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Studies of combining ability in maize (*Zea mays* L.,) hybrids using Line x Tester analysis

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Abstract
The present study was conducted during *Kharif* 2022 using total 56 maize entries (including 40 maize hybrids, 13 parents and 3 standard checks) to assess the combining ability for grain yield and its contributing traits. IAMI 123, IAMI 112 and HKI 163 were found good general combiner for most of the traits among all the parental line. IAMI 123 was to be a good general combiner for grain yield (q/ha), final plant stand (thousand/ha) and No of ears (thousand/ha). For 100 grain wt (g), IAMI 112 and the traits *viz*., final plant stand (thousand/ha), No. of ears (thousand/ha), No. of kernel rows/ ear, tester HKI 163 was to be a good general combiner. For earliness traits *viz*., days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity IAMI 112, IAMI123 and HKI 163 were found good general combiner. Among the testers LM 13 would be a good general combiner for grain yield (q/ha), 100 grain wt (g) and ear length (cm), while BML 6 is good for earliness (days to 80% brown husk maturity) and No. of kernel rows/ear. For grain yield (q/ha) a close examine of the results with respects to sca effects indicated that only seven crosses *viz*., IAMI-101 X LM-13, IAMI-112 X HKI-163, IAMI-112 X CML-451, IAMI-118 X LM-13, IAMI-121 X CML-451, IAMI-123 X LM-14 and IAMI-123 X BML-6 were found significant sca among forty crosses. Therefore, these hybrids are considered as best specific combiner for grain yield (q/ha) and would be used in a hybridization programme.

Keywords: Maize, combining ability, SCA and GCA

Introduction
Maize (*Zea mays* L., 2n=20) is the third most important cereal crop after wheat and rice and it occupies a prominent position in global agriculture. Maize is a member of the grass family Poaceae (Gramineae), tribe Maydeae and believed to have originated in Southern Mexico and Guatemala (Weatherwax, 1955) [25]. Maize plays a significant role in human and livestock nutrition worldwide due to its diversified uses as food for human, feed for live stocks and poultry. It is also a source of industrial raw material for the production of flour, flakes, corn starch, corn oil, corn syrup, glucose, alcohol, ethanol, gluten, dextrose, custard powder and many more products (Patel, 2022) [18]. India produces 2% of the world's production and 5% of the world's maize acreage (Tripathi *et al*., 2011) [23]. India ranks 4th in terms of area and 7th in production of maize globally (Patel, 2022) [18]. It currently covers 9.89 million hectares in India, producing 31.65 metric tonnes with an average yield of 3.19 t/ha, is significantly lower than the global average of 5.82 t/ha (IIMR, Annual Report 2022) [7]. Maize is also known as 'Queen of cereals' due to its high yield potential among cereals. In Canada and the United States it referred to as "corn", which literarily means "that which sustains life" (Akinyele and Adigun, 2006) [1]. In India it has many common/local name whereas, in Chhattisgarh *"Makka, Makai*, *Bhutta* and *Jondra*" is a most common and popularized crop in the state. Due to monoecious plant habit and protandrous nature of maize, it becomes a highly cross-pollinated and where anemophilous pollination is found in it. Combining ability analysis is of special importance in cross pollinated crops as it helps in identifying potential inbred parents that can be used for producing hybrids. Such studies also help in elucidating the nature and magnitude of different types of gene action governing the expression of quantitative characters of economic importance (Pal and Prodhan, 1994) [17]. The GCA effects involve additive, additive x additive type of gene action which shows fixable genetic variance can be exploited through selection and hybridization programme. Another important aspect from practical point of view which needs consideration for the identification of potential cross combinations with respect to grain yield and its contributing traits.

The specific combining ability effects shows dominance and epistatic gene effects which can be used as an index to determine the usefulness of a particular cross combination for exploitation through heterosis breeding and hybridization programme.

Thus, the present study was undertaken to estimate the combining ability of parents and hybrids, nature and Magnitude of gene action for grain yield and its contributing traits in maize by adopting Line x Tester analysis (Kempthorne, 1957) [12]. The design has been widely used in maize by several workers and continues to be applied in quantitative genetic studies in maize (Joshi *et al*., 2002; Sharma *et al*., 2004) [8, 19].

