Kg/ha in *Kharif* 2019 (Dept. of Statistics- C.G. Govt., 2019). In Chhattisgarh maize is grown as a *kharif* crop and is designated second place in terms of both area and production. However, there is a low productivity of maize in the state when compared to All India and states like Tamil Nadu, Andhra Pradesh, Karnataka, Bihar etc. but there is huge possibility to increase this.

With the increasing population the burden of providing food is also increasing in proportionate manner and this could be tackled by developing new potential hybrids which need to be climate resilient too. In keeping view of the above situation, crop improvement programme is also running along with the production and technology to meet up the need and demand of the population. In crop improvement programme, elite parents are identified and used to develop new hybrids by using suitable mating design (Tesfaye *et al.,* 2019) [7]. For the selection of desirable lines or parents, knowledge of genetic variability, heritability and genetic advance are the most beneficent tools for breeder (Bello *et al.,* 2012) [1].

In the field of breeding there are several techniques available to evaluate best line and develop a new hybrid. Among all the methods, Line x Tester method given by Kempthorne (1957) [11] was used in conducting the experiment. A line x tester mating involves crossing no. of lines to a common parent (tester). The tester is used as a male parent and the lines which are to be evaluated are either male-sterile or self-incompatible, or are emasculated before the pollen are shed to prevent selfing.

The design has already been used by several workers in maize and is applied in study of quantitative genetics in maize (Dinesh *et al.,* 2019; Sinha *et al*., 2019 etc.) [4].

Material and Methods

The present study was conducted at Research farm of RMD College of Agriculture and Research Station, Ajirma, Ambikapur (Chhattisgarh) under the Section of Genetics and Plant Breeding during *Rabi*-Summer 2021-22, 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). The experimental material utilized in the research work comprised of 9 maize inbred lines (female), 5 tester (male) & their 45 crosses and 3 standard checks *viz.,* NK-30, COH(M) 8 and CGASM1. Details of these parents are present in table – 1. During *Kharif* 2021 and a total of 45 crosses were made by adopting Line x Tester method. These crosses were later sown in Randomized Block Design with 3 replications. Each genotype was sown as 3 rows of 4 m length with row-to-row and plant-to-plant distance of 60 cm and 20 cm respectively. The observation was recorded for 15 characters *viz.,* plant population (lakh/ha), days to 50% tasseling, days to 50% silking, days to 80% maturity, ear height (cm), ear length (cm), ear diameter (cm), plant height (cm), ear weight without husk (kg), number of cobs (lakh/ha), number of kernel rows/cob, number of kernels/row, 100 grain weight (g), shelling%, grain yield (t/ha) on the basis of whole plot and / or 5 randomly selected plants from each genotype in each replication. Data was statistically analyzed using ANOVA appropriate for RBD.

Result and Discussion

The calculation of mean, range, genotypic coefficient of variation (GCV) phenotypic coefficient of variation (PCV) and, heritability (h^2) in broad sense and genetic advance as per cent of mean for all the selected 15 characters has been summarized in table - 3 and depicted in form of graphical representation in fig-1 & discussed below:

Genetic variability

GCV (genotypic coefficient of variation) & PCV (phenotypic coefficient of variation) was estimated for all the selected traits under the experiment and classified as low, moderate and high based on the value range as given by Siva Subramanian & Menon (1973) [12].

High GCV & PCV was found for 2 trait *viz.,* grain yield (23.30% & 26.73%) & ear weight without husk (21.93% & 25.15%) which showed that selection response for these traits were higher. GCV & PCV of moderate magnitude was recorded for plant population (11.73%&15.33%) & no. of cobs (11.12% & 15.15%), whereas other characters exhibited low PCV & GCV including days to 50% tasseling (4.29% & 4.62%), days to 50% silking (4.14%&4.49%), days to 80% maturity height (2.71% & 3.21%), ear height (9.01% & 11.43%), ear length (5.22% & 9.67%), ear diameter (6.01% & 10.12%), plant height (9.86% & 11.67%), no. of kernel rows/cob (7.79% & 10.62%), no. of kernels/row (9.38% & 11.78%), 100 grain weight (8.88%&11.39%), shelling percentage (1.46% & 2.03%).

High variability of character is shown by the high estimate of GCV & PCV. High PCV & GCV value indicate the character is economically important and there is a scope for further improvement of it in future via selection. Higher PCV and GCV for grain yield per plant were previously reported by Yusuf (2010) [10] and Sumathi *et al*., (2005) [6].

