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Breeding Potential of Maize Land Races for Yield and Yield Contributing Characters

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ABSTRACT: Maize landraces constitute gene pool of unexplored alleles that can be exploited to mitigate the challenges of the narrowed genetic base, declined genetic gains and reduced resilience to abiotic stress in modern varieties developed by repeated recycling of few elite breeding lines. In the present study Combining ability analysis was conducted using 15 landraces obtained from NBPGR, Hyderabad and 3 inbreds of PJTSAU in line × tester design in maize (*Zea mays* L.) to broaden the genetic base of morphological and yield contributing characters. Three land races *viz*., IC 611611 and IC 623875 and IC 623877 and two testers BML-6 and BML-7 were good general combiners for grain yield. Of the nine specific crosses for grain yield, two crosses *i.e*. IC 623875 × BML-6 and IC 611611 × KML-109 had significant grain yield over the check and forwarded to get early maturing high yielding inbreds. The estimates of general combining ability and specific combining ability revealed the preponderance of non-additive gene action in controlling the studied traits.

Keywords: Maize, combining ability, gene action, line × tester analysis.

INTRODUCTION

Maize (*Zea mays* L.) is the third most important crop in India after rice and wheat and is cultivated round the year and grain is used as feed, food and industrial raw material. Maize production in India has increased more than 16 times from a mere 2 million tons in 1949-50 to 31.65 million tons in and presently it occupies 9.89 million hectare area with the mean yield of 3.19 tons/hectare (IndiaAgriStat.com) contributing to 9% of the Indian food basket. This achievement is remarkable despites ~75% maize is grown under rainfed and low input conditions in the country. It is being estimated that the demand for maize will continue to increase in view of increasing demand in poultry and livestock sectors in the country and growing non-vegetarian population and changing food habits. To meet the growing demand, enhancement of maize yield in coming years across all the growing locations in India is the big challenge in the era of climate change.

Landraces are domesticated local varieties that have not developed through modern plant breeding programmes unlike cultivars. Landraces can be distinguished by specific morphological traits and had shown wide adaptability to biotic and abiotic stresses. They can constitute variable populations where variation can be observed between and within populations (Zeven, 1998).

In the global maize germplasm no dearth of favorable alleles was observed for improvement of yield, abiotic stress tolerance, disease resistance or nutritional quality. However, these desirable alleles are often scattered over a wide array of landraces or populations and there is a need to highlight the enormous genetic diversity found in maize, especially in the landraces and the wild relative, teosinte and novel and systematic initiatives has to be undertaken to understand and for utilization in the breeding programmes to develop biotic and abiotic stress resistant inbreds/hybrids (Bhupender *et al.*, 2019).

Combining ability analysis is of special importance in cross-pollinated crops like maize as it helps in identifying potential parents that can be used for producing hybrids and synthetics. The nature and magnitude of gene action is an important factor in developing an effective breeding program, which can be understood through combining ability analysis. Therefore, the present study was carried out to develop top crosses involving land races to estimate combining ability and to unravel the gene action governing yield and its components and drought tolerant traits.

MATERIALS AND METHODS

The present study comprised of fifteen diverse maize germplasm lines *viz*. IC623875, IC636977, IC623877, IC623873, IC611611, IC611609, IC636965, IC 627707, IC 623879, IC611615, IC 623878, IC623880, IC627704, IC 627708 and IC 627705 collected from NBPGR, Hyderabad. These lines were crossed with three testers (BML-6, BML-7 and KML-109) in line × tester mating design during *kharif*, 2021. The resultant 45 F_1 hybrids along with parents and five checks [Karimnagar makka, DHM 117, KMH-25K45, Bio-9544 and NK 6240] were evaluated in RBD in the field with three replications at ARS, Karimnagar during *Rabi*, 2021-22. Each entry was planted in two rows of 3 m length by following a spacing of 60 cm between rows and 20 cm between plants to plant. All the recommended agronomic package of practices was followed to raise a good crop. Data on fifteen quantitative characters *i.e*. plant height, ear height, ear length, ear girth, number of kernel rows and number of kernels per row, test weight (g) shelling percentage, SPAD chlorophyll content and stay green character were recorded on five randomly selected competitive plants in each replication while, days to 50 percent tasseling, days to 50 percent silking, anthesis-silking interval, days to maturity, and grain yield (kg/ha) and were recorded on plot basis.