Materials and Methods

The experimental material comprising of 8 inbred lines *viz*., IAMI 101, IAMI 106, IAMI 111, IAMI 112, IAMI 115, IAMI 118, IAMI 121 and IAMI 123 were crossed with 5 testers namely LM-13, LM-14, HKI 163, CML 451 and BML 6 were collected from All India Co-ordinated Research Project on Maize, section of Genetics & Plant Breeding, RMD CARS Ambikapur Chhattisgarh. To obtained 40 maize hybrids parents were crossed in a Line X Testers mating design during *Rabi* 2021-22. These forty crosses, along with their 13 parents (eight lines and five testers) and 3 checks namely NK-30, CoH (M) 8, and CGASM-1 were used to study the combining ability (GCA and sca effect) for grain yield and it's contributing traits. These experiment materials were evaluated in Randomized Complete Block Design with three replications, during *Kharif*-2022 at Research and instructional farm of IGKV, RMD College of Agriculture & Research Station, Ambikapur (Distt.- Surguja), Chhattisgarh. To raise a good maize crop all necessary agronomic practices had been applied. The data were recorded for fourteen traits *viz*., final plant stand (thousand/ha), days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, no of ears (thousand/ha), plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), 100-grain wt (g), no of kernel rows/ear, no of kernels/row, shelling percentage and grain yield (q/ha) in randomly selected five plants from each replication. The collected data was analyzed, analysis of variance for line x tester design and combining ability effects (GCA and SCA) were worked out as per suggested by Kempthorne (1957) [12].

Results and Discussions

Analysis of variances for Line x Tester analysis

In the present study, the analysis of variance for L x T analysis for grain yield and its contributing traits (Table-1) were significant variation among the parent and cross combination for most of the traits. The mean sum of squares due to crosses, were highly significant for all the characters indicating significant heterotic response except final plant stand (thousand/ha), No. of ears (thousand/ha), ear length (cm) and shelling percentage.

The mean sum of squares due to line effect were showed highly significant for most of the traits *viz*., days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, ear height(cm), plant height (cm), ear girth (cm) and No. of kernel rows/ear. While, the traits *viz*., days to 50% tasseling, days to 50% silking, 100 grain weight (g) ear length (cm), ear girth (cm), No. of kernel rows/ear and grain yield (q/ha) were showed significant for tester effect.

The mean sum of squares due to line × tester effect was significant for days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, ear height (cm), plant height (cm), 100 grain weight (g), no. of kernels/row, and grain yield (q/ha) and rest of traits *viz*., final plant stand (thousand/ha), No. of ears (thousand/ha), ear length (cm), ear girth (cm), no. of kernel rows /ear and shelling percentage were non-significant. The variance due to line, testers and Line x Tester interaction was highly significant for almost all the traits it indicated that there was good levels of genetic differences present in studied materials (among lines and testers). This present finding if confirmed by previous scientist of Sinha *et al.* (2017) [22], Junaidu *et al.* (2015) [9], Amiruzzaman *et al.* (2013) [3], Mural and Chikkalingaiah (2012) [15], Kanagarasu *et al.* (2010) [11] and Uddin *et al.* (2008) [24].

Table 1: Analysis of variance for Line x Tester analysis for grain yield and its contributing traits in maize

Source of Variations	DF	FPP	DT	DS	DM	EH	PH	NE	SW	EL	EG	NKR	NK	SH	GY
Replication	2	2.01	0.4	0.7	0.2	67.6	234.5	9.1	4.9	2.4	0.1	0.6	11.9	1.5	0.5
Crosses	39	67.7	5.8**	7.4**	22.3**	100.4**	295.7**	84.3	71.0**	1.8	0.2**	3.5**	11.5**	2.3	155.5**
Line Effect	7	78.1	13.4**	18.4**	66.4**	283.6**	884.2**	85.4	85.4	0.7	0.3**	10.6**	15.1	1.9	19.3
Tester Effect	4	46.5	9.4*	13.3*	14.6	24.4	147.5	71.7	216.1**	6.02**	0.24**	8.3**	10.2	0.2	652.9**
Line * Tester Eff.	28	68.2	3.5**	3.8**	12.4**	65.4**	169.7*	85.8	46.7**	1.5	0.05	1.04	10.8**	2.6	118.5**
Error	78	46.4	0.5	0.5	0.7	19.1	100.5	61.1	10.5	1.6	0.1	0.9	5.9	2.1	27.1
Total	119	62.9	2.9	3.3	7.4	76.5	362.5	76.4	35.6	2.5	0.2	2.1	18.3	10.5	157.9

