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Selection of Tropical Inbred Lines for Yield and Morpho-agronomical Traits in Maize (*Zea mays* L.)

Swargam Vaishnavi [a*], V. Swarnalatha [b++], D. Bhadru [c#] and B. Mallaiah [d++]

[a] Department of Genetics and Plant Breeding, PJTSAU, Hyderabad, Telangana, India.
[b] Department of Genetics and Plant Breeding, SRTC, Hyderabad, Telangana, India.
[c] Department of Genetics and Plant Breeding, MRC, Hyderabad, Telangana, India.
[d] Department of Plant Pathology, MRC, 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

Aim: To determine the genetic parameters and the magnitude of association between yield and morpho-agronomical traits to improve the efficiency of selection in further crossing programme for high density planting.

Study Design: Randomized Block Design with two replications.

Place and Duration of Study: The experiment was conducted at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad in *Kharif* 2023.

[++] *Senior Scientist;*
[#] *Principal Scientist;*
**Corresponding author: E-mail: vswargam11@gmail.com;*

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Methodology: The present investigation was carried out to asses correlation, cause and cause effect relationship among 52 maize tropical inbred lines for the morpho-agronomical traits such as Number of leaves above the ear, Number of leaves below the ear, Tassel branch number, Tassel main axis length (cm), Plant height (cm), Ear height (cm), Leaf angle, Leaf length, Leaf width, Total number of leaves per plant which influences the leaf and stem architecture of maize.

Results: Results suggested that traits like plant height, total number of leaves, leaf length, leaf width, No. of Kernels per row, No. of rows per cob and shelling percent were important for selection of genotypes as these traits recorded moderate to high range of GCV, PCV, heritability, genetic advance over mean and exhibited positive significant correlations along with direct effects on yield/cob for some of the mentioned traits. So, these traits were taken into consideration for selection of promising inbred lines GP88, PFSR29, PFSR32, PFSR51, BML6, BML20 among 52 genotypes for further crossing programme.

Keywords: Maize; correlation; path analysis; genetic parameters; leaf angle; plant architecture; tassel morphology.

1. INTRODUCTION

“Maize with its widespread cultivation across millions of hectares worldwide, it stands out as a staple food source and a key component of various industries. Thus, due to its versatile applications in food, feed and industrial raw material, maize has attained status of industrial crop” [1]. “In India it is cultivated in 9.95 million hectares area with 33.72 million tones of production and 3.38 tonnes of productivity” (*www.indiastat.com*). “In Telangana state, the area under maize cultivation is 1.83 lakh hectares with production of 28.8 lakh per hectare” [2]. “To meet the food demand, crop productivity must be doubled by 2050 with the enhanced rate of 2.4% per year” [3]. “For the development of productive and adapted cultivars to supply the market demand it is important to understand the morphological, physiological, phenological, and allometric characteristics that contribute to better adaptation of maize to high plant densities” [4]. “Breeding for tolerance to high plant density (HPD) stress resulted in remarkable increase in grain yield per unit area in temperate maize. In spite of improved germplasm and reasonable adoption of hybrid technology, average maize productivity in tropics is still much below the achievable potential. As breeder selection for plant density leads to increased leaf angle, leaf size, and tassel size and angle, these traits have been optimized, allowing light to penetrate into the aboveground canopy with considerable yield advantages” [5]. “More tassel branch numbers will consume more energy to produce pollen, thus reducing the absorption of nutrients by ear, and then affecting corn yield. Studies have found that smaller tassels with a few branches are beneficial to the increase of yield during modern maize breeding” [6]. “Ample evidence also indicates that more upright leaf is a selected trait during genetic improvement of crops” [7,6].

So, the current study was carried out to identify ideal plant architecture in tropical maize inbreds in normal planting density (83,333) and inheritable distinguished agro-morphological yield contributing traits to enhance the potential of further development of hybrids for high density planting (>1,00,000).

The study of variability and genetic advance in the germplasm will help to ascertain the real potential of the genotype as suggested by Niji et al. [8]. “Whereas genetic advance shows the degree of gain obtained for the characters under a particular selection pressure. 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” [9]. The estimates of genetic parameters like heritability and genetic advance helps in predicting the gain under selection.

“As yield is a dependent character and it is based on number of quantitative characters, it is important to study the association between pairs of these attributes for faster assessment of high yielding genotypes in selection programme. Correlation studies reflect the extent of association between two characters and helps in determining the yield contributing characters. Correlation coefficients generally show relationships among independent variables and the degree of linear relation between these characteristics, but it does not sufficiently predict the success of selection. However, path-coefficient analysis that is originally developed by Wright [10] is the most valuable tool to establish the exact correlation in terms of cause and effect. It allows one to identify the direct, indirect and total (direct + indirect) causal effect, as well as to remove any spurious effect that may be present" [11].

Therefore, the present study was conducted to determine the genetic variability, heritability, genetic advance and the magnitude of the relations between yield and its contributing characters to improve the efficiency of selection in further crossing programme.

