www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(1): 1887-1890

www.thepharmajournal.com
Received: 07-11-2022
Accepted: 08-12-2022

Krupa Ninama
Department of Genetics and Plant Breeding, C P College of Agriculture, S D Agricultural University, Sardarkrushinagar, Gujarat, India

Ramesh Patel
Maize Research Station, S D Agricultural University, Bhiloda, Gujarat, India

Nishit Soni
Department of Genetics and Plant Breeding, C P College of Agriculture, S D Agricultural University, Sardarkrushinagar, Gujarat, India

Ketan Prajapati
Agricultura Research Stations D Agricultural University, Ladol, Gujarat, India

Dhaval Chaudhari
Department of Genetics and Plant Breeding, C P College of Agriculture, S D Agricultural University, Sardarkrushinagar, Gujarat, India

Corresponding Author:
Krupa Ninama
Department of Genetics and Plant Breeding, C P College of Agriculture, S D Agricultural University, Sardarkrushinagar, Gujarat, India

Evaluation of bio-fortified maize genotypes (*zea mays* l.) for variability, heritability and genetic advance

Krupa Ninama, Ramesh Patel, Nishit Soni, Ketan Prajapati and Dhaval Chaudhari

Abstract
The present investigation was carried out to assess the variability, heritability and genetic advance in thirty-five biofortified maize genotypes for seventeen yield and its contributing traits. The analysis of variance revealed the presence of significant variability among the maize genotypes under study. Among all the characters under study, anthesis silking interval exhibited highest PCV (21.45) and GCV (28.77), whereas lowest PCV (2.74) for cob girth and GCV (3.67) were recorded for days to tasselling. Iron content, β-carotene content, zinc content, kernel yield per plant and cob yield per plant expressed high heritability coupled with high genetic advance, which indicated the preponderance of additive gene action in controlling the traits. Hence direct selection of such characters would be effective in improving the yield. Emphasis should be given on these characters, while selection to improve yield potential of crop.

Keywords: Genetic advance, heritability, genotypic coefficient of variation, phenotypic coefficient

Introduction
Deficiencies of vitamin A, iron, and zinc are widespread in world, where the diets are mainly plant-based, and the intakes of animal products are low. The overall objective of this investigation was to determine the extent of genetic variation of these micro-nutrients in 35 yellow-seeded improved maize inbred lines. The yellow-seeded improved maize genotypes were analyzed for physical and chemical characteristics and total carotene content; the maize inbred lines were analyzed for iron and zinc content. The results showed statistically significant and large genotypic differences in total carotene content among maize genotypes. The total β-carotene content ranged from 8.90 to 19.92 ppm with mean of 14.88 ppm. Significant genotypic variation was also observed for iron 9.34 to 36.67 ppm with average of 19.14 ppm and zinc concentrations 13.37 to 29.04 ppm with general mean 19.23 ppm in maize inbred lines. A strong and positive relationship was observed between iron and zinc concentrations for maize inbred lines. The potential exists for improving β-carotene, iron, and zinc contents in maize genotypes through plant-breeding.
Maize *(Zea mays* L.) is one of the important cereal crops and occupies a prominent position in global agriculture after wheat and rice. Maize has diversified uses as food and industrial raw materials. Maize acreage and production have an increasing tendency with the introduction of hybrids due to its high yield potential. It possesses one of the most well studied genetic systems among cereals which have motivated a rich history of research into the genetics of various traits in maize**.** It offers tremendous scope for the plant breeders for genetic improvement. The success of plant breeding depends on the extent of genetic variability present in a crop. Knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for genetic improvement. A critical analysis of genetic variability present in the germplasm of a crop and its estimation is a pre-requisite for initiating any crop improvement programme as well as adopting appropriate selection techniques.

Material and Methods
Total 35 bio-fortified maize genotypes were evaluated in randomized block design with three replications at Maize Research Station, S.D. Agricultural University, Bhiloda (Arvalli) Gujarat, during *Kharif*, 2021. Each entry was raised in single row of four meters length with a spacing of 60 cm between rows and 20 cm between plants.