**Significant at P=1% & *Significant at P=5%

FPP= Final plant stand (thousand/ha), DT= Days to 50% tasseling, DS= Days 50% silking, DM= Days to 50% maturity, EH= Ear height (cm), PH= Plant height (cm), NE= Number of ears (thousand/ha), SW=100 grain weight (g), EL= Ear length (cm), EG= Ear girth (cm), NKR= No. of kernel rows/ear,

NK= No. of kernels/row, SH= Shelling percentage, GY= Grain yield (q/ ha).

Combining ability (GCA and SCA) effects

Combining ability analysis is useful to assess the potential of parents (inbred lines) with high GCA and parental combination with high GCA. General combining ability (GCA) effects contributes a significant role in making choice of parents & also selection of germplasm base for utilization in hybrid breeding programmes for further improvement. The estimates of GCA & SCA effects were worked out for grain yield and its all contributing traits in 8 lines, 5 testers and 40 crosses of maize has been presented in Table-2 and 3 respectively.

IAMI 123, IAMI 112 and HKI 163 were good general combiner for most of the traits among all the parental line. Traits wise estimation of GCA effects of line IAMI 123 were found had positive GCA effects for grain yield (q/ha), final plant stand (thousand/ha) and No of ears (thousand/ha) whereas traits *viz*., days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, ear height (cm) and plant height (cm) had negative GCA effects for earliness and short structure plant type thus this line would be good general combiner these traits. IAMI 112 had a significant negative GCA effect for days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, ear height (cm) and plant height (cm) is a desirable traits for earliness and short plant whereas, 100 grain wt (g) had a significant positive GCA effect so this line is to be a good general combiner for these traits. IAMI 101 was good general combiner for earliness (days to 50% tasseling and days to 50% silking), while, IAMI 118 was good general combiner for earliness (days to 80% brown husk maturity), ear height (cm) and No. of kernel rows/ear. IAMI 121 had positive significant GCA effects for ear girth (cm) and No. of kernel rows/ear. IAMI 111 had positive GCA for No of ears (thousand/ha) and ear length (cm) thus these parents would be a good general combiner for respective traits.

Among the testers LM 13 would be a good general combiner for grain yield (q/ha), 100 grain wt (g) and ear length (cm) with positive GCA effect, while BML 6 is good for earliness(days to 80% brown husk maturity) and No. of kernel rows/ear. HKI 163 were good general combiner for most of the traits *viz*., final plant stand (thousand/ha), No. of ears (thousand/ha), No. of kernel rows/ ear and for earliness in traits like days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity. The results were further strengthened by the earlier finding of Gowda *et al.* (2013) [6], Kanagarasu *et al.* (2010) [11], Kumar *et al.* (2015) [13], Kabdal *et al.* (2003) [10], Sharma *et al.* (2019) [20], and Ambikabathy *et al.* (2019) [2].

For grain yield (q/ha) a close examine of the results with respects to sca effects indicated that only seven crosses *viz.*, IAMI-101 X LM-13, IAMI-112 X HKI-163, IAMI-112 X CML-451, IAMI-118 X LM-13, IAMI-121 X CML-451, IAMI-123 X LM-14 and IAMI-123 X BML-6 were found significant sca among forty crosses. Therefore, these hybrids are considered as best specific combiner for grain yield (q/ha) and would be used in a hybridization programme. Crosses IAMI-106 X LM-14, IAMI-112 X BML-6, IAMI-118 X LM-13 and IAMI-123 X BML-6 were desirable with negative sca effects for earliness in all three traits *viz*., days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, while IAMI-106 X CML-451, IAMI-115 X BML-6, IAMI-121 X LM-14, IAMI-121 X CML-451, IAMI-115 X LM-14 these crosses were also recognized for early maturity. Crosses *viz*., IAMI-101 X LM-13, IAMI-106 X HKI-163, IAMI-111 X CML-451, IAMI-111 X BML-6, IAMI-115 X LM-13, IAMI-118 X LM-14 and IAMI-123 X BML-6 were showed positive significant for 100 grain wt. (g) while for No. of ears (thousand/ha) significant positive sca was recorded by crosses IAMI-115 X LM-14 and IAMI-123 X BML-6. IAMI-101 X LM-14, IAMI-111 X CML-451 were recorded as good specific combiner for ear length (cm) whereas crosses *viz*., IAMI-112 X CML-451 and IAMI-123 X HKI-163 were identified as good specific combiner for No. of kernel rows/ ear and No. of kernels/rows respectively.