RESULTS AND DISCUSSION

ANOVA (Table 1) revealed significant genetic differences among the genotypes for all the quantitative traits under study which is a prerequisite for any crop improvement. Variance due to hybrids and parents were highly significant for all the studied traits except Anthesis – Silking Interval (ASI) indicating the manifestation of parental genetic variability in their crosses. Mean squares for parents *Vs* crosses were highly significant (at the 0.01 level of probability) for all the characters indicating the presence of heterosis and heterotic effects. The mean squares for hybrids were partitioned into three components *viz*., due to lines, due to testers and due to line × tester interactions and differences among hybrids due to lines were significant for days to maturity only and due to testers and line × tester interactions were significant for flowering and maturity traits, plant height, ear height, ear diameter, 100 kernel weight and grain yield. This suggested that testers and crosses are variable for morphological, yield and yield contributing traits and *gca* and *sca* played a significant role in the genetic expression of these traits.

Non significant differences were observed in case of lines for all the traits except days to maturity. Although variation is non significant in lines *i.e.* maize land races crosses had shown significant variation for all the traits. This could be due to complimentary gene action of alleles at individual loci resulting in over dominance either in positive or negative or both the directions. Proportion of *sca* variance was higher than gca variance indicating possibility of exploitation of hybrids and preponderance of non additive gene action in governing the traits. Similar results were reported by Oppong Allen *et al.* (2019).

The estimates of GCA effects (Table 2) revealed that the lines IC 611611, IC 623875 and IC 624877 were good general combiners for grain yield. Line IC611611 was also a good general combiner for ear length, ear girth, number of kernel rows, number of kernels per row and 100 kernels weight apart from grain yield. For flowering and maturity traits six lines viz. IC 627704, IC 623880, IC 623878, IC 623879, IC 627707 and IC 623877 were found to be early general combiners. For kernel rows IC 636977, IC 623873, for 100 kernel weight IC 623877, for shelling percentage IC 627707 and for SPAD chlorophyll content IC 623878 were good general combiners.

Among the testers, BML-6 was good general combiner for ear diameter, number of kernel rows and number of kernels per row and BML-7 was good general combiner for thousand seed weight and SPAD chlorophyll content and for grain yield and plant height both were found to be good general combiners. For flowering, maturity traits and for shelling percentage KML-109 was a good general combiner.

Of all the forty five hybrids tested, nine crosses had positive and significant effects for grain yield and among these, four crosses involving BML-6 as tester with four lines *i.e*. IC 623873, IC 623875, IC 636965 and IC 627708, three crosses involving BM-7 as tester with three lines *i.e*. IC 611615, IC 623878 and IC 623879 and two crosses viz. IC 611611 × KML-109 and IC 623878 × KML-109 were good specific combiners for grain yield (Table 3). Among these, three crosses namely IC 623873 × BML-6, IC 623878 × BML-7 and IC 627708 × BML-6 had shown positive and significant effects for ear and grain traits i.e. ear length, number of kernel rows, number of kernels per row and 100 kernel weight and the first two had positive and significant effects for ear diameter also. Remaining crosses except IC 611615 × BML-7 had positive and significant effects for either one or two of the ear traits. For SPAD chlorophyll content IC 623877 × BML-7 had positive and significant effect. All the nine crosses had either one or both parents as good general combiners for grain yield. It clearly indicated that possibility of good specific combinations by involving good general combiners for yield and yield attributing characters.

Table 1: ANOVA for line x tester analysis for yield and yield contributing traits in maize.

Source	d.f.	DT	DS	ASI	DM	PLHT	EHT	EL
Replications	2	4.20*	3.72	0.02	36.04**	172.09	28.05	4.93*
Treatments	62	67.43**	70.58**	0.47*	66.76**	1975.32**	1312.61**	8.37**
Parents	17	18.69**	19.01**	0.19	19.50**	284.30**	294.45**	6.87**
Parents vs. Crosses	1.00	431.43**	540.80**	6.76**	305.61**	83515.37**	56370.14**	103.79**
Crosses	44	77.99**	79.81**	0.43	79.59**	775.49**	454.68**	6.78**
Lines	14	85.74	91.47	0.41	99.13*	499.42	306.10	6.19
Testers	2	454.07**	449.90**	0.27	437.96**	7255.99**	3662.79**	8.33
Lines × Testers	28	47.26**	47.55**	0.46	44.23**	450.63**	299.82**	6.97**
Error	124	1.32	1.42	0.31	2.26	111.65	48.59	1.31
gca variance		0.391	0.411	0.000	0.450	4.136	1.972	-0.002
sca variance		7.656	7.687	0.024	6.995	56.498	41.871	0.942
Additive variance (VA)		1.565	1.643	-0.001	1.801	16.544	7.886	-0.009
Dominance variance (VD)		30.625	30.749	0.097	27.979	225.992	167.483	3.769
gca variance/*sca* variance		0.051	0.053	-0.010	0.064	0.073	0.047	-0.002