2. METHODOLOGY

The field experiment was conducted at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad during *kharif* 2023 in Randomized Block Design. Fifty two MRC inbred lines (Table 1) were sown by adopting 60 cm X 20 cm spacing and the plot size was 4 meters in length with 2 rows and two replications. Recommended agronomic package of practices were followed to raise a healthy crop. Data was recorded on five randomly selected plants for 17 characters viz., days to 50% tasseling, days to 50% silking, number of leaves above the ear, number of leaves below the ear, tassel branch number, tassel main axis length (cm), plant height(cm), ear height(cm), leaf angle of the leaf near the ear, leaf length of the leaf near the ear(cm), leaf width of the leaf near the ear(cm), total number of leaves per plant, number of rows per cob, number of kernels per row, 100 kernel weight(g), shelling percentage(%), Grain yield per plant(g).Readings from five plants were averaged replication wise and the mean value was used for statistical analysis.

2.1 Statistical Analysis

The data collected was subjected to statistical analysis using INDOSTAT software version 9.2 and the methods adopted by the software for the analysis of variance (ANOVA) was as described by Panse and Sukhatme [12], mean, standard error and range were calculated as per Singh and Chaudhary [13]. Phenotypic and genotypic coefficients of variation (PCV and GCV) were as per Burton [14] and were categorized as low (0-10%), moderate (10-20%) and high (>20%) as indicated by Sivasubramanian and Madhavamenon [15]. Heritability in broad sense was estimated as the ratio of genotypic variance to the phenotypic variance as suggested by Hanson et al. [16] and it was categorized as low (0-30%), moderate (30- 60%) and high (>60%) as indicated by Johnson et al. [17]. Genetic advance (GA) and genetic advance as percent of the mean (GAM) were calculated by using the formulae given by Johnson et al. [17]. The Genetic advance as percent of the mean was categorized as low (0-10%), moderate (10- 20%) and high (>20%) according to Johnson et al. [17]. Correlation coefficients were calculated by using the formulae given by Johnson et al. [17].

Table 1. List of inbred lines used in study

S. No	Inbreds	S. No	Inbreds	S. No	Inbreds
1	MGC 90	19	MGW 360	37	PFSR 51
2	PFSR 1	20	MGC 331	38	MGC 137
3	PFSR 32	21	GP 27	39	PFSR 90
4	P852	22	BML 6	40	PFSR 104
5	MGW 316	23	GP 311	41	MGC 161
6	PFSR 137	24	PFSR 92	42	GP 86
7	MGC 89	25	D1	43	PFSR 3
8	GP 35	26	MGW 334	44	MGC 6
9	GP 82	27	GP 125	45	3070
10	BML 14	28	PFSR 49	46	MGC 61
11	PFSR 129	29	7 11	47	MGC 157
12	GP 94	30	GP 2	48	CML 286
13	GP 88	31	MGW 270	49	PFSR 95
14	PFSR 132	32	3122	50	GP 170
15	MGW 325	33	GP 83	51	BML 45
16	MGW 419	34	PFSR 130	52	CML 451
17	BML 11	35	BML 7		
18	PFSR 29	36	BML 20		

The direct and indirect effects for genotypes were estimated by using path coefficient analysis suggested by Wright [18] and Dewey and Lu [19].

3. RESULTS AND DISCUSSION

3.1 Genetic Parameters

3.1.1 Analysis of variance

The ANOVA revealed significant difference among genotypes for all the traits (Table 2) indicating the presence of considerable significant variation among the genotypes selected, which is pre-requisite for the breeder to take up any breeding programme.

3.1.2 Mean performance

In the present study, wide variability can be assessed for all the traits among the inbred lines (Table 3). The mean performance is recorded for the inbreds in the following order. Inbred line MGW 316 recorded shortest plant height (84 cm) and GP 83 recorded highest (161 cm) with a mean of 121.18 cm indicating high range of genetic variability. Lower ear placement is very important in maize and inbred line BML 20 was recorded with lowest ear height (22.0 cm) and BML 6 recorded the highest ear height (82 cm) with a mean of 50.408 cm. For days to 50% silking GP 83 registered as late (78 days) and D1 recorded as early (49 days) with a mean 62.385. For Days to 50% tasseling GP 83 recorded as late (76 days) and D1 recorded as early (47 days) with a mean 60.125 cm. The erect leaf is an ideal architecture to the plants for the adequate spatial distribution and can increase the interception of solar radiation and its use efficiency, inbred line GP 88 was observed with low leaf angle (25^0) and highest in D1 (70^0) with a mean 40.89^0. For the observation number of leaves below the ear inbred 3070 (3) recorded lowest and highest in GP 83 (7.8) with a mean (5.18). In inbred line MGC 6 highest leaves number above the ear noted around (3.2) and lowest for MGC 331 with a mean 5.4. Total number of leaves are recorded high in PFSR 137(13.80) and lowest for MGC 6 (7.4) with a mean of 10.609. Leaf length was recorded highest in PFSR 51(66.6 cm) and lowest for MGW 319 (30 cm) with a mean (51.99 cm). Leaf width was recorded highest in CML 286 (9.2 cm) and lowest for MGW 360 (4.8 cm) with a mean (6.74 cm). Tassel branch number noted high in PFSR 32(14.7) and low for BML 11 (2.26) with a mean 7.668. Tassel main axis length recorded lowest in 3070 (12.5 cm) and highest in MGC 89 (28.6 cm) with a mean (20.88). The range of genetic variability for the trait number of rows per cob varied from 5.7 (MGW 270) to 26.0 (BML 7) with a mean of 14.03. The range of variation for number of kernels per row was 41.0 (MGW 325) to 6.3 (GP 94) with a mean of 15.967. The highest test weight was recorded in GP 27 (38 g) and lowest weight in MGW 419 (8 g) with a mean 21.538 g. Highest shelling% was recorded