The estimates of gene action were worked out for grain yield and its all contributing traits were shown in Table-4. The additive to dominance variance ratio is less than unity showing the predominance of non additive components of gene action and was recorded for the traits *viz*., final plant stand (thousand/ha), days to 50% tasseling, days to 50% silking, days to 80% brown husk maturity, ear height (cm), plant height (cm), no. of ears (thousand/ha), 100 grain weight (g), no. of kernels/row, shelling percentage and grain yield (q/ha). The traits *viz*., ear length (cm), ear girth (cm) and no. of kernel rows /ear govern additive gene action due to the additive to dominance variance ratio is more than unity thus the direct selection would be rewarding for such traits. This result can be confirmed by the results of Kuselan *et al.* (2017) [14], Beruk (2021) [5], Murtadha *et al.* (2018) [16], Singh *et al.* (2017) [21], Kumar *et al.* (2015) [13], Uddin *et al.* (2008) [24], and Assefa *et al.* (2017) [4].

Table 2: General Combining Ability (GCA) effects of line & testers for grain yield & its contributing traits in maize at Ambikapur

S.N.	Traits / Parents	FPP	DT	DS	DM	EH	PH	NE	SW	EL	EG	NKR	NK	SH	GY
	Lines														
1	IAMI 101	0.5	-1.4**	-1.5 **	0.9 **	6.9 **	9.6 **	0.5	-1.3	-0.1	-0.2**	-0.54 *	-0.18	-0.16	-1.11
2	IAMI 106	2.2	1.3 **	1.3**	3.8 **	4.1**	11.3 **	2.1	0.4	-0.2	-0.1	-0.03	1.62 **	-0.52	-0.18
3	IAMI 111	0.3	0.3	0.3	1.3 **	1.8	4.7	0.4	2.1 *	-0.1	0.2**	0.07	0.35	-0.49	0.78
4	IAMI 112	-1.8	-0.7 **	-0.8 **	-2.9 **	-3.7 **	-6.5 *	-1.8	3.6 **	0.4	-0.04	-0.91**	-1.22*	0.49	1.04
5	IAMI 115	-0.6	0.2	0.1	-0.6 **	-3.7 **	-5.1	-0.7	0.4	-0.1	0.06	0.47*	0.61	0.16	-1.97
6	IAMI 118	1.5	-0.2	-0.3	-1.1 **	-3.1 *	-4.6	1.1	0.8	-0.2	0.03	-0.06	1.02	0.26	-0.18
7	IAMI 121	-4.5*	1.3 **	1.8 **	0.3	2.3	-0.5	-4.5 *	-3.9**	-0.1	0.18**	1.75**	-0.12	0.09	0.16
8	IAMI 123	2.4*	-0.7**	-0.7 **	-1.9 **	-4.7**	-8.9**	3.1*	-2.2**	0.3	-0.20 **	-0.73**	1.16	0.16	1.46*
SE (LINES)		1.79	0.19	0.19	0.20	1.21	2.58	2.00	0.79	0.30	0.06	0.23	0.59	0.36	1.23
	Testers														
1	LM 13	-0.9	0.5**	0.7 **	-0.1	-0.4	2.3	-0.3	4.5**	0.7**	-0.09	-0.85**	-0.16	0.05	9.16**
2	LM 14	-1.1	0.3 *	0.5 **	0.6 **	1.2	3.1	-1.7	1.1	0.3	0.09	0.28	0.13	-0.04	-0.87
3	HKI 163	2.2*	-1.1 **	-1.2**	-0.9 **	0.2	-2.4	2.8*	-3.5**	0.1	-0.07	0.55**	0.46	0.07	-2.12*
4	CML 451	-0.7	0.2	0.1	0.9 **	0.6	-1.3	-0.9	-0.6	-0.4	-0.05	-0.37 *	-1.03*	0.04	-2.57 *
5	BML 6	0.5	0.1	-0.1	-0.5 **	-1.5	-1.7	0.2	-1.4 *	-0.5*	0.12*	0.38*	0.61	-0.13	-3.61**
SE (TESTER)		1.41	0.15	0.15	0.16	0.95	2.04	1.58	0.63	0.24	0.05	0.18	0.47	0.28	0.97