Source	d.f.	ED	KR	KPR	100 KW (g)	Sh(%)	SPAD	GY
Replications	2	0.22	0.09	54.05**	68.10**	2.98	107.48**	8527727.9**
Treatments	62	0.68**	4.36**	64.46**	30.49**	17.44**	62.17**	18570972.5**
Parents	17	0.52**	4.81**	17.02**	15.00**	16.59**	75.35**	2254774.6**
Parents vs. Crosses	1.00	20.50**	77.69**	2058.43**	525.41**	503.18**	331.42**	757019626.6**
Crosses	44	0.29**	2.52**	37.47**	25.22**	6.73**	50.96**	8092034.1**
Lines	14	0.26	1.79	40.69	21.52	7.72	33.36	7765023.6
Testers	2	1.68**	7.27	39.32	111.20*	11.45	219.87	46080940.3**
Lines × Testers	28	0.21**	2.55**	35.74**	20.93**	5.90	47.70	5542046.1**
Error	124	0.08	0.36	5.50	4.53	3.79	14.05	523212.8
gca variance		0.001	0.000	0.022	0.055	0.011	0.042	32465
sca variance		0.022	0.365	5.039	2.734	0.352	5.608	836472
Additive variance (VA)		0.004	-0.001	0.089	0.218	0.042	0.166	129861
Dominance variance (VD)		0.089	1.459	20.154	10.935	1.409	22.432	3345889
gca variance/*sca* variance		0.045	-0.001	0.004	0.020	0.030	0.007	0.039

*Significant at P<0.05; **Highly significant at P<0.01

Table 2: Estimates of general combining ability effects of parents for yield and its contributing characters in maize.

Lines	DT	DS	ASI	DM	PLHT	EHT	EL	ED	KR	KPR	100KW	Sh	SPAD	GY
IC 623875	4.119**	4.496**	0.378*	4.556**	-4.384	-2.203	-0.04	0.193*	0.144	0.950	0.981	-1.136	-1.049	1167.727**
IC 636977	4.341**	4.385**	0.044	4.444**	17.727**	15.53**	-0.063	-0.089	0.733**	0.739	-1.147	-1.025	-1.716	229.260
IC 623877	-1.104**	-1.17**	-0.067	-1.111*	8.727*	5.641*	0.515	0.109	0.344	0.684	2.538**	-0.016	-2.182	664.287**
IC 623873	-0.215	-0.17	0.044	-0.111	3.616	1.197	0.448	0.219*	0.455*	0.395	0.855	-0.604	-0.524	446.982
IC 611611	4.452**	4.385**	-0.067	4.444**	-3.161	-2.025	1.548**	0.413**	0.81**	4.017**	3.322**	-1.086	0.727	2150.910**
IC 611609	-0.215	0.163	0.378*	0.000	-2.828	-3.914	-0.963*	-0.148	-0.334	-2.327**	0.311	0.345	2.285	-67.107
IC 636965	4.119**	4.274**	0.156	5.444**	8.061*	3.197	0.348	-0.166	-0.567**	-0.327	-1.469*	0.111	-0.220	-340.217
IC 627707	-2.326**	-2.393**	-0.067	-2.667**	-1.828	-1.47	-0.552	-0.055	-0.279	-0.616	-1.429*	1.842**	-0.990	-727.072**
IC 623879	-2.215**	-2.059**	0.156	-2.000**	-0.161	5.197*	0.215	-0.122	-0.323	1.374	-1.462*	0.966	0.178	-406.725
IC 611615	1.23**	1.274**	0.044	0.222	-5.05	-4.47	0.459	0.083	-0.123	0.884	0.418	-0.146	2.343	-85.368
IC 623878	-3.993**	-4.17**	-0.178	-4.000**	-6.939	-6.470**	-2.03**	-0.206*	-0.701**	-5.905**	-1.807*	-0.982	3.551**	-1691.020**