Table 2. Analysis of variance for yield and yield attributing traits in 52 maize inbred lines

Source of variation	Mean sum of squares		
	Replications	Genotypes	Error
d.f	1	51	51
Days to 50% tasseling	0.0878	68.527**	4.871
Days to 50% silking	2.462	68.522**	4.422
Plant Height(cm)	15.346	804.645**	31.712
Ear Height(cm)	0.055	385.423**	16.561
Leaf Angle	5.087	201.634**	1.283
No.of Leaves above ear	0.025	1.154**	0.061
No.of Leaves below ear	0.092	2.538**	0.173
Total Number of Leaves	0.022	3.992**	0.326
Leaf Length(cm)	32.906	98.378**	11.761
Leaf Width(cm)	0.493	1.578**	0.192
Tassel Branch Number	0.097	18.504**	0.603
Tassel Main Axis Length(cm)	8.962	20.801**	2.515
No.of Kernels Per Row	5.166	57.215**	2.179
No.of Rows Per Cob	0.654	54.087**	1.736
Test Weight	3.846	80.389**	3.14
Shelling%	6.793	87.118**	10.381
Yield/Cob	0.501	350.016**	20.134

in MGC 6 (84.35%) and lowest in MGC 157 (59%) with a mean 70.72%. Wide range of variability noticed for the trait yield per cob with range of 30.98 g (MGW 360) to 92.76 g (MGC 61) with a mean of 71.406 g.

3.1.3 Coefficient of variations

Phenotypic Coefficient of Variation (PCV) recorded slightly higher than Genotypic Coefficient of Variation (GCV) for all the traits, indicating the less influence of environment in expression of the traits (Table 3). Therefore, selection on the basis of phenotype alone can be effective for the selection of genotypes and improvement of these traits. Medium range of PCV and GCV were observed in the traits Plant height (16.875, 16.22), No. of leaves above the ear (14.376, 13.63), Total number of leaves (13.851, 12.762), Leaf length (14.272, 12.657), Leaf width (13.958, 12.352), Tassel main axis length (16.352, 14.481) and Yield/cob (19.052,17.986). In traits Days to 50% tasseling (10.076, 9.383), Days to 50% silking (9.681, 9.075) and shelling% (9.873, 8.759) the estimates of PCV and GCV were recorded lowest. The difference between PCV and GCV estimates were found to be more for the traits Ear height, Leaf length, No. of kernels per row, Yield/cob indicating that for these traits the phenotypic selection may be misleading.

Traits like Ear height, No. of leaves below the ear, Tassel branch number, Tassel main axis length, No. of kernels per row, No. of rows per cob and Test weight had high values of coefficient of variation indicates that the chances of getting substantial gains under selection are likely to be less for these characters.

3.1.4 Heritability and genetic advance

“The genetic components of variation together with heritability estimates would give the better picture of amount of genetic advance to be expected from the selection” [14]. “All the traits were registered with high estimates of broad sense heritability. However, selection for improvement of such characters may not be useful, because broad sense heritability is based on total genetic variance which includes additive, dominant and epistatic variances. Thus, heritability estimates coupled with high genetic advance (at 5%) would be more reliable and useful on correlating selection criteria” [20]. The traits Plant height, Ear height, leaf angle and Yield/cob exhibited high estimates of genetic advance. High heritability and moderate genetic advance for Days to 50% tasseling, Days to 50% silking, Leaf length, No. of kernels per row, No. of rows per cob, Test weight and Shelling percent indicating the role of additive gene effects, the moderate genetic advance may be due to environmental effects and selection would be rewarding for this trait. High heritability accompanied with high genetic advance as percent of mean were recorded for Plant height, Ear height, Leaf angle, Tassel branch number, Tassel main axis length, No. of kernels per row, No. of rows per cob and Test weight, indicating that the heritability is due to additive gene effects. High heritability with low genetic advance (at 5%) was recorded for No. of leaves above the ear, No. of leaves below the ear, Total number of leaves, Leaf width, Tassel branch number and Tassel main axis length indicates that heritability may be due to the non-additive type of gene action influenced by environmental effects and selection may not be rewarding for this trait and there is a need for creation of variability either by hybridization or mutation followed by selection.

