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Genetic study of babycorn yield and micronutrient biofortification

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Abstract

Twenty four inbred lines were evaluated in this study for babycorn yield and related traits, besides babycorn micronutrients (iron, calcium, phosphorous and copper). The study revealed considerable genetic variability for the traits under study. Most of the yield components displayed significant positive correlation with babycorn yield, except days to fifty percent tasseling, silking, plant height, ear height which also displayed positive significant correlation with babycorn Fe concentration. Plant height and number of leaves per plant also showed positive significant correlation with babycorn Ca concentration. Positive significant genotypic correlation with the babycorn yield was found for fodder yield, P, Ca and Cu concentrations. Path coefficient analysis at genotypic level revealed that the highest positive direct effects on babycorn yield was exhibited by days to 50% tasseling (28.21) followed by babycorn weight(16.07), plant height (14.85), babycorn girth(5.07), number of leaves per plant(4.44), iron content (4.01) and copper content (3.65). Analysis of interrelations among various traits indicated the possibility to develop early maturing high yielding genotypes with enriched babycorn phosphorous, iron, calcium and copper concentration.

Keywords: Maize, babycorn yield, micronutrients, correlations

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop next to wheat and rice in the world as well as in India. In India maize is cultivated on 9.4m ha with production of 2.3m tonnes and productivity of 2.55 t/ha. Maize provides a large proportion of the daily intake of energy and other nutrients, including micronutrients for poor populations in many areas. More than half of the worlds population, especially women and children from the developing countries, suffer from micronutrient malnutrition or hidden hunger, resulting from the consumption staple foods with very low levels of bioavailable vitamins and mineral (UNSCN, 2004) [12]. To combat this problem of 'hidden hunger', plant breeding techniques are now being emphasized to develop genotypes of staple foods whose edible portions are denser in bioavailable minerals and vitamins, a process referred to as 'biofortification (Lodha *et al.*, 2005) [7].

The maize improvement programmes in many countries, including India, presently focus mainly on developing superior high yielding single cross hybrids. Improving the nutritional quality, especially for micronutrients, is now an important breeding goal in maize, particularly for baby corn iron, calcium, phosphorous and copper concentrations. CIMMYT and IITA are working on Zn biofortification of white maize (Andersson *et al.*, 2017) [1]. HarvestPlus is working under partnerships of different CGIAR programmes and various other national and international institutes for crop biofortification in more than 60 countries, and currently, 7.5 million households are growing biofortified crops and more than 35 million households are consuming biofortified crops across the world (CIMMYT, 2018) [3]. Biofortification breeding programmes need extra care during different stages of breeding because any contamination either physical or genetic may deteriorate the genetic basis of quality traits. Fortification of maize with iron is recommended to prevent iron deficiency in populations, particularly vulnerable groups such as children and women. Iron-deficiency anaemia (IDA) is a common occurrence among women, infants, and children. Insufficient intake of calcium leads to decreased bone mineralization, with increased risk of rickets in children, and osteoporosis in adults. Maize contains only small amount of intrinsic calcium, so fortification is encouraged in populations where maize is a staple food.

Phosphorus is the second most abundant mineral in the human body. Eighty five percent of it is housed in the skeleton. To breed high yielding crops with improved quality, evaluation of genetic variability for the target traits, besides yield and its components, is the first important step. It is also useful to study the interrelationships among various component characters to develop selection criteria for improvement of the target traits. However, the knowledge of correlation alone does not present the complete picture, since the understanding of direct and indirect effects of component traits towards the target trait is necessary for achieving gainful increment in a judicious manner. Therefore, the present study was undertaken to analyze the genetic variability in inbreds of maize, besides assessing correlation, the direct and indirect effects of various characters, including baby corn micronutrient concentrations on babycorn yield.

Materials and Methods

The materials consisted of a set of twenty four inbred lines were evaluated at experimental farm of Bihar Agricultural College, Sabour, Bhagalpur during *Rabi*-2018 in trial. The materials were planted in randomized block design (RBD) with three replications per entry and two row per replication and with a plant-to-plant spacing of 20 cm and row-to-row spacing of 60 cm. Standard agronomic practices were followed for raising and maintenance of the plants. Data were recorded on standing crops on five randomly selected plants. Data were recorded on 15 different characters [baby corn yield (q/ha), fodder yield (q/ha) baby corn length (cm), baby corn girth(cm), baby corn weight (g), no. of cobs/plant, no. of leaves/plant, plant height (cm), ear height (cm), days to 50% tasseling and silking], besides baby corn phosphorous content, baby corn calcium content, iron content and baby corn copper content. Biochemical analysis for babycorn calcium content was carried out on triplicate samples directly by flame photometer. Phosphorous concentration was carried out by spectrophotometer. Iron and copper concentration was estimated by atomic absorption spectrophotometer from the diacid digested sample using air-acetylene flame.