IC 623880	-4.881**	-4.948**	-0.067	-5.000**	-3.606	-3.247	-0.841*	-0.072	-0.056	-0.872	-1.481*	0.76	0.570	-897.783**
IC 627704	-2.77**	-3.17**	-0.4*	-3.222**	-1.828	-5.359*	0.426	-0.006	0.188	0.217	-0.567	0.463	-2.665*	-851.005**
IC 627708	-0.437	-0.504	-0.067	-0.556	-12.628**	-5.025*	0.326	-0.103	-0.279	0.906	0.750	1.189	2.129	428.342
IC 627705	-0.104	-0.393	-0.289	-0.444	4.283	3.419	0.204	-0.051	-0.012	-0.116	0.185	-0.682	-2.439	-21.212
SE±	0.383	0.398	0.186	0.501	3.522	2.324	0.382	0.093	0.201	0.782	0.710	0.649	1.249	241.112
Testers														
BML-6	2.741**	2.785**	0.044	2.978**	1.505	5.064**	0.151	0.147**	0.464**	1.079**	0.250	-0.229	-2.484**	882.692**
BML-7	0.741**	0.652**	-0.089	0.267	11.879**	5.353**	0.335	0.072	-0.252**	-0.521	1.432**	-0.349	1.751**	221.724*
KML-109	-3.481**	-3.437**	0.044	-3.244**	-13.384**	-10.416**	-0.485**	-0.219**	-0.212*	-0.558	-1.682**	0.578*	0.732	-1104.416**
SE±	0.171	0.178	0.083	0.224	1.575	1.039	0.171	0.042	0.090	0.350	0.317	0.290	0.559	107.828

*Significant at P<0.05; **Highly significant at P<0.01

Table 3: Specific combining ability effects of hybrids for yield and its contributing characters in maize.

Crosses	DT	DS	ASI	DM	PLHT	EHT	EL	ED	KR	KPR	100KW	Sh	SPAD	GY
IC 623875 × BML-6	0.481	0.215	-0.267	0.133	-4.727	-0.441	1.852**	0.169	0.47	3.476*	1.992	0.449	5.897**	1675.653**
IC 623875 × BML-7	2.148**	2.015**	-0.133	2.178*	-8.434	-5.064	-0.036	0.153	-0.815*	0.143	2.507*	-2.143	-1.571	-187.935
IC 623875 × KML-109	-2.630**	-2.230**	0.4	-2.311**	13.161*	5.505	-1.816**	-0.322*	0.345	-3.619**	-4.499**	1.694	-4.325*	-1487.718**
IC 636977 × BML-6	-0.074	-0.341	-0.267	-0.422	18.495**	11.159**	-0.462	-0.254	-0.553	-2.779*	-2.140	-0.864	-2.659	307.245
IC 636977 × BML-7	3.259**	2.793**	-0.467	2.956**	-24.879**	-17.464**	-0.279	0.197	-0.337	0.154	2.395	-0.582	1.42	-349.782
IC 636977 × KML-109	-3.185**	-2.452**	0.733*	-2.533**	6.384	6.305	0.741	0.057	0.890*	2.625	-0.255	1.445	1.239	42.538
IC 623877 × BML-6	4.370**	4.881**	0.511	4.800**	-4.172	-9.286*	-0.839	0.309	0.603	-1.924	-0.405	0.487	-0.853	632.641
IC 623877 × BML-7	-6.630**	-6.652**	-0.022	-6.489**	-13.879*	-6.575	-0.524	-0.218	-0.281	0.343	-1.526	-0.401	8.895**	-992.187*
IC 623877 × KML-109	2.259**	1.77*	-0.489	1.689	18.05**	15.861**	1.363*	-0.091	-0.321	1.581	1.931	-0.086	-8.042**	359.546
IC 623873 × BML-6	4.815**	5.215**	0.4	5.133**	13.939*	13.492**	2.627**	0.412*	0.892*	3.099*	4.355**	-2.151	2.449	1695.495**
IC 623873 × BML-7	-5.185**	-5.652**	-0.467	-5.489**	-10.767	-8.130*	-2.757**	-0.193	0.007	-2.701*	-2.453*	1.782	-4.376*	-1541.299**
IC 623873 × KML-109	0.37	0.437	0.067	0.356	-3.172	-5.361	0.13	-0.219	-0.899*	-0.397	-1.902	0.369	1.927	-154.197
IC 611611 × BML-6	-0.519	-0.674	-0.156	-0.756	2.05	0.047	0.227	0.086	-1.264**	1.743	0.038	-1.467	-2.925	-1424.959**
IC 611611 × BML-7	3.148**	3.126**	-0.022	3.289**	-4.99	-4.908	0.643	-0.021	-0.148	1.143	-1.411	0.527	3.653	-275.233
IC 611611 × KML-109	-2.630**	-2.452**	0.178	-2.533**	2.939	4.861	-0.87	-0.065	1.412**	-2.886*	1.373	0.941	-0.728	1700.192**
IC 611609 × BML-6	1.815**	2.215**	0.4	2.356**	-6.95	-10.064*	-2.195**	-0.269	-0.019	-3.313*	-1.415	-2.395*	2.814	-626.336
IC 611609 × BML-7	-1.852**	-1.985**	-0.133	-1.6	15.01*	17.314**	1.021	0.012	-0.004	1.187	1.380	1.775	0.019	159.847
IC 611609 × KML-109	0.037	-0.23	-0.267	-0.756	-8.061	-7.25	1.174	0.257	0.023	2.125	0.034	0.62	-2.832	466.489
IC 636965 × BML-6	0.148	0.437	0.289	-0.756	-6.505	-6.841	1.361*	0.141	0.247	4.554**	3.899**	0.081	-3.599	1112.200**
IC 636965 × BML-7	3.481**	3.237**	-0.244	2.289**	-2.212	-2.797	-0.457	-0.099	-0.437	-2.713*	0.460	0.01	0.433	-347.713
IC 636965 × KML-109	-3.630**	-3.674**	-0.044	-1.533	8.717	9.639*	-0.904	-0.041	0.19	-1.842	-4.359**	-0.091	3.166	-764.487
IC 627707 × BML-6	-2.407**	-2.230**	0.178	-2.311**	-2.95	-5.508	-0.673	-0.042	-0.241	0.976	-1.248	1.576	-0.835	-604.609
IC 627707 × BML-7	0.926	1.237	0.311	1.733*	3.677	1.203	-0.057	0.025	0.807*	-2.590	0.154	-0.544	-0.63	305.208
IC 627707 × KML-109	1.481*	0.993	-0.489	0.578	-0.727	4.305	0.73	0.017	-0.566	1.614	1.094	-1.032	1.466	299.401