**Significant at P=1% & *Significant at P=5%

FPP= Final plant stand (thousand/ha), DT= Days to 50% tasseling, DS= Days 50% silking, DM= Days to 50% maturity, EH= Ear height (cm), PH= Plant height (cm), NE= Number of ears (thousand/ha), SW=100 grain weight (g), EL= Ear length (cm), EG= Ear girth (cm), NKR= No. of kernel rows/ear, NK= No. of kernels/row, SH= Shelling percentage, GY= Grain yield (q/ ha).

Table 3: Specific Combining Ability (SCA) effects of line & testers for grain yield & its contributing traits in maize at Ambikapur

S. N.	Traits / Hybrids	FPP	DT	DS	DM	EH	PH	NE	SW	EL	EG	NKR	NK	SH	GY
1	IAMI-101 X LM-13	2.4	-0.7	-0.7	-0.7	-11.6**	-14.0*	3.8	3.6*	-0.5	0.03	0.2	-1.9	0.3	7.2*
2	IAMI-101 X LM-14	-3.05	-0.1	-0.3	0.6	7.9**	8.5	-4.0	1.3	1.4*	0.05	0.4	2.3	-1.3	0.9
3	IAMI-101 X HKI-163	-1.8	0.3	0.5	0.4	0.3	-0.7	-1.3	1.5	-0.01	-0.02	-0.2	-0.9	-0.6	-2.9
4	IAMI-101 X CML-451	2.5	0.4	0.6	-0.5	0.8	-2.4	2.9	-3.0	-0.8	0.11	-0.01	0.09	0.5	-4.9
5	IAMI-101 X BML-6	-0.06	0.1	-0.05	0.3	2.5	8.6	-1.4	-3.4	0.3	-0.17	-0.5	0.5	1.07	-0.2
6	IAMI-106 X LM-13	-0.9	-0.4	-0.3	-1.6**	-0.3	-1.4	0.5	2.2	0.4	0.14	0.7	-0.5	-0.5	1.5
7	IAMI-106 X LM-14	-3.8	0.9*	0.9 *	2.7**	0.1	4.3	-4.8	-1.4	-0.3	-0.13	-0.4	-1.7	-1.7*	-1.7
8	IAMI-106X HKI-163	2.5	-0.7	-1.3**	-2.2**	3.9	7.3	2.2	4.2*	0.07	-0.01	0.04	-1.5	-1.09	4.8
9	IAMI-106 X CML-451	1.6	0.07	0.1	-2.7**	-0.8	0.2	4.8	-2.5	-0.2	0.05	0.02	2.4	1.3	-3.3
10	IAMI-106 X BML-6	0.6	0.1	0.5	3.8**	-2.9	-10.3	-2.6	-2.4	-0.03	-0.05	-0.5	1.4	1.9*	-1.4
11	IAMI-111 X LM-13	1.3	-0.4	0.2	0.9	2.2	5.3	1.5	-2.4	0.2	-0.17	-0.5	1.9	0.02	3.1
12	IAMI-111 X LM-14	-3.9	-1.7 **	-2.6**	0.3	-4.5	-10.2	-4.2	-6.5**	-0.8	-0.01	-0.4	1.2	0.4	-0.5
13	IAMI-111 X HKI-163	-0.4	1.6**	1.7**	0.4	-0.9	-3.9	0.9	-4.2*	-1.0	-0.11	-0.4	-2.86*	0.6	-5.2
14	IAMI-111 X CML-451	-1.8	-0.6	-0.5	-0.8	2.2	1.2	-2.5	6.8**	1.5*	0.14	0.6	0.4	-1.1	2.3
15	IAMI-111 X BML-6	4.8	1.1*	1.2**	-0.7	1.0	7.6	4.2	6.3**	0.2	0.14	0.66	-0.7	0.07	0.2
16	IAMI-112 X LM-13	-1.07	0.6	0.3	2.1**	10.8**	15.2*	-3.4	-1.5	0.4	-0.06	0.05	0.5	-0.5	-14.9**
17	IAMI-112 X LM-14	1.6	2.2**	2.2**	-0.9	3.2	5.9	2.5	-1.4	-0.3	0.01	-0.2	-0.95	0.4	1.5