3.2 Correlation

No. of Kernels per row, No. of rows per cob and shelling percent were observed to exhibit significant positive correlations with Yield/Cob at phenotypic and genotypic level (Table 4). Whereas, Days to 50% tasseling, Days to 50% silking, Plant height, Ear height, No. of leaves below the ear, Total no. of leaves, Leaf length, Leaf width, Tassel branch number showed non-significant positive correlation with Yield/cob at both levels. Leaf angle, No. of leaves above the ear, Tassel main axis length recorded non-significant negative correlation at both phenotypic and genotypic levels with Yield/Cob. Test weight showed significant positive correlation for phenotype and non-significant positive correlation at genotypic level with Yield/cob. Inter correlations among yield components revealed that days to 50% silking recorded significant positive correlation with days to 50% tasseling. Similarly, ear height with plant height, leaf angle is significant negatively correlated with days to 50% tasseling and days to 50% silking. No. of leaves above ear is significant positively correlated with plant height and ear height. No. of leaves below the ear is significant-positively correlated with plant height and ear height. Total number of leaves is significant positively correlated with plant height, ear height, No. of leaves above the ear and No. of leaves below the ear. Leaf length is significant-positively correlated with days to 50% tasseling, days to 50% silking, plant height, ear height, Leaves below the ear, total no. of leaves and significant-negatively correlated with leaf angle. Leaf width is positive-significantly correlated with leaves above the ear. Tassel branch number is positive-significantly correlated with tassel branch number. Tassel main axis length is significant-positively correlated with no. of leaves below the ear, leaf length and significant negatively correlated with leaf width. Kernels per row is negatively correlated with tassel main axis length. No. of rows per cob is positively correlated with days to 50% tasseling, days to 50% silking, no. of leaves below ear, tassel branch number, leaf length, leaf width and tassel branch number. Test weight is positively correlated with plant height, ear height, no. of leaves above the ear and negatively correlated with tassel main axis and no. of rows per cob. These traits can be improved through simultaneous selection of other traits. The results were in agreement with the findings of Reddy, V.R et al., [20], Rajwade, J.K et al., [21], Verma, V et al., [22] and Pranay et al*.,* [23] for the traits days to 50% tasseling, days to 50% silking, no.of kernels per row, no.of rows per cob, plant height, ear height and test weight.

Fig. 1. Inbreds showing small (<45^0) and wide (>45^0) leaf angles

Fig. 2. Inbreds showing dense and sparse tassel

Table 3. Genetic parameters for yield and yield attributing traits in inbred lines

Character	Mean	Range		CV%	PCV%	GCV%	Heritability (%) in broad sense	GA 5%	GAM (%) 5%
		Min	Max						
Days to 50% tasseling	60.125	47.00	76.00	3.671	10.076	9.383	86.7	10.823	18.001
Days to 50% silking	62.385	49.00	78.00	3.371	9.681	9.075	87.9	10.932	17.524
Plant Height (cm)	121.182	84.00	161.00	4.647	16.875	16.222	92.4	38.931	32.126
Ear Height (cm)	50.408	22.00	82.10	8.073	28.125	26.941	91.8	26.799	53.164
Leaf Angle	40.894	25.00	70.00	2.769	24.631	24.475	98.7	20.487	50.098
No.of Leaves above ear	5.423	3.20	6.80	4.572	14.376	13.63	89.9	1.444	26.620
No.of Leaves below ear	5.186	3.00	7.80	8.012	22.45	20.972	87.3	2.093	40.357
Total Number of Leaves	10.609	7.40	13.80	5.383	13.851	12.762	84.9	2.57	24.224
Leaf Length (cm)	51.995	30.00	66.60	6.596	14.272	12.657	78.6	12.022	23.122
Leaf Width (cm)	6.74	4.80	9.20	6.502	13.958	12.352	78.3	1.518	22.515
Tassel Branch Number	7.668	2.26	14.70	10.123	40.311	39.019	93.7	5.966	77.803
Tassel Main Axis Length (cm)	20.881	12.50	28.60	7.594	16.352	14.481	78.4	5.516	26.419
No.of Kernels Per Row	15.967	6.30	41.00	9.245	34.129	32.853	92.7	10.402	65.147
No.of Rows Per Cob	14.033	5.70	26.00	9.388	37.657	36.458	93.8	10.206	72.73
Test Weight	21.538	8.00	38.00	8.228	30.005	28.855	92.5	12.312	57.162
Shelling%	70.721	59.09	84.35	4.556	9.873	8.759	78.7	11.32	16.007
Yield/Cob	71.406	30.988	92.76	6.284	19.052	17.986	89.1	24.976	34.978

Table 4. Phenotypic (P) and genotypic (G) correlations for yield and yield attributing traits in maize inbred lines