Heritability & Genetic advance

Heritability and GA was recorded for all the 15 characters and it was found that the characters *viz.* days to 50% tasseling (86.30%) and days to 50% silking (85.04%) had very high heritability with GA of 8.21 & 7.86 respectively, whereas the characters including days to 80% maturity (71.17%) had GA of 4.71, ear height (62.09%) with GA 14.62, ear length (70.79%) with GA 19.00, plant height (71.47%) with GA 17.18, ear weight without husk (76.08%) having GA 39.42, no. of kernels/row (63.33%) with GA 15.38 & grain yield (75.98%) with GA 41.85 showed high heritability on the other hand characters *viz.* number of cobs (53.85%) with GA 16.81, number of kernel rows/cob (54.10) with GA 11.81, 100 grain weight (60.72%) with GA 14.25, shelling% (51.40%) with GA 2.15 presented a medium level of heritability. However, traits like plant population (58.51%) with GA 18.47 & ear diameter (35.28%) with GA 7.35 exhibited low heritability.

Traits with high heritability and GA (genetic advance) indicate that the heritability is most likely because of the additive gene effect and selection would be effective, on the other hand if the heritability is high and GA is low it indicates the non-additive gene action and favorable influence of environment rather than genotype and due to this reason, such traits may not be effective.

Traits with low heritability and high GA (genetic advance) indicate the additive gene action and selection would be rewarding while traits with low heritability and low GA shows high influence of environment and ineffective selection.

When the recording was interpreted it was found that the trait grain yield & ear weight without husk was having high GA and high heritability which indicate the additive gene action and selection based on this trait would be rewarding for further breeding program. Similar results were found in the earlier experiments also, done by various investigators including Devi *et al.*, (2001) [2], Sofi & Rather *et al.*, (2007) [5], Rafiq *et al.*, (2010) [3] & Wannows *et al.*, (2010) [8].

Table 1: Selected Parents for the program

S.N.	Parents	Line/tester	Source
1	AMI-2021-101	LINE	Monsanto India Ltd.
2	AMI-2021-106-1	LINE	J.K Seeds
3	AMI-2021-111-1	LINE	ANGRU, Hyderabad
4	AMI-2021-112-3	LINE	Sheena Seeds Pvt. Ltd.
5	AMI-2021-113-1	LINE	Monsanto India Ltd.
6	AMI-2021-115-1	LINE	Bisco Bioscience Pvt. Ltd.
7	AMI-2021-118-2	LINE	ANGRU, Hyderabad
8	AMI-2021-121-2	LINE	Advanta Pvt. Ltd.
9	AMI-2021-123-2	LINE	Monsanto India Ltd.
10	LM13	TESTER	PAU, Ludhiana
11	LM14	TESTER	PAU, Ludhiana
12	CML 451	TESTER	SKUAST, Kashmir
13	BML 6	TESTER	WNC, Hyderabad
14	HKI 163	TESTER	TCA, Dholi
15	NK 30	CHECK	Syngenta India Pvt. Ltd.
16	CGASM 1	CHECK	RMD CARS, Ambikapur
17	COH(M) 8	CHECK	TNAU, Coimbatore

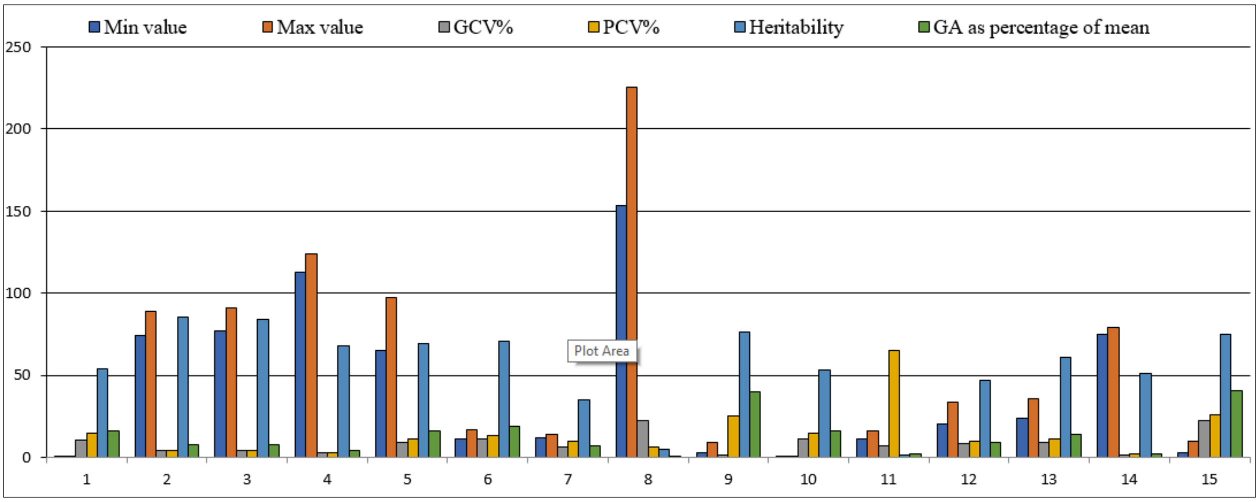
Table 2: Analysis of variance for grain yield and its component in maize