IC 623879 × BML-6	-2.852**	-2.896**	-0.044	-2.978**	-4.616	3.825	0.161	0.095	-1.864**	-1.347	0.049	1.011	1.427	-1200.753**
IC 623879 × BML-7	0.148	0.57	0.422	0.733	10.01	1.203	1.21	-0.153	1.119**	3.386*	0.020	-0.454	-0.615	1389.044**
IC 623879 × KML-109	2.704**	2.326**	-0.378	2.244*	-5.394	-5.028	-1.370*	0.058	0.745*	-2.039	-0.069	-0.557	-0.812	-188.291
IC 611615 × BML-6	-2.630**	-2.896**	-0.267	-1.867*	5.606	1.825	0.516	0.19	0.47	2.143	0.125	1.627	-1.734	-835.927*
IC 611615 × BML-7	2.370**	2.237**	-0.133	0.178	2.566	6.203	-0.701	0.022	0.185	-1.924	0.364	-2.197	0.121	1331.036**
IC 611615 × KML-109	0.259	0.659	0.4	1.689	-8.172	-8.028*	0.185	-0.212	-0.655	-0.219	-0.489	0.57	1.613	-495.108
IC 623878 × BML-6	-8.407**	-8.785**	-0.378	-8.644**	-12.839*	-9.175*	-3.162**	-0.692**	-1.419**	-9.201**	-4.457**	0.794	6.680**	-2546.952**
IC 623878 × BML-7	3.593**	3.681**	0.089	3.733**	14.121*	13.870**	1.454*	0.443**	1.296**	3.799**	2.651*	0.929	-4.321*	1453.491**
IC 623878 × KML-109	4.815**	5.104**	0.289	4.911**	-1.283	-4.695	1.707*	0.249	0.123	5.403**	1.805	-1.723	-2.359	1093.461**
IC 623880 × BML-6	-2.185**	-2.341**	-0.156	-1.978*	-14.172*	-4.73	-0.651	-0.141	0.336	0.832	-2.752*	1.361	-4.159	-1057.02*
IC 623880 × BML-7	1.815**	1.793*	-0.022	2.067*	8.455	2.647	-0.035	0.061	0.119	-2.301	0.276	-0.238	1.56	416.787
IC 623880 × KML-109	0.37	0.548	0.178	-0.089	5.717	2.083	0.685	0.08	-0.455	1.469	2.477*	-1.123	2.599	640.232
IC 627704 × BML-6	-2.296**	-2.119**	0.178	-2.089*	12.05*	9.714*	0.483	-0.065	1.492**	-0.124	-1.570	0.293	-1.246	-497.667
IC 627704 × BML-7	0.704	1.015	0.311	1.289	4.344	2.092	0.332	-0.105	-1.059**	0.943	-1.322	-0.216	-0.038	205.483
IC 627704 × KML-109	1.593*	1.104	-0.489	0.8	-16.394**	-11.806**	-0.815	0.17	-0.433	-0.819	2.892*	-0.078	1.285	292.184
IC 627708 × BML-6	5.037**	4.881**	-0.156	4.911**	-3.15	-3.953	1.783**	0.272	0.692*	3.787**	2.980*	-0.349	0.503	2959.295**
IC 627708 × BML-7	-4.296**	-3.985**	0.311	-3.711**	7.077	1.759	-0.668	-0.147	-0.593	0.121	-2.862*	0.748	-2.249	-1608.372**
IC 627708 × KML-109	-0.741	-0.896	-0.156	-1.2	-3.927	2.194	-1.115	-0.125	-0.099	-3.908**	-0.118	-0.398	1.747	-1350.923**
IC 627705× BML-6	4.704**	4.437**	-0.267	4.467**	7.939	9.936*	-1.028	-0.21	0.159	-1.924	0.549	-0.454	-1.76	411.694
IC 627705 × BML-7	-3.630**	-3.430**	0.2	-3.156**	-0.101	-1.353	0.854	0.022	0.141	1.010	-0.633	1.005	-2.298	41.623
IC 627705 × KML-109	-1.074	-1.007	0.067	-1.311	-7.839	-8.584*	0.174	0.187	-0.299	0.914	0.084	-0.551	4.058	-453.318
SE ±	0.663	0.689	0.322	0.867	6.100	4.025	0.662	0.162	0.348	1.355	1.229	1.124	2.164	417.617