CHARACTER		DTT	DTS	PH	EH	LA	LAE	LBE	TNL	LL	LW
DTT	**P**	**1.000**	0.9927**	0.288**	0.2278*	-0.3084**	0.036	0.0745	0.0781	0.3318**	0.1473
	G	**1.000****	1.0051**	0.3332*	0.246	-0.3354*	0.0481	0.072	0.0841	0.4303**	0.1986
DTS	**P**		**1.000****	0.2897**	0.2254*	-0.3098**	0.034	0.0701	0.0734	0.3339**	0.1441
	G		**1.000****	0.3324*	0.2383	-0.3328*	0.053	0.0665	0.0824	0.4319**	0.1892
PH	**P**			**1.000****	0.7898**	-0.1743	0.4562**	0.3673**	0.5331**	0.4349**	0.0947
	G			**1.000****	0.8607**	-0.1797	0.4876**	0.3998**	0.5873**	0.4942**	0.1128
EH	**P**				**1.000****	-0.0383	0.3753**	0.3755**	0.4966**	0.4147**	-0.0017
	G				**1.000****	-0.0402	0.4214**	0.4271**	0.5731**	0.5091**	0.0527
LA	**P**					**1.000****	-0.0856	-0.1256	-0.145	-0.4072**	-0.0417
	G					**1.000****	-0.0908	-0.136	-0.1588	-0.4515**	-0.0464
LAE	**P**						**1.000****	0.108	0.6162**	0.1376	0.347**
	G						**1.000****	0.0647	0.5979**	0.1055	0.3995**
LBE	**P**							**1.000****	0.8496**	0.3655**	0.0246
	G							**1.000****	0.8386**	0.4338**	0.0172
TNL	**P**								**1.000****	0.3626**	0.2036*
	G								**1.000****	0.406**	0.2319
LL	**P**									**1.000****	0.1734
	G									**1.000****	0.2315
LW	**P**										**1.000****
	G										**1.000****
TBN	**P**										
	G										
TML	**P**										
	G										
KPR	**P**										
	G										
RPC	**P**										
	G										
TW	**P**										
	G										
SH%	**P**										
	G										

CHARACTER		TBN	TML	KPR	RPC	TW	SH	Yield/Cob
DTT	P	0.2267*	0.0446	-0.1973*	0.4194**	-0.0725	-0.0588	0.1048
	G	0.2483	0.0434	-0.234	0.4533**	-0.1078	-0.0704	0.129
DTS	P	0.2206*	0.0475	-0.2103*	0.4221**	-0.0795	-0.0702	0.0831
	G	0.2362	0.0643	-0.2479	0.446**	-0.113	-0.0692	0.1037
PH	P	0.1336	0.0651	0.0097	0.1155	0.3279**	-0.069	0.1026
	G	0.1243	0.1022	0.0169	0.1177	0.368**	-0.0731	0.1015
EH	P	0.1811	-0.0116	0.0378	0.1231	0.3493**	0	0.1913
	G	0.1761	-0.0021	0.0295	0.1249	0.3829**	-0.0174	0.217
LA	P	0.0779	-0.1278	0.2176*	-0.0856	0.0339	0.0347	-0.0914
	G	0.0871	-0.1415	0.2273	-0.0937	0.0321	0.0513	-0.091
LAE	P	0.1272	-0.161	0.1135	-0.085	0.2853**	-0.2063*	-0.0098
	G	0.1178	-0.2444	0.1284	-0.0641	0.3159*	-0.267	-0.0084
LBE	P	0.1574	0.2654**	-0.1338	0.4045**	-0.0993	0.0083	0.0674
	G	0.1568	0.278*	-0.1381	0.4588**	-0.1157	0.0106	0.0795
TNL	P	0.1922	0.1248	-0.0458	0.2754**	0.0727	-0.1029	0.0482
	G	0.1902	0.0899	-0.0409	0.3335*	0.0795	-0.1372	0.0593
LL	P	0.1966*	0.2307*	-0.1003	0.3188**	0.0688	0.0734	0.0479
	G	0.2455	0.2888*	-0.1187	0.3992**	0.092	0.0673	0.06
LW	P	0.3967**	-0.3047**	0.1911	0.2586**	0.1675	-0.014	0.1594
	G	0.4908**	-0.4491**	0.2373	0.3225*	0.2075	-0.0204	0.2035
TBN	P	1.000**	-0.1691	0.0297	0.4195**	-0.0243	0.1063	0.164
	G	1.000**	-0.2056	0.025	0.4463**	-0.0285	0.1478	0.1825
TML	P		1.000**	-0.3218**	0.1397	-0.3173**	0.012	-0.1723
	G		1.000**	-0.3752**	0.166	-0.3951**	-0.0389	-0.2323
KPR	P			1.000**	-0.2313	0.2604**	0.1078	0.2961**
	G			1.000**	-0.2512	0.2718	0.1419	0.3561**
RPC	P				1.000**	-0.3276**	0.1857	0.275**
	G				1.000**	-0.348*	0.2344	0.2982*
TW	P					1.000**	0.1085	0.2146*
	G					1.000**	0.1205	0.2185
SH%	P						1.000**	0.441**
	G						1.000**	0.4614**

Table 5. Phenotypic (P) and genotypic (G) path coefficients for yield and yield attributing traits in inbred lines