S.N	Characters	Mean sum of squares		
		Replication	Genotypes	Error
	Degree of freedom (df)	2	61	122
1	Final Plant Population (lakh/ha)	0.002	0.023**	0.005
2	Days to 50% Tasseling	0.33	35.32**	1.85
3	Days to 50% Silking	0.19	34.99**	2.04
4	Days to 80% Maturity	0.04	31.56**	4.26
5	Ear height (cm)	131.63	324.41**	39.23
6	Ear length (cm)	1.88	3.54**	1.34
7	Ear diameter (cm)	1.33	0.83	0.72
8	Plant height (cm)	50.08	1269.02**	162.13
9	Ear weight without husk (kg)	1.05	9.4**	0.88
10	No. of Cobs (lakh/ha)	0.004	0.021**	0.005
11	No. of kernel rows/cob	0.09	3.96**	1.09
12	No. of kernels/row	2.16	26.73**	4.74
13	100 grain weight (g)	438.73	435.79**	415.26
14	Shelling%	2.94	5.04**	1.21
15	Grain Yield (t/ha)	0.306	5.507**	0.547

*Differ significantly at 1 percent level of probability.

Table 3: Genotypic and phenotypic coefficient of variance (GCV and PCV), heritability (h^2) and genetic advance as a percentage of mean for different characters in maize.

S.N	Characters	Mean	Range	GCV%	PCV%	Heritability% (h^2)	GA as percentage of mean
1	Plant Population (lakh/ha)	0.71	0.51 - 0.78	11.73	15.33	58.51	18.47
2	Days to 50% Tasseling	79.58	74 - 89	4.29	4.62	86.30	8.21
3	Days to 50% Silking	82.34	77 - 91	4.14	4.49	85.04	7.86
4	Days to 80% Maturity	119.47	113 - 124	2.71	3.21	71.17	4.71
5	Ear height (cm)	204.31	65 - 97.3	9.01	11.43	62.09	14.62
6	Ear length (cm)	88.96	11.5 - 16.6	5.22	9.67	70.79	19.00
7	Ear diameter (cm)	14.25	12.1 - 14.1	6.01	10.12	35.28	7.35
8	Plant height (cm)	13.32	153.1 - 225.7	9.86	11.67	71.47	17.18
9	Ear weight without husk (kg)	7.61	2.723 - 9.050	21.93	25.15	76.08	39.42
10	No. of Cobs (lakh/ha)	0.68	0.48 - 0.75	11.12	15.15	53.85	16.81
11	No. of kernel rows/cob	31.64	11.5 - 16.3	7.79	10.62	54.10	11.81
12	No. of kernels/row	14.56	20.2 - 33.9	9.38	11.78	63.33	15.38
13	100 grain weight (g)	30.50	23.5 - 35.5	8.88	11.39	60.72	14.25
14	Shelling%	77.67	75.1 - 79.5	1.46	2.03	51.40	2.15
15	Grain Yield (t/ha)	5.65	2.758 - 9.493	23.30	26.73	75.98	41.85



***Notation 1:** Plant Population (lakh/ha), 2- Days to 50% Tasseling, 3- Days to 50% Silking, 4- Days to 80% Maturity, 5- Ear height (cm), 6- Ear length (cm), 7- Ear diameter (cm), 8- Plant height (cm), 9- Ear weight without husk (kg), 10- No. of Cobs (lakh/ha), 11- No. of kernel rows/cob, 12- No. of kernels/row, 13- 100 grain weight (g), 14- Shelling%, 15-Grain Yield (t/ha)

Fig 1: Genotypic and phenotypic coefficient of variance (GCV and PCV), heritability (h^2) and genetic advance as a percentage of mean for different characters in maize

Conclusion

It was found that the genotype tested under the research work possess considerable amount of variability which can be depicted from ANOVA (table-2). Among all the traits GCV & PCV was highest for Grain yield & Ear weight without husk. Heritability was found highest for Days to 50% tasseling & Days to 50% silking where the GA was recorded to be 8.21% & 7.86% respectively. Therefore these lines could be further used for breeding program for the mentioned above traits as and when required.

Authors' contribution

Conceptualization of research (SKS); Contribution of experimental materials (SKS); Execution of field/lab experiments and data collection (SKG, RG, JS); Preparation of manuscript (SKS, SKG); Analysis of data and interpretation (SKG)

Declaration: The authors declare no conflict of interest.

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