Results

The analysis of variance revealed highly significant differences among the genotypes for all the 15 characters indicating the existence of genetic variability among the experimental material (Table 1). Similar results were reported by Vaghela (2008) [13].

Table 1: Analysis of variance of twenty four genotypes for fifteen characters

Sl. No.	Characters	Mean Sum of Squares (MSS)				
		Replications (d.f= 2)	Treatments (d.f= 23)	Error (d.f= 46)	C.D. at 5%	C.V.
1	Days to 50% Tasseling	7.76	221.27*	4.07	3.31	2.09
2	Days to 50% Silking	4.26	220.45*	6.37	4.15	2.55
3	Plant height (cm)	661.54	1378.23*	64.80	13.23	7.34
4	Ear height (cm)	149.27	233.53*	17.53	6.88	8.41
5	No. of leaves/plant	3.66	4.30*	0.28	0.87	5.56
6	Baby corn length (cm)	1.03	1.47*	0.27	0.86	7.11
7	Baby corn girth (cm)	0.05	0.03*	0.01	0.14	6.69
8	Baby corn weight (g)	1.97	1.13*	0.24	0.80	7.42
9	No. of cobs/plant	0.29	0.61*	0.05	0.36	11.06
10	Baby corn yield (q/ha)	3.00	6.13*	1.35	1.91	10.27
11	Fodder yield (q/ha)	819.07	891.07*	102.57	16.65	5.56
12	Phosphorous content(mg/100gm)	2.67	6669.41*	0.15	0.64	0.28
13	Iron content (mg/100gm)	0.01	2.52*	0.001	0.05	0.96
14	Calcium content (mg/100g)	0.66	2098.48*	0.17	0.68	0.54
15	Copper content (mg/100g)	0.0013	16.97*	0.002	0.07	0.76

*Significant @ 5%

The contributions of the component traits towards total divergence of the genotypes were studied. The per cent contribution of each character towards divergence is presented in Table 2. It was observed that phosphorous content was the single largest contributor (46.01%) towards divergence followed by copper content (30.07%), calcium content (18.48%), iron content (4.71%).

Table 2: Contribution of different characters towards genetic divergence (D^2) in twentyfour genotypes of baby Corn

S. No.	Source	Times ranked first	Contribution
1	Days to 50% tasseling	0	0.00%
2	Days to 50% silking	0	0.00%
3	Plant height (cm)	0	0.00%
4	Ear height (cm)	0	0.00%
5	No. of leaves/ plant	0	0.00%
6	Baby corn length (cm)	0	0.00%
7	Baby corn girth (cm)	0	0.00%
8	Baby corn weight (g)	0	0.00%
9	No. of cobs/plant	0	0.00%
10	Baby corn yield (q/ha)	0	0.00%
11	Fodder yield (q/ha)	0	0.00%
12	Phosphorous content (mg/100g)	127	46.01%
13	Iron content (mg/100g)	13	4.71%
14	Calcium content (mg/100g)	51	18.48%
15	Copper content (mg/100g)	83	30.07%

Highest heritability in broad sense was observed as per Table 3 for days to 50% tasseling (0.95), followed by days to 50% silking (0.92), plant height (0.87), number of leaves/plant (0.83), ear height (0.80) and number of babycorn/plant (0.80). High to moderate heritability found in fodder yield (0.72). Genetic advance as % of mean (GA) was the highest for copper content (87.74), followed by calcium content (71.08), phosphorous content (69.66), iron content (59.68), number of babycorn/plant (40.36), plant height (36.67), ear height (31.50). Similarly lowest value for genetic advance observed in baby corn girth (11.44), baby corn weight (12.67), baby corn length (13.70). Traits with high heritability but low genetic advance may have high influence of the environment and were not stable, includes days to 50% tasseling and days to 50% silking. In contrast, the high heritability coupled with high genetic advance noticed for plant height, ear height, number of babycorn/plant, baby corn phosphorous content, calcium content, iron content and copper content which indicates the role of additive gene action in controlling the traits (Table 3).