CHARACTER		DTT	DTS	PH	EH	LA	LAE	LBE	TNL	LL	LW
DTT	**P**	**0.9082**	-0.9077	-0.0262	0.0582	0.0771	-0.0042	-0.0099	0.0097	-0.0723	0.0032
	G	**-0.6898**	0.7902	-0.1725	0.2002	0.1501	-0.0425	-0.0829	0.1150	-0.2399	0.0221
DTS	**P**	0.9016	**-0.9144**	-0.0264	0.0575	0.0775	-0.0040	-0.0094	0.0091	-0.0728	0.0031
	G	-0.6934	**0.7862**	-0.1721	0.1938	0.1488	-0.0469	-0.07655	0.1126	-0.2408	0.0211
PH	**P**	0.2615	-0.2649	**-0.0911**	0.2017	0.0436	-0.0544	-0.0492	0.0663	-0.0948	0.0020
	G	-0.2298	0.2613	**-0.5180**	0.7004	0.0804	-0.4313	-0.4602	0.8032	-0.2756	0.0126
EH	**P**	0.2069	-0.2061	-0.0720	**0.2552**	0.0095	-0.4476	-0.0503	0.0617	-0.0904	-0.00004
	G	-0.1697	0.1873	-0.4458	**0.8137**	0.0179	-0.3727	-0.4917	0.7839	-0.2838	0.0058
LA	**P**	-0.2801	0.2832	0.0158	-0.0097	**-0.2501**	0.0102	0.0168	-0.0180	0.0888	-0.00091
	G	0.2314	-0.2616	0.0931	-0.0327	**-0.4474**	0.0803	0.1565	-0.2172	0.2517	-0.0052
LAE	**P**	0.0327	-0.0307	-0.0415	0.0958	0.0214	**-0.1190**	-0.0144	0.0766	-0.0300	0.00751
	G	-0.0331	0.0416	-0.2526	0.3428	0.0406	**-0.8845**	-0.0745	0.8178	-0.0588	0.04451
LBE	**P**	0.0675	-0.0641	-0.0334	0.0959	0.0314	-0.0128	**-0.1340**	0.1057	-0.0797	0.00054
	G	-0.0496	0.0522	-0.2071	0.3475	0.0608	-0.0573	**-1.1512**	1.1469	-0.2419	0.0019
TNL	**P**	0.0710	-0.0671	-0.0486	0.1268	0.0362	-0.0734	-0.1139	**0.1244**	-0.0791	0.00443
	G	-0.0580	0.0647	-0.3042	0.4664	0.0710	-0.5289	-0.9653	**1.3677**	-0.2264	0.02584
LL	**P**	0.3013	-0.3053	-0.0396	0.1059	0.1018	-0.0164	-0.0490	0.0451	**-0.2181**	0.00376
	G	-0.2968	0.3395	-0.2560	0.4143	0.2019	-0.0933	-0.49944	0.5553	**-0.5576**	0.02579
LW	**P**	0.1336	-0.1317	-0.0086	-0.0004	0.0104	-0.0413	-0.0033	0.0253	-0.0378	**0.02169**
	G	-0.1370	0.1487	-0.0584	0.0428	0.0207	-0.3533	-0.0198	0.3172	-0.1291	**0.11141**
TBN	**P**	0.2059	-0.2017	-0.0121	0.0462	-0.0194	-0.0151	-0.0210	0.0238	-0.0428	0.00861
	G	-0.1712	0.1857	-0.0643	0.1433	-0.0389	-0.1042	-0.1804	0.2601	-0.1368	0.05468
TML	**P**	0.0405	-0.0434	-0.0059	-0.0029	0.0319	0.0191	-0.0355	0.0155	-0.0503	-0.00661
	G	-0.0299	0.0505	-0.0529	-0.0017	0.0633	0.2162	0.3200	0.1228	-0.1611	-0.05004
KPR	**P**	-0.1792	0.1923	-0.0008	0.0096	-0.0544	-0.0135	0.0179	-0.0057	0.0218	0.00414
	G	0.1614	-0.1949	-0.0087	0.02400	-0.1017	-0.1136	0.1590	-0.0558	0.0662	0.02644
RPC	**P**	0.3809	-0.3859	-0.0105	0.0314	0.0214	0.0101	-0.0542	0.0342	-0.0695	0.00561
	G	-0.3127	0.3506	-0.0609	0.1016	0.04191	0.05669	-0.5281	0.4561	-0.2225	0.03593
TW	**P**	-0.0658	0.0727	-0.0298	0.0892	-0.0084	-0.0340	0.0133	0.0090	-0.0150	0.00364
	G	0.0743	-0.0888	-0.1906	0.3115	-0.01435	-0.2794	0.1332	0.1087	-0.0513	0.02312
SH%	**P**	-0.0534	0.0641	0.0062	0.0000	-0.0086	0.0246	-0.0011	-0.0127	-0.0160	-0.00030
	G	0.0485	-0.0543	0.0378	-0.0142	-0.02297	0.2361	-0.0122	-0.1876	-0.03753	-0.0023