18	IAMI-112X HKI-163	1.4	-0.8	-0.5	-2.07**	-4.0	-5.09	-0.9	0.05	-0.5	-0.01	-0.7	-1.7	-0.2	10.5**
19	IAMI-112 X CML-451	2.6*	-0.7	-1.0*	2.02**	-6.5*	-11.6*	2.9	1.7	-0.2	0.09	1.03 *	0.9	-0.1	7.06*
20	IAMI-112 X BML-6	-4.5	-1.3**	-0.9*	-1.2*	-3.5	-4.5	-1.2	1.3	0.5	-0.04	-0.3	1.2	0.4	-4.05
21	IAMI-115 X LM-13	1.4	1.1**	1.0*	2.1**	-1.6	-5.5	-0.05	3.8*	-0.3	0.08	-0.3	1.05	0.6	3.8
22	IAMI-115 X LM-14	8.7 *	-0.3	-0.4	-1.6**	1.5	0.09	9.6*	1.6	-0.2	-0.04	-0.2	-0.8	-0.25	0.8
23	IAMI-115 X HKI-163	1.01	-0.9*	-0.7	-0.07	-4.5	-5.3	3.4	-2.5	0.6	0.07	0.6	1.5	0.5	-2.2
24	IAMI-115 X CML-451	-4.7	-0.5	-0.3	2.4**	-0.2	1.7	-8.1	-1.4	0.4	-0.04	0.5	-0.9	0.4	-2.2
25	IAMI-115 X BML-6	-6.4	0.6	0.4	-2.8**	4.7	9.01	-4.9	-1.6	-0.5	-0.08	-0.6	-0.8	-1.3	-0.3
26	IAMI-118 X LM-13	9.7*	-1.6**	-1.8 **	-2.7**	-2.4	-0.3	8.6	2.9	0.8	0.03	0.6	2.4	0.3	11.7**
27	IAMI-118 X LM-14	2.8	0.3	0.2	1.9**	-0.1	2.9	6.0	4.6*	0.1	0.25	-0.2	0.1	0.1	0.7
28	IAMI-118 X HKI-163	-2.9	-0.6	-0.4	0.5	0.7	-0.3	-3.9	-1.4	0.5	0.03	0.6	1.5	0.07	-3.3
29	IAMI-118 X CML-451	-5.8	1.8**	1.7**	0.2	2.6	4.8	-5.9	-0.1	-0.6	-0.12	-1.3*	-1.9	-0.4	-6.4*
30	IAMI-118 X BML-6	-3.7	0.2	0.4	0.05	-0.8	-7.1	-4.7	-5.9**	-0.8	-0.18	0.2	-2.0	0.01	-2.7
31	IAMI-121 X LM-13	-4.8	-0.02	0.3	1.2**	1.8	1.0	-3.5	-4.7 **	0.3	0.12	-0.7	0.7	-0.1	-1.3
32	IAMI-121 X LM-14	-2.7	-1.1*	0.2	-2.7**	-1.5	-4.2	-3.7	0.05	0.06	-0.13	0.6	-1.8	1.4	-7.6**
33	IAMI-121 X HKI-163	-0.7	0.6	-0.1	1.7**	-1.4	-0.2	-0.1	2.9	-0.3	0.03	0.1	1.0	0.6	-1.0
34	IAMI-121 X CML-451	6.8	0.07	-0.03	-2.2**	1.8	3.4	7.2	2.0	0.3	-0.2	-0.3	0.4	-0.4	7.3**
35	IAMI-121 X BML-6	1.5	0.4	-0.33	1.9**	-0.7	0.1	0.1	-0.4	-0.4	0.2	0.3	-0.3	-1.4	2.6
36	IAMI-123 X LM-13	-8.0*	1.3**	1.2**	-1.2**	1.0	-0.2	-7.4	-3.9*	-1.3	-0.2	-0.1	-4.1**	-0.2	-11.1**
37	IAMI-123 X LM-14	0.3	-0.1	-0.3	-0.2	-6.6*	-7.4*	-1.4	1.9	0.4	-0.02	0.2	1.6	0.9	5.8*
38	IAMI-123 X HKI-163	0.9	0.6	0.7	1.3**	5.8*	8.4	-0.3	-0.6	0.7	-0.02	-0.2	2.9*	0.2	-0.6
39	IAMI-123 X CML-451	-1.0	-0.6	-0.5	1.7**	0.02	2.7	-1.4	-3.5	-0.5	-0.04	-0.5	-1.4	-0.06	0.2
40	IAMI-123 X BML-6	7.9	-1.2**	-1.2*	-1.5**	-0.4	-3.5	10.5*	6.2**	0.7	0.2	0.6	0.8	-0.9	5.7*
	SE(Hybrids)	3.99	0.42	0.43	0.46	2.70	5.76	4.48	1.77	0.67	0.14	0.52	1.32	0.80	2.75