The recommended package of practices was followed to raise a good crop. Observations for the characters namely days to tasseling, days to silking and days to maturity were recorded on plot basis. Whereas observation was recorded on five randomly tagged plants for plant height, primary ear height, cob length, cob girth, number of kernel rows per cob, number of kernels per row, 100-kernel weight and kernel yield per plant. The data collected on all the characters were subjected to standard methods of analysis of variance (Panse and Sukhatme, 1978) [10]. Phenotypic and genotypic coefficient of variation was calculated as suggested by (Burton, 1952) [3], Heritability (broad sense) and genetic advance (Allord, 1960) and genetic advance as a percent of mean (Johnson *et al.*, 1955) [7] were also estimated.

Results and Discussion

Genetic variability

Significant differences among the genotypes for all the traits (Table 1), indicating that good amount of genetic variability among the experimental material under study. Thus, there is ample scope of selection for improvement of different quantitative and qualitative traits. The mean values, genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance as per cent of mean (Table 2) thirty-five genotypes were calculated for yield and its contributing traits. Phenotypic coefficient of variation values are slightly higher than the genotypic coefficient of variation values indicating that the environment influence is less on characters under study. Therefore, response to direct selection may be effective in improving these trait.The characters studied in the present investigation exhibited Low (less than 10 %), moderate (10-20 %) and high (more than 20 %) phenotypic and genotypic coefficients of variation indicating in the characters under study. The iron content and anthesis silking interval exhibited high phenotypic (43.97) , genotypic (44.54) and phenotypic (21.45) , genotypic (28.77) coefficients of variation respectively. Chakraborti *et al.* (2009) and Agrahari (2018).

β-carotene content (19.74/20.99), kernel yield per plant (19.63/23.40), cob yield per plant (18.80/22.54), zinc content (18.09/19.22) and primary ear height (10.63/13.05) had moderate phenotypic and genotypic coefficients variations. Similar results were obtained by Soni *et al*. (2017) for the β-carotene content, Similar results was obtained by Kumar *et al*. (2011), Rajesh *et al*. (2013) [11], Kumar *et al*. (2014) [8], Bhiusal *et al*. (2017), Beulah *et al*. (2018) and Verma *et al*. (2020) for kernel yield per plant. Similar results founded by Bhiusal *et al*. (2017) for cob yield per plant. Similar results obtained by Jaiswal *et al*. (2019) for zinc content. Chakraborti *et al*. (2009), Kumar *et al*. (2011), Rajesh *et al*. (2013) [11], Kumar *et al*. (2014) [8], Bhiusal *et al*. (2017), Beulah *et al*. (2018), and Taiwo *et al*. (2020) reported similar result for primary ear height.

Phenotypic and genotypic coefficients of variation were low for cob length (5.46/9.64), kernel rows per cob (3.60/7.22), days to maturity (3.57/3.87), days to silking (3.41/4.03), shelling per cent (3.32/6.74), days to tasseling (3.05/3.67), and cob girth (2.74/5.56). These results were in accordance with the findings of Kumar *et al.*, (2014) [8]. While three traits namely kernel rows per cob (7.87/11.76), 100 kernel weight (7.77/11.07) and plant height (7.67/10.29) expressed low PCV values coupled with moderate GCV values indicating low influence of environment on these characters.

Heritability and genetic advance

Out of seventeen characters, nine characters *viz*., iron content (97.46 %), zinc content (88.56 %), carotene content (88.34%), days to maturity (85.41 %), days to silking (71.39 %), kernel yield per plant (70.33 %), cob yield per plant (69.56 %),days to tasseling(69.12 %) and primary ear height (66.34 %) expressed high estimates of heritability in broad sense. Selection would be effective for genetic improvement of these characters due to high heritability, which revealed that these characters are less influenced by environment and there could be greater correspondence between phenotypic and breeding values. Similar results were reported by Rajesh *et al.*, (2013) [11].100-kernel weight (49.22 %), kernels per row (44.81 %) and con length (32.04 %) had moderate heritability, whereas cob girth (24.27 %), shelling per cent (24.29 %) and kernels row per cob (24.86 %) recorded low heritability. Genetic advance as a per cent of mean is classified as low (less than 10 %), moderate (10-20 %) and high (more than 20 %). Among the characters under study, cob girth (2.78 %),shelling percent (3.37 %), kernel rows per cob (3.69 %), days to tasseling (5.22 %),days to silking(5.93 %),cob length (6.36 %)and days to maturity (6.80 %) exhibited low genetic advance as a per cent of mean. These results were in trends with the findings of Kumar *et al.*, (2014) [8]. Primary ear height (17.83 %), plant height (11.77 %) 100 kernel weight (11.22%) and kernels per row (10.85 %) had moderate genetic advance as a per cent of mean. Similar results was obtained by Beulah *et al.*,(2018) for primary ear height and 100 kernel weight. Remaining six traits namely iron content (89.43 %), β-carotene content (38.21 %),zinc content(35.07 %),kernel yield per plant(33.90 %) and anthesis silking interval (32.95 %) exhibited high estimates of genetic advance as a per cent of mean. Bhiusal et al., (2017) reported similar results for anthesis silking interval and kernel yield per plant.