CHARACTER		TBN	TML	KPR	RPC	TW	SH	Yield/Cob
DTT	**P**	-0.00448	-0.0018	-0.0594	0.1665	-0.0133	-0.0185	0.1048
	G	-0.0017	0.00576	-0.10833	0.2303	-0.0284	-0.01828	0.1291
DTS	**P**	-0.00436	-0.0020	-0.0633	0.1675	-0.0146	-0.0221	0.0831
	G	-0.0016	0.0085	-0.1147	0.2266	-0.02985	-0.01796	0.1037
PH	**P**	-0.00264	-0.0027	0.0029	0.0458	0.0602	-0.0217	0.1026
	G	-0.00087	0.01358	0.00784	0.05978	0.0972	-0.01897	0.1015
EH	**P**	-0.00358	0.0004	0.0113	0.0488	0.0641	0.0000	0.1913
	G	-0.00124	-0.00028	0.01365	0.06344	0.1011	-0.00452	0.2170
LA	**P**	-0.00154	0.0053	0.0655	-0.0339	0.0062	0.0109	-0.0914
	G	-0.00061	-0.01881	0.10526	-0.0476	0.0085	0.01333	-0.0910
LAE	**P**	-0.00251	0.0067	0.0341	-0.0337	0.0524	-0.0650	-0.0098
	G	-0.00083	-0.03248	0.05945	-0.03256	0.08343	-0.06932	-0.0084
LBE	**P**	-0.00311	-0.0111	-0.0402	0.1606	-0.0182	0.0026	0.0674
	G	-0.0011	0.03694	-0.06396	0.23308	-0.03057	0.00276	0.0795
TNL	**P**	-0.00380	-0.0052	-0.0137	0.1093	0.0134	-0.0324	0.0482
	G	-0.00133	0.01194	-0.01892	0.1694	0.02099	-0.03563	0.0593
LL	**P**	-0.00389	-0.0097	-0.0302	0.1265	0.0126	0.0231	0.0479
	G	-0.00172	0.03839	-0.05495	0.2028	0.02431	0.01748	0.0600
LW	**P**	-0.00785	0.0128	0.0575	0.1026	0.0307	-0.0044	0.1594
	G	-0.00344	-0.05969	0.10989	0.1638	0.05482	-0.0052	0.2035
TBN	**P**	**-0.01978**	0.00711	0.0089	0.1665	-0.0044	0.0334	0.1640
	G	**-0.0070**	-0.02732	0.01159	0.2267	-0.00752	0.03836	0.1826
TML	**P**	0.00334	**-0.0421**	-0.0968	0.0554	-0.0582	0.0037	-0.1723
	G	0.00144	**0.13289**	-0.17373	0.08433	-0.1043	-0.0101	-0.2322
KPR	**P**	-0.00059	0.0135	**0.3010**	-0.0918	0.0478	0.0339	0.2961
	G	-0.00018	-0.04986	**0.4630**	-0.12764	0.0717	0.03685	0.3561
RPC	**P**	-0.0083	-0.0058	-0.0696	**0.3970**	-0.0602	0.0584	0.2750
	G	-0.0031	0.02206	-0.11632	**0.50808**	-0.0919	0.0608	0.2982
TW	**P**	0.00048	0.0133	0.0784	-0.1301	**0.1836**	0.0342	0.2146
	G	0.00020	-0.05251	0.1258	-0.17682	**0.2641**	0.03127	0.2185
SH%	**P**	-0.0021	-0.0005	0.0324	0.0737	0.0199	**0.3147**	0.4411
	G	-0.00104	-0.00517	0.06571	0.1191	0.0318	**0.25964**	0.4614

Phenotypic and genotypic residual effects were 0.5467 and 0.3948 respectively

3.3 Path Coefficient Analysis

High correlation coefficients may not always provide the full picture or may mislead decision-makers because the correlation between two variables may be caused by a third component. As a result, the cause and effect relationship between dependent and independent variables must be examined in order to determine the nature of the link.

Path coefficient analysis (Table 5) revealed that the traits total number of leaves (0.1244,1.3677), leaf width (0.02169,0.11141), No. of kernels per row (0.3010,0.4630), No. of rows per cob (0.3970,0.50808), test weight (0.1836,0.2641), shelling percent (0.3147,0.259) had a positive direct effect on grain yield per plant at both phenotypic and genotypic analysis respectively, implying that selecting for these characteristics would likely to result in an overall improvement in grain yield per plant. On the other hand, plant height (-0.0911,-0.5180), leaf angle (-0.2501,-0.4474), Number of leaves above the ear (-0.1190,-0.8845), Number of leaves below the ear (-0.134,-1.1512), Leaf length (-0.2181,-0.5576) and Tassel branch number (-0.01978,-0.0070) exhibited negative direct effect on yield/cob at both phenotypic and genotypic analysis. Most of the traits exhibited indirect influence on yield/cob through days to 50% tasseling, days to 50% silking, plant height, ear height, No. of leaves below the ear, Total number of leaves, Leaf length, Leaf width, Tassel branch number, Kernels per row, row per cob, test weight and shelling%. The results thus emphasize that selection could be more effective by indirect selection of these traits. Phenotypic and genotypic residual effects were 0.5467 and 0.3948 respectively, indicating that some characters which had due weightage in selection for yield improvement are to be included. These findings were in harmony with the findings of Raghu et al., [24] for plant height and ear height, Begum et al., [25] for days to 50% tasseling and ear height. Dan Singh Jakhar et al., (2017) for ear height.

From the results of the present study we have selected six inbred lines (Table 6) among 52 genotypes which showed desirable characters for future studies.

Table 6. Promising inbred lines identified for yield contributing traits during this study

S. No	Inbred	Characters
1	GP 88	Late maturing, tall plant, small (>45^0) leaf angle, Narrow leaf, dense tassel, medium main axis length of the tassel, medium number of rows of grains
2	PFSR 29	Medium maturing, tall plant, small (<45^0) leaf angle, narrow leaf width, dense tassel, medium main axis length of tassel, many number of rows of grains.
3	PFSR 32	Late maturing, Medium height, Narrow leaf, small leaf angle, dense tassel, Medium main axis length of the tassel, medium number of rows of grains
4	PFSR 51	Medium maturing, medium plant length, small (<45^0) leaf angle, narrow leaf width, sparse tassel, long main axis length of the tassel, medium number of rows of grains
5	BML 6	Late maturing, long plant length, small (<45^0) leaf angle, narrow leaf width, sparse tassel, high number of rows of grains.
6	BML 20	Medium maturing, short plant length, small (<45^0) leaf angle, narrow leaf width, sparse tassel, long main axis length of the tassel, high number of rows of grains.