Table 3: Estimation of range, mean, components of variance, genetic parameters and genetic advance for fifteen characters in twenty four maize inbred lines

Characters	Range		Mean	Vg	Vp	GCV%	PCV%	H^2_{bs}	GA (as % of mean 5%)
	Minimum	Maximum							
DT	81.67	112.33	96.44	72.40	76.47	8.82	9.07	0.95	17.68
DS	82.00	113.00	99.06	71.36	77.73	8.53	8.90	0.92	16.83
PH	76.42	136.68	109.71	437.81	502.61	19.07	20.44	0.87	36.67
EH	31.83	67.88	49.76	72.00	89.53	17.05	19.01	0.80	31.50
LPP	7.33	11.47	9.54	1.34	1.62	12.13	13.35	0.83	22.73
BL	4.94	8.55	7.32	0.40	0.67	8.62	11.18	0.60	13.70
BG	1.16	1.61	1.29	0.01	0.02	7.46	10.02	0.55	11.44
BW	5.20	8.01	6.59	0.30	0.54	8.27	11.11	0.55	12.67
CPP	1.28	2.97	1.98	0.19	0.24	21.94	24.57	0.80	40.36
BC YLD	9.45	13.83	11.31	1.60	2.94	11.17	15.17	0.54	16.94
FD YLD	161.63	230.11	182.27	263.04	365.62	8.90	10.49	0.72	15.55
P	80.50	250.32	139.42	2223.09	2223.24	33.82	33.82	1.00	69.66
Fe	1.60	4.73	3.16	0.84	0.84	28.99	29.00	1.00	59.68
Ca	28.82	111.97	76.64	699.44	699.61	34.51	34.51	1.00	71.08
Cu	2.25	10.33	5.58	5.65	5.66	42.60	42.60	1.00	87.74

Note: DT: Days to 50% tasseling; DS: Days to 50% silking, PH: Plant height (cm); EH: Ear height (cm); LPP: Number of leaves per plant; BL: Babycorn length (cm); BG: Babycorn girth (cm); BW: Babycorn weight (g); CPP: Number of cobs per plant; BC YLD: Babycorn yield (q/ha); FD YLD: Fodder yield (q/ha); P: Babycorn phosphorous content (mg/100g); Fe: Babycorn iron content (mg/100g); Ca: Babycorn calcium content (mg/100g); Cu: Babycorn copper content (mg/100g).

Babycorn yield is a complex character and is dependent on several contributing characters. Hence, knowledge of character association is of immense importance to assess the relationship among yield and its components for enhancing the usefulness of selection. Genotypic and phenotypic correlations were computed for all the traits under study (Table 4). Genotypic correlations reveal the existence of real associations. Hence only the genotypic correlations are discussed below. The study of correlations among babycorn yield and its component traits, besides babycorn micronutrient traits, shall be useful to develop selection criteria to breed high yielding babycorn genotypes enriched with micronutrient. Positive significant genotypic correlation with the babycorn yield was found for fodder yield, phosphorous, calcium and copper concentrations. However, babycorn iron concentration was found to be negatively correlated with yield. Babycorn iron concentration was positively correlated to days to 50% tasseling, silking, plant height and ear height. No significant correlation was recorded for iron with babycorn calcium and copper concentrations.

Table 4: Correlation coefficients among the fifteen different traits in the twentyfour inbred lines