******Significant at P=1% & *****Significant at P=5%

FPP= Final plant stand (thousand/ha), DT= Days to 50% tasseling, DS= Days 50% silking, DM= Days to 50% maturity, EH= Ear height (cm), PH= Plant height (cm), NE= Number of ears(thousand/ha), SW=100 grain weight (g), EL= Ear length (cm), EG= Ear girth (cm), NKR= No. of kernel rows/ear, NK= No. of kernels/ row, SH= Shelling percentage, GY= Grain yield (q/ ha).

Table 4: Magnitude of additive variance and dominance variance for yield and its contributing traits in maize

S.N.	Characters	Additive variance ($\sigma 2_{gca}$ = ½ VA)	Dominance variance ($\sigma 2_{sca}$ = VD)	(VA/ VD)	Magnitude
1	Final plant stand (thousand/ha.)	2.966	27.045	0.11	Non additive gene action
2	Days to 50% tasseling	2.235	3.906	0.57	Non additive gene action
3	Days 50% silking	3.137	4.37	0.72	Non additive gene action
4	Days to 80% brown husk maturity	8.175	15.678	0.52	Non additive gene action
5	Ear height (cm)	27.108	58.028	0.47	Non additive gene action
6	Plant height (cm)	85.391	93.454	0.92	Non additive gene action
7	Number of ears (thousand/ha.)	3.764	34.13	0.11	Non additive gene action
8	100 grain weight (g)	28.987	49.668	0.58	Non additive gene action
9	Ear length (cm)	0.412	0.151	2.73	Additive gene action
10	Ear girth (cm)	0.045	0.01	4.65	Additive gene action
11	No of kernel rows/ear	1.779	0.32	5.57	Additive gene action
12	No of kernels/ row	1.521	7.521	0.20	Non additive gene action
13	Shelling percentage	0.174	0.957	0.18	Non additive gene action
14	Grain yield (q/ ha)	64.291	127.762	0.50	Non additive gene action

Conclusion

A close examine of the results IAMI 123, IAMI 112 and HKI 163 were found good general combiner for most of the contributing traits among all the parental line whereas, IAMI 123 (line) and LM 13 (tester) were good general combiner for grain yield (q/ha). For grain yield (q/ha) only seven crosses *viz.*, IAMI-101 X LM-13, IAMI-112 X HKI-163, IAMI-112 X CML-451, IAMI-118 X LM-13, IAMI-121 X CML-451, IAMI-123 X LM-14 and IAMI-123 X BML-6 were found good specific combiner among forty crosses. Therefore, these hybrids are considered as best specific combiner for grain yield (q/ha) and would be used in a hybridization programme.