4. CONCLUSION

From the findings of the present investigation, it may be concluded that characters plant height, total number of leaves, leaf length, leaf width, No. of Kernels per row, No. of rows per cob and shelling percent were important for selection of genotypes as these traits recorded moderate to high range of GCV, PCV, heritability, genetic advance over mean and exhibited positive significant correlations along with direct effects on yield/cob for some of the mentioned traits. So, these traits were taken into consideration for selection of following inbred lines (GP88, PFSR29, PFSR32, PFSR51, BML6, BML20) among 52 genotypes for future crossing programme.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shiferaw B, Prasanna BM, Hellin J, Banziger M. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. Food Security. 2011;3:307-327.
2. Available:http://www.agri.telangana.gov.in/
3. Ray DK, Ramankutty N, Mueller ND, West PC, Foley JA. Recent patterns of crop yield growth and stagnation. Nature Communications. 2012;3(1):1293.
4. Sangoi L, Gracietti MA, Rampazzo C, Bianchetti P. Response of Brazilian maize hybrids from different eras to changes in plant density. Field Crops Research. 2002; 79(1):39-51.
5. Begna SH, Hamilton RI, Dwyer LM, Stewart DW, Smith DL. Effects of population density on the vegetative growth of leafy reduced-stature maize in short-season areas. Journal of Agronomy and Crop Science. 1999;182(1):49-55.
6. Wang B, Lin Z, Li X, Zhao Y, Zhao B, Wu G, Ma X, Wang H, Xie Y, Li Q. Song G. Genome-wide selection and genetic improvement during modern maize breeding. Nature Genetics. 2020;52(6): 565-571.
7. Duvick DN. The contribution of breeding to yield advances in maize (*Zea mays* L.). Adv. Agron. 2005;86:83–145.
8. Niji MS. Genetic variability, heritability and character association studies in sweet corn (*Zea mays* L. *saccharata*). Electronic Journal of Plant Breeding. 2018;9(3):1038-1044.
9. Bocanski J, Sreckov Z, Nastasic A. Genetic and phenotypic relationship between grain yield and components of grain yield of maize (*Zea mays* L.). Genetika. 2009;41(2):145-154.
10. Wright S. Path coefficients and path regression: Alternative complementary concepts. Biometric. 1929;16:189-202.
11. Hefny M. Genetic parameters and path analysis of yield and its components in corn inbred lines (*Zea mays* L.) at different sowing dates. Asian Journal of Crop Science. 2011;3(3):106-117.
12. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council of Agricultural research, New Delhi; 1985.
13. Singh RK, Chaudhary BD. Biometrical Methods in Quantitative Genetic Analysis. Kalayani Publishers, New Delhi, India. 1985;318.
14. Burton GM. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Cong. 1952;1:277-283.
15. Sivasubramanian V, Madhavamenon P. Path analysis for yield and yield components of rice. Madras Ag. Journal. 1973;60:217-1221.
16. Hanson CH, Robinson HF, Comstock RE. Biometrical studies of yield in segregating populations of Korean Lespedeza. Agron. J. 1956;48:268-272.
17. Johnson HW, Robinson HF, Comstock RE. Estimation of genetic and environmental variability in soybeans. Agronomy Journal. 1955;47:314-318.
18. Wright S. Correlation and causation. J. Agric. Res. 1921;20:557-585.
19. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 1959;51:515-518.
20. Reddy VR, Jabeen F, Sudarshan MR, Rao AS. Studies on genetic variability, heritability, correlation and path analysis in maize (*Zea mays* L.) over locations. International Journal of Applied Biology and Pharmaceutical Technology. 2012; 4(1):196-199.
21. Rajwade JK, Jagadev PN, Lenka D, Gupta S. Correlation and path coefficient studies on elite genotypes of maize inbred lines. Journal of Pharmacognosy and Phytochemistry. 2018;7(2):2765-2771.
22. Verma V, Yadav MS, Kumar A, Gathiye GS. Correlation and path analysis for seed yield and components traits in maize (*Zea mays* L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(1):2278-2280.
23. Pranay G, Shashibhushan D, Rani KJ, Bhadru D, Kumar CV. Correlation and path analysis in elite maize (*Zea mays* L.) lines. International Journal of Plant & Soil Science. 2022;34(24):414-422.

24. Raghu B, Suresh J, Kumar SS, Saidaiah P. Character association and path analysis in maize (*Zea mays* L.). Madras Agricultural Journal. 2011; 98:1.

25. Begum S, Ahmed A, Omy SH, Rohman MM, Amiruzzaman M. Genetic variability, character association and path analysis in maize (*Zea mays* L.). Bangladesh J. Agril. Res. 2016;41(1):173-182.

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