Character	DT	DS	PH	EH	LPP	BL	BG	BW	BCPP	BC YLD	FD YLD	P	Fe	Ca	Cu
DT		0.971**	0.488**	0.406**	0.411**	0.197	-0.050	0.236*	-0.326**	-0.007	0.009	-0.177	0.332**	0.143	0.201
DS	1.005**		0.476**	0.394**	0.386**	0.171	0.013	0.260*	-0.293*	0.014	0.030	-0.183	0.330**	0.120	0.214
PH	0.529**	0.498**		0.751**	0.630**	0.078	-0.001	-0.023	-0.024	0.105	0.035	-0.120	0.422**	0.366**	-0.015
EH	0.465**	0.435**	0.881**		0.507**	0.017	0.010	-0.046	-0.135	0.016	-0.021	-0.041	0.461**	0.198	0.098
LPP	0.472**	0.441**	0.703**	0.609**		0.197	-0.027	-0.055	-0.139	0.175	0.123	0.143	0.345**	0.353**	0.101
BL	0.261*	0.307**	0.214	-0.062	0.433**		0.219	0.403**	0.243*	0.359**	0.371**	0.179	-0.064	0.245*	0.191
BG	-0.076	-0.050	-0.019	-0.052	-0.014	0.383**		0.347**	0.463**	0.292*	0.313**	0.169	-0.160	0.107	-0.150
BW	0.292*	0.305**	-0.092	-0.192	-0.041	0.626**	0.367**		0.227NS	0.445**	0.311**	0.224	-0.107	-0.022	0.139
CPP	-0.380**	-0.343**	-0.045	-0.215	-0.127	0.360**	0.653**	0.246*		0.520**	0.408**	0.210	-0.128	0.284*	-0.097
BC YLD	-0.014	0.049	0.167	0.033	0.327**	0.592**	0.577**	0.635**	0.631**		0.388**	0.299*	-0.006	0.284*	0.281*
FD YLD	-0.018	0.005	0.048	0.008	0.199	0.673**	0.473**	0.611**	0.462**	0.601**		0.131	0.021	-0.090	-0.074
P	-0.182	-0.192	-0.129	-0.046	0.156	0.233*	0.228	0.302**	0.234*	0.406**	0.153		-0.317**	0.119	0.293*
Fe	0.340**	0.342**	0.453**	0.512**	0.378**	-0.077	-0.228	-0.141	-0.142	-0.002	0.023	-0.318**		-0.118	-0.134
Ca	0.146	0.125	0.391**	0.220	0.389**	0.318**	0.146	-0.030	0.317**	0.387**	-0.106	0.119	-0.118		0.416**
Cu	0.206	0.223	-0.016	0.109	0.110	0.246*	-0.203	0.182	-0.108	0.380**	-0.089	0.293*	-0.135	0.416**	

Above Diagonal: Phenotypic correlation coefficient; Below Diagonal: Genotypic correlation coefficient; *Significant at P = 0.05; **Significant at P = 0.01

Genotypic and phenotypic path coefficient analysis for baby corn yield was carried out (Table 5). Path coefficient analysis at genotypic level revealed that the highest positive direct effects on babycorn yield was exhibited by days to 50% tasseling (28.21) followed by babycorn weight (16.07), plant height (14.85), babycorn girth (5.07), number of leaves per plant (4.44), iron content (4.01) and copper content (3.65) while days to 50% silking (-30.90), ear height (-12.57), babycorn length (-11.44), calcium content (-8.01), phosphorous content (-5.11), number of babycorn per plant (-2.89) & fodder yield (-2.50) showed negative direct effects on babycorn yield. Days to 50% tasseling showed indirect negative effect via number of babycorn per plant (-10.72), phosphorous content (-5.14), babycorn girth (-2.13) and fodder yield (-0.52) and indirect positive effect via, days to 50% silking (28.35), plant height (14.94), number of leaves per plant (13.32), ear height (13.11), iron content (9.61) and baby corn weight (8.24). Days to 50% silking showed indirect negative effect via days to 50% tasseling (-31.05), plant height (-15.40), number of leaves per plant (-13.62), ear height (-13.45), iron content (-10.57), babycorn length (-9.50) and fodder yield (-0.52) and indirect positive effect via, number of babycorn per plant (-10.58), phosphorous content (-5.93) and babycorn girth (-1.54). Plant height possessed indirect negative effect on baby corn yield via phosphorous content (-1.91), babycorn weight (-1.37), number of babycorn per plant (- 0.67), baby corn girth (-0.28) and copper content (-0.24) while indirect positive effect via ear height (13.07), number of leaves per plant (10.43), days to 50% tasseling (7.86), days to 50% silkling (7.40), iron content (6.73).

Ear height had indirect negative effect on baby corn yield via plant height (-11.07), number of leaves/plant (-7.66), iron content (-6.44), days to 50% tasseling (5.84) and days to 50% silking (5.47) while indirect positive effect via number of babycorn per plant (2.70), baby corn weight (2.41), babycorn length (0.77), babycorn girth (0.66) and phosphorous content (0.57). Number of leaves per plant showed indirect negative effect via number of babycorn per plant (-0.56), babycorn weight (-0.18) and baby corn girth (-0.06) and indirect positive effect via plant height (3.12), ear height (2.70), days to 50% tasseling (2.10), days to 50% silking (1.96) and babycorn length (1.92).