References

1. Akinyele BO, Adigun AB. Soil texture and the phenotypic expression of maize (*Zea mays* L.). Res. J Bot. 2006;3:136-143.
2. Ambikabathy A, Selvam NJ, Selvi DT, Dhasarathan M, Vairam N, Renganathan VG, *et al*. Determination of Combining Ability and Heterosis for Yield and Yield Related Traits in Maize Hybrids Based on Line X Tester Analysis. Res. J of Agril. Sci. 2019;10(1):215-220.
3. Amiruzzaman M, Islam MA, Hassan L, Rohman MM. Heterosis and combining ability in a diallel among elite inbred lines of maize (*Zea mays* L.). Emi. J food and Agri. 2013;25(2):132-137.
4. Assefa T, Zeleke H, Afriye T, Otyama P. Line × Tester Analysis of Tropical High Land Maize (*Zea mays* L.) Inbred Lines Top Crossed with Three East African Maize Populations. American J Plant Sci. 2017;8:126-136.
5. Beruk H. Combining Ability Analysis for Grain Yield and Yield Related Traits in Quality Protein Maize (*Zea mays* L.). Journal of Current Research. 2021;13(03):16463-16466.
6. Gowda RK, Kage UK, Lohithaswa HC, Shekara BG, Shobha D. Combining Ability Studies in Maize (*Zea mays* L.), Molecular Plant Breeding. 2013;4(14):116-127.
7. ICAR-IIMR www.iimr.icar.gov.in (Annual Report, ICAR-Indian Institute of Maize Research, Pusa Campus, New Delhi – 110012); c2022.
8. Joshi VN, Dubey RB, Marker S. Combining ability for polygenic traits in early maturity hybrids of maize (*Zea mays* L.), Indian J Genet. Plant Breed. 2002;62:312-315.
9. Junaidu HI, Onovo JC, Mijinyawa A, AbdulKarim BM. Combining Ability in Quality Protein Maize Using Diallele Crosses Among Five Inbred Lines Journal of Natural Sciences Research. 2015;5(14):145-148.
10. Kabdal MK, Verma SS, Ahmad N, Panwar UBS. Genetic variability and correlation studies of yield and its attributing characters in maize (*Zea mays* L.). Agric. Sci. Digest. 2003;23(2):137-139.
11. Kanagarasu S, Nallathambi G, Ganesan KN. Combining ability analysis for yield and its component traits in maize (*Zea mays* L.) Electronic Journal of Plant Breeding. 2010;1(4):915-920.
12. Kempthorne O. An introduction to genetic statistics, John Willy and Sons. Inc. New York; c1957. p. 545.
13. Kumar R, Mandal SS, Mishra AK, Smriti, Singh R, Kumar P. Heterosis and combining ability for yield and its contributing traits of Kharif maize (*Zea mays* L.). The Bioscan. 2015;10(4):2049-2056.
14. Kuselan K, Manivannan N, Ravikesavan R, Paranidharan V. Combining ability analysis for yield and its component characters in maize (*Zea mays* L.). Electron. J Plant Breed. 2017;8(2):591-600.
15. Mural RV, Chikkalingaiah. Combining ability analysis in quality protein maize (*Zea mays* L.) for grain yield and its component traits. Electronic Journal of Plant Breeding. 2012;3(2):747-752.
16. Murtadha MA, Ariyo OJ, Alghamdi SS. Analysis of combining ability over environments in diallel crosses of maize (*Zea mays*). Journal of the Saudi Society of Agricultural Sciences. 2018;17:69-78.
17. Pal AK, Prodhan SH. Combining ability analysis of grain yield and oil content along with some other attributes in maize (*Zea mays* L.). Indian J Genet. 1994;54:376-380.
18. Patel. Gene action and combining ability analysis for kernel yield and its attributing traits in maize [*Zea mays* (L.)]. Electronic Journal of Plant Breeding. 2022;13(1):273-278.
19. Sharma S, Narwal R, Kumar MS, Dass S. Line x tester analysis in maize (*Zea mays* L.), Forage Res. 2004;30:28-30.
20. Sharma P, Kamboj MC, Punia MS. Assessment of combining ability effects using quality protein maize donors as testers for yield and yield traits in maize. Electron. J Plant Breed. 2019;10(4):1367-1375.
21. Singh M, Dubey RB, Ameta KD, Haritwal S, Ola B. Combining ability analysis for yield contributing and quality traits in yellow grained late maturing maize (*Zea mays* L.) hybrids using Line x Tester. J Pharmacog. Phytochem. 2017;6(5):112-118.
22. Sinha SK, Thakur D. Estimation of Combining Ability in Maize (*Zea mays* L.) using Line x Tester Analysis International Journal of Tropical Agriculture. 2017;35(4):1035-1046.
23. Tripathi KK, Warrier R, Govila OP, Ahuja V. Biology of *Zea mays* (Maize). Department of Biotechnology, Ministry of Science and Technology and Ministry of Environment and Forests, Government of India; c2011.
24. Uddin MS, Amiruzzaman M, Bagum SA, Hakim MA, Ali MR. Combining ability and heterosis in maize (*Zea mays* L.). Bangladesh J Genet Pl. Breed. 2008;21(1):21-28.
25. Weatherwax P. History and origin of corn I. Early history of corn and theories as to its origin. In: G.F., Sprague (Ed.), Corn and corn improvement. Academic Press, New York; c1955.