Table 1: Analysis of variance for randomized block design for yield and yield component characters in maize

Characters Source of variation	Replication	Genotypes	Error
def.	**2**	**41**	**82**
Days to tasseling	0.07	6.49**	0.84
Days to silking	0.35	8.82**	1.04
Anthesis silking interval	0.58	0.90**	0.19
Days to maturity	2.92	25.34**	1.37
Plant height	273.34	584.04**	123.04
Primary ear height	71.94	289.80**	41.92
Cob length	4.03	4.81**	1.99
Cob girth	0.17	1.02**	0.52
Kernel rows per cob	0.93	1.42**	0.71
Kernels per row	0.90	17.43**	5.07
100-kernels weight	5.27	17.36**	4.44
Cob yield per plant	218.30	1035.30**	131.80
Shelling percentage	22.67	43.64**	22.23
Iron content	2.77	214.30**	1.85
Zinc content	3.43	37.87**	1.56
β-carotene content	3.19	27.01**	1.14
Kernel yield per plant	160.77	724.96**	89.37

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

Table 2: Estimation of variability, heritability and genetic advance for yield and yield component characters in Maize genotypes

Sr.No.	Character	Range	Phenotypic Variance	Genotypic Variance	PCV (%)	GCV (%)	h^2 (%)	GA	GA as % of Mean
1.	Days to tasseling	42.33-49.00	1.88	2.72	3.05	3.67	69.12	2.35	5.22
2.	Days to silking	43.67-51.67	2.59	3.63	3.41	4.03	71.39	2.80	5.93
3.	Anthesis silking interval	1.00-3.00	0.24	0.43	21.45	28.77	55.60	0.75	32.95
4.	Days to maturity	74.67-84.67	7.99	9.36	3.57	3.87	85.41	5.38	6.80
5.	Plant height	129.00-191.20	153.67	276.71	7.67	10.29	55.53	19.03	11.77
6.	Primary ear height	69.93-113.07	82.63	124.54	10.63	13.05	66.34	15.25	17.83
7.	Cob length	15.20-20.13	0.94	2.93	5.46	9.64	32.04	1.13	6.36
8.	Cob girth	13.13-15.80	0.17	0.69	2.74	5.56	24.27	0.41	2.78
9.	Kernel rows per cob	12.13-14.67	0.24	0.95	3.60	7.22	24.86	0.50	3.69
10.	Kernels per row	20.07-31.13	4.12	9.19	7.87	11.76	44.81	2.80	10.85
11.	100-kernels weight	22.67-31.67	4.31	8.75	7.77	11.07	49.22	3.00	11.22
12.	Cob yield per plant	45.87-132.40	301.17	432.97	18.80	22.54	69.56	29.82	32.30
13	Shelling percentage	68.88-87.67	7.13	29.37	3.32	6.74	24.29	2.71	3.37
14	Iron content	9.34-36.67	70.82	72.66	43.97	44.54	97.46	17.11	89.43
15	Zinc content	13.37-29.04	12.10	13.66	18.09	19.22	88.56	6.74	35.07
16	β-carotene content	8.90-19.92	8.62	9.76	19.74	20.99	88.34	5.69	38.21
17	Kernel yield per plant	34.87-111.67	211.86	301.23	19.63	23.40	70.33	25.15	33.90

Min-Minimum; Max-Maximum; PCV-Phenotypic Coefficient of variation; GCV-Genotypic coefficient of variation; h^2-Heritability in broad sense; GA-Genetic Advance

Among all the characters studied, days to tasseling, days to silking and days to maturity exhibited high heritability coupled with low genetic advance as a per cent of mean, these indicates that the expression of the trait is under the control of non-additive type of gene action, and its response to selection would be poor. In such case hybridization programmed is rewarded.