Babycorn length possessed indirect negative effect on baby corn yield via fodder yield (-7.69), babycorn weight (-7.16), number of leaves/plant (-4.95), babycorn girth (-4.38), number of babycorn per plant (-4.11), calcium content (-3.64) while indirect positive effect via iron content (0.57) and ear height (0.70).

Babycorn girth had indirect negative effect on babycorn yield via iron content (-0.37), copper content (-0.10), days to 50% tasseling (-0.38) and ear height (-0.27) and days to 50% silking (-0.25) while showed indirect positive effect via number of babycorn per plant (3.31), fodder yield (2.40), babycorn weight (1.86), phosphorous content (1.15) and calcium content (0.74).

Baby corn weight showed indirect negative effect via ear height (-3.08), iron content (-2.27), plant height (-1.48), number of leaves per plant (-0.66), and calcium content (-0.47) while indirect positive effect via babycorn length (10.06), fodder yield (9.81), days to 50% silkling (4.91), phosphorous content(4.85), days to 50% tasseling (4.70) and copper content (2.93).

Number of babycorn per plant showed indirect negative effect via babycorn girth (-1.89), fodder yield (-1.33) baby corn length (-1.04) calcium content (0.92) and phosphorous content (0.68) indirect positive effect via days to 50% tasseling (3.12), days to 50% silking (2.70), ear height (2.10), iron content,(2.93) and copper content (2.93).

Fodder yield had indirect negative effect on babycorn yield via babycorn length (-1.68), baby corn weight (-1.53), babycorn girth (-1.18) and number of babycorn per plant (-1.16), and phosphorous content (-0.38) while showed indirect positive effect via days to 50% tasseling (0.05), calcium content (0.27) and copper content (0.22).

Phosphorous content possessed indirect negative effect on babycorn yield via babycorn weight (-1.54), copper content (-1.50), baby corn length (1.19), number of babycorn per plant (1.19) babycorn girth (-1.16), number of leaves per plant (-0.80), fodder yield (-0.78) and calcium content (-0.61) while showed indirect positive effect via iron content (1.62), days to 50% silking (0.98), days to 50% tasseling (0.93), plant height (0.66) and ear height (0.23).

Iron content showed indirect negative effect via phosphorous content (-1.27), baby corn girth (-0.91), baby corn weight (-0.57), number of babycorn per plant (-0.57), copper content (-0.54), calcium content (-0.47) while indirect positive effect via ear height (2.05), plant height (1.82) number of leaves per plant (1.51) days to 50% tasseling (1.37) and days to 50% silking (1.37). Calcium content showed indirect negative effect via copper content (-3.33), plant height (-3.13), number of leaves per plant (-3.11), baby corn girth (-0.91), baby corn weight (-0.57), babycorn length (-2.55), number of babycorn per plant (-2.54) and ear height (-1.76) while indirect positive effect via iron content (0.95), fodder yield (0.85) babycorn weight (0.24). Copper content had indirect negative effect on babycorn yield via babycorn girth (-0.74), iron content (-0.49), fodder yield (0.32), plant height (-0.06) while showed indirect positive effect via calcium content (1.52), phosphorous content (1.07) iron content (0.90), days to 50% silking (0.82), days to 50% tasseling (0.75), babycorn weight (0.67), ear height (0.40) and number of leaves per plant (0.40).

Table 5: Direct (diagonal) and indirect effects of fifteen component characters attributing to baby corn yield in twenty genotypes of maize