*Significant at P<0.05; **Highly significant at P<0.01

Table 4: Estimates of perse of promising crosses for yield and its contributing characters in maize.

Lines	DT	DS	DM	PLHT	EHT	EL	ED	KR	KPR	100KW	Sh	GY	GY (sca)
IC 627708 × BML-6	66	69	110	202	113	19.13	4.91	16.27	38.40	32.85	79.93	13178	2959.295**
IC 611611 × KML-109	57	60	101	203	109	17.07	4.72	17.40	33.20	31.89	79.75	11654	1700.192**
IC 623873 × BML-6	66	70	110	236	137	20.10	5.37	17.20	37.20	34.33	76.33	11933	1695.495**
IC 623875 × BML-6	66	69	110	209	119	18.84	5.10	16.47	38.13	32.10	78.40	12634	1675.653**
IC 623878 × BML-7	58	61	101	238	129	18.63	4.39	15.93	36.87	28.86	79.48	10112	1389.044**
IC 611615 × BML-7	63	66	103	226	124	16.97	4.77	15.20	31.07	31.09	76.62	10375	1331.036**
IC 636965 × BML-6	66	69	110	220	118	18.73	4.71	15.53	37.93	31.55	79.28	10562	1112.200**

Further based on per se performance only four crosses IC 627708 × BML-6 IC 623875 × BML-6, IC623873 × BML-6 and IC 611611 × KML-109 had significant effects for grain yield with grain yields of 13178 kg/ha, 12634 kg/ha, 11933 kg/ha and 11654 kg/ha, respectively and the IC 611611 × KML-109 was an early hybrid. The high yields obtained from some of the crosses indicate the potential to raise yield substantially in maize landraces when crossed with suitable materials. Similar findings have been reported in other studies as reported by Dhillon *et al*., (2002); Prasanna, (2012). It revealed that one of the parent must be a good general combiner in the exploitation of land races for getting high yielding hybrids but not necessarily a good specific combiner.

CONCLUSION

Present climate change scenario and scarcity of irrigation water emphasized the need of development of drought-tolerant maize of genotypes/base population that can perform reasonably well in drought-stress environments is the most important objective in any maize breeding programmes. Finally based on *per se* performance and *sca* effects, crosses *i.e.*, IC 627708 × BML-6 IC 623875 × BML-6, IC623873 × BML-6 (grain yield) and IC 611611 × KML-109 (maturity) are to be forwarded to generate highly segregating lines with high grain yield and early maturity and these filial generations are to be screened for major biotic and abiotic stresses so that high yielding inbreds resistant to biotic and abiotic stresses will be obtained.

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Conflicts of interest. None.

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