Primary ear height and plant height expressed high heritability coupled with moderate genetic advance as a per cent of mean. This suggested that the expression of this trait was mostly influenced by additive type of gene action.

Iron content, β-carotene content, zinc content, kernel yield per plant and cob yield per plant expressed high heritability coupled with high genetic advance, which indicated the preponderance of additive gene action in controlling the traits. These results were in accordance with the findings of Rajesh *et al.*, (2013). Moderate heritability coupled with moderate genetic advance values were reported for kernels per row, 100-kernel weight and plant height, while cob girth, shelling per cent and kernel rows per cob exhibited low heritability coupled with low genetic advance.

A perusal of genetic parameters *viz.*, phenotypic and genotypic coefficients of variation revealed less influence of environment on the characters under study. Therefore, response to direct selection may be effective in improving these traits.

Iron content, β-carotene content, zinc content, kernel yield per plant and cob yield per plant expressed high heritability coupled with high genetic advance, which indicated the preponderance of additive gene action in controlling the traits. Hence direct selection of such characters would be effective in improving the yield.

Primary ear height and plant height expressed high heritability coupled with moderate genetic advance as a per cent of mean. This suggested that the expression of this trait was mostly influenced by additive type of gene action. Hence its response to selection would be effective in improving the yield.

While days to maturity exhibited high heritability coupled with low genetic advance as a per cent of mean, indicates that the expression of the trait is under the control of non-additive type of gene action and its response to selection would be poor.

References

1. Akbar M, Shakoor S, Hussain A, Sarwar M. Evaluation of maize 3-way crosses through genetic variability, broad sense heritability, character association and path analysis. Journal of Agricultural Research. 2008;46(1):39-45.
2. Alake CO, Ojo DK, Oduwaye OA, Adekoya MA. Genetic variability and correlation studies in yield and yield related characters of tropical maize (*Zea mays* L.) Agricultural & Environment. 2008;8(1/2):14-27.
3. Burton GW. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress. 1952;1:277-283.
4. Choudhary AK, Chaudhary LB. Genetic studies in some crosses of maize (*Zea mays* L.). Journal of Research Birsa Agricultural University. 2002;5(1/2):10-16.
5. Falconer DS. Introduction to Quantitative Genetics. Oliver and Boyd, London. 1981;340.
6. Hepziba SJ, Geetha K, Ibrahim SM. Evaluation of genetic diversity, variability, character association and patha analysis in diverse inbreds of maize (*Zea mays* L.). Electronic Journal of Plant Breeding. 2013;4(1):1067-1072.
7. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybean. Agronomy Journal. 1955;47:314-318.
8. Kumar GP, Reddy VN, Kumar SS, Rao PV. Genetic variability, heritability and genetic advance studies in newly developed maize genotypes (*Zea mays* L.) International Journal of Pure and Applied Biosciences. 2014;2(1):272-275.
9. Nayak VH, Singh R, Potla KR. Genetic variability analysis of yield and yield related traits in inbred lines of maize (*Zea mays* L.). Environment and Ecology. 2013;31(4):1669-1671.
10. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi. 1985; pp. 235-246.

11. Rajesh V, Kumar SS, Reddy VN, Shankar AS. Studies on genetic variability, heritability and genetic advance estimates in newly developed maize genotypes (*Zea mays* L.). International Journal of Applied Biology and Pharmaceutical Technology. 2013;4(4):242-245.
12. Reddy VR, Jabeen F, Sudarshan MR, Rao AS. Studies on genetic variability, heritability, correlation and path analysis in maize (*Zea mays* L.) over location. International Journal of Applied Biology and Pharmaceutical Technology. 2013;4(1):195-199.
13. Singh P, Das S, Kumar Y, Dutt Y, Sangwan O. Variability studies for grain yield and its component traits in maize (*Zea mays* L.). Annals of Agri Bio Research. 2003;8:2-31.