Character	DT	DS	PH	EH	LPP	BL	BG	BW	CPP	FD YLD	P	Fe	Ca	Cu
DT	28.21	-31.05	7.86	-5.84	2.10	-2.99	-0.38	4.70	1.10	0.05	0.93	1.37	-1.17	0.75
DS	28.35	-30.90	7.40	-5.47	1.96	-3.52	-0.25	4.91	0.99	-0.01	0.98	1.37	-1.00	0.82
PH	14.94	-15.40	14.85	-11.07	3.12	-2.45	-0.10	-1.48	0.13	-0.12	0.66	1.82	-3.13	-0.06
EH	13.11	-13.45	13.07	-12.57	2.70	0.70	-0.27	-3.08	0.62	-0.02	0.23	2.05	-1.76	0.40
LPP	13.32	-13.62	10.43	-7.66	4.44	-4.95	-0.07	-0.66	0.37	-0.50	-0.80	1.51	-3.11	0.40
BL	7.38	-9.50	3.18	0.77	1.92	-11.44	1.94	10.06	-1.04	-1.68	-1.19	-0.31	-2.55	0.90
BG	-2.13	1.54	-0.28	0.66	-0.06	-4.38	5.07	5.90	-1.89	-1.18	-1.16	-0.91	-1.17	-0.74
BW	8.24	-9.44	-1.37	2.41	-0.18	-7.16	1.86	16.07	-0.71	-1.53	-1.54	-0.57	0.24	0.67
CPP	-10.72	10.58	-0.67	2.70	-0.56	-4.11	3.31	3.95	-2.89	-1.16	-1.19	-0.57	-2.54	-0.39
FD YLD	-0.52	-0.16	0.71	-0.10	0.88	-7.69	2.40	9.81	-1.33	-2.50	-0.78	0.09	0.85	-0.32
P	-5.14	5.93	-1.91	0.57	0.69	-2.67	1.15	4.85	-0.68	-0.38	-5.11	-1.27	-0.96	1.07

Fe	9.61	-10.57	6.73	-6.44	1.68	0.88	-1.15	-2.27	0.41	-0.06	1.62	4.01	0.95	-0.49
Ca	4.13	-3.87	5.80	-2.76	1.73	-3.64	0.74	-0.47	-0.92	0.27	-0.61	-0.47	-8.01	1.52
Cu	5.81	-6.90	-0.24	-1.37	0.49	-2.81	-1.03	2.93	0.31	0.22	-1.50	-0.54	-3.33	3.65
BC YLD	-0.01	0.05	0.17	0.03	0.33	0.59	0.58	0.64	0.63	0.60	-0.002	0.39	0.38	1.00

Discussion

Babycorn phosphorous, iron, calcium and copper concentrations made significant contribution towards the genetic divergence of the lines, indicating the presence of considerable variability for these traits in the inbred lines. Presence of such genetic variation for the micronutrient traits, coupled with babycorn yield and its attributes, is highly encouraging as this provides a possibility to breed high yielding maize genotypes enriched with babycorn micronutrients. The study of correlations among babycorn yield and its component traits, besides babycorn micronutrient traits, shall be useful to develop selection criteria to breed high yielding maize genotypes enriched with babycorn micronutrient. These findings were in conformity with Kumar *et al.* (2013) [6], Kapoor and Batra (2015) [4], Sandeep *et al.* (2014) [11], Kashiani *et al.* (2014) [5] for ear height, plant height, and ear length. The higher estimate of heritability indicates the preponderance of additive gene effect and is less affected by environment.

Positive significant genotypic correlation with the babycorn yield was found for fodder yield, phosphorous, calcium and copper concentrations. However, babycorn iron concentration was found to be negatively correlated with babycorn yield. This result was supported by Long *et al*. (2004) [8] who also reported significant negative correlation of grain yield with kernel iron concentration and no interrelation with kernel zinc concentration, but in a diallel hybrid population. Babycorn iron concentration was positively correlated to days to 50% tasseling, silking, plant height and ear height. Babycorn phosphorous concentration was negatively correlated to days to 50% tasseling, silking, indicating the possibility of developing high yielding early maturing genotypes with high babycorn P density. Chakraborti *et al* (2009) [2] interestingly found these two traits also displayed negative correlations with grain yield, indicating the possibility of developing high yielding early maturing genotypes with high kernel Zn density. Maqbool, (2017) [10] found that nutritional traits may not have any correlation with yield traits or independent of each other.

Dilution effects of yield on kernel Fe concentration in maize genotypes was earlier reported by Long *et al*. (2004) [8]. This may prove to be an important constraint in breeding high yielding maize hybrids enriched for kernel Fe and Zn. However, no significant negative correlation was observed between kernel micronutrient concentrations and babycorn yield in the present study as well as other earlier studies Chakraborti *et al* (2009) [2], indicating that the constraint imposed by the 'dilution effect' can be overcome in many of the maize genotypes.

Overall, the present study revealed high genetic variability among the inbred lines for all the traits studied. Analysis of interrelations among various traits indicated the possibility to develop early maturing high yielding genotypes with enriched babycorn phosphorous concentration. Wide range of genetic diversity is available in the maize germplasm, but there is need to utilize that variability for biofortified cultivar development.

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