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Combining ability analysis in inter varietal crosses of maize (*Zea mays* L.)

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Abstract : A ten parent diallel cross of indigenous open pollinated maize lines without reciprocals and their 45 F_1s were assessed for their combining ability in yield and yield component characters. Both additive and non-additive genetic components were observed with the high magnitude of non-additive gene effects for all the twelve characters studied except days to tasseling and ear length. The composite variety BM-1 and the indigenous line IC 011 had good *gca* for grain yield / plant, ear girth, number of kernels/row, shelling percentage and 100-grain weight. The other lines IC 014 and IC 013 had good *gca* effects for reduced plant height and earliness. The three crosses *viz.* IC 019 x IC 011, IC 0116 x IC(Y) 0111 and IC 01 3 x BM-1 composite were screened as the best *sca* effects for grain yield per plant.

Key Words : Combining ability, diallel, gca, sca, maize.

Introduction

Production of single cross hybrid maize necessitates to select suitable early maturing parental lines and the best cross combinations for further exploitation. Selection of parents on the basis of only *per se* performance with good *gca* effects is the high approach to assess the nature of gene action involved in the inheritance of character. The variance due to general combining ability (*gca*) is usually considered to be an indicator of the extent of additive type of gene action, whereas specific combining ability (*sca*) is taken as the measure of non-additive type of gene actions in hybrid production. The present investigation therefore aims to know the gene action for various quantitative characters in local indigenous maize cultivars and to identify best combinations that could be used in the development of early maize hybrids.

Materials and Methods

Ten open pollinated indigenous early maturing cultivars [IC 014, IC 013, IC 019, IC 018, IC 0116, IC 011, IC 015, IC(Y) 0110, IC(Y)O11 and BM-1 composite] were collected from various parts of plateau region of Jharkhand state and crossed in half diallel fashion. The 45 F_1s along with their 10 parents were evaluated in Complete Randomized Block Design with three replications in the Department of Plant Bleeding and Genetics, Birsa Agricultural University, Ranchi during *Kharif* 1996. Each entry was sown in two row plot of 5 m length adopting 70 x 25 cm spacing between rows and plants. Observations were recorded on twelve quantitative characters. Data related to days to tasseling and days to silk were recorded on plot basis while data related to other characters were recorded on ten randomly selected plants leaving border plants of each row. Mean data of each plot over replications were used for analysis of variance. The combining ability analysis was carried out following method-2 model-1 of Griffing (1956).

Results and Discussion

The analysis of variance revealed the presence of significant amount of variability among the parents and hybrids for all the traits.

The analysis of variance for combining ability observed to be highly significant (mean sum of square) both for *gca* as well as *sca* for all the characters studied (Table 1). Thus, both additive and non-additive gene actions were found to be important for controlling almost all the characters as reported by Rao *et al.* (1996). However, Mathur and Bhatnagar (1995) observed the role of dominant component for inheritance of shelling percentage.

Though the variance components due to both *gca* and *sca* were significant for all the characters studied, the ratio of additive/ non-

Table 1. ANOVA (MS) for combining ability and estimates of variance

Source	Grain yield/ plant(g)	Days to 50% tasseling	Days to 50% silk	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No.of kernel rows/ ear	No.of kernels/ row	Shelling %	100-grains weight (g)
Gca	180.14**	31.40**	22.05**	22.52**	457.40**	118.67**	55.36**	0.054**	1.65**	24.72*	15.24**	15.04**
Sca	79.50**	3.87**	6.90**	8.56**	102.66**	38.46**	1.05**	0.028**	0.52**	8.30**	6.46**	3.69**
Error	5.55	0.69	1.40	1.41	6.50	2.68	0.25	0.007	0.14	0.77	2.50	0.62
σ^2 gca	14.55	2.56	1.72	1.76	37.57	9.67	0.43	0.004	0.13	1.99	1.06	1.20
σ^2 sca	73.95	3.18	5.50	7.15	96.15	35.79	0.80	0.022	0.38	7.53	3.95	3.07
σ^2 gca/σ^2 sca	0.20	0.81	0.31	0.25	0.39	0.27	0.54	0.182	0.34	0.26	0.27	0.39
a h^2 (n)	26.79	56.91	32.27	29.12	42.27	33.45	44.78	21.80	32.54	32.48	24.74	39.47

** Significant at 1 per cent level.

Table 2. General combining ability effects of the parent

S. No.	Parents/ Characters	Grain/ yield/ plant	Days to 50% tasseling	Days to 50% silk	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No.of kernels rows/ear	No.of kernels/ row	Shelling %	100 grains weight(g)
1	IC 014	-3.838**	-2.439**	-1.006**	-2.078**	-7.290**	-3.984**	-0.567**	-0.091**	0.134	-0.817**	1.529**	-1.778**
2.	IC 013	-2.577**	-1.800**	-1.177**	-1.911**	-5.026**	-1.492**	-0.542**	-0.022	-0.313**	-1.148**	0.438	0.625**
3.	IC 019	3.881**	3.228**	3.689**	2.672**	8.210**	2.897**	1.456**	0.002	0.073	2.547**	-0.137	0.026
4.	IC 018	1.355*	0.339	-0.394*	0.006	8.602**	4.469**	0.201	0.042*	0.015	0.508*	-1.048*	-0.727**
5.	IC 0116	-1.166*	0.172	-3.339*	0.894*	1.182*	3.177**	-0.168	0.001	-0.410**	-0.378	-1.042**	-0.083
6.	IC 011	3.319**	0.006	-0.478*	0.006	-6.190**	-3.387**	0.001	0.071**	-0.324**	0.630**	1.099*	1.071**
7.	IC 015	-5.089**	-1.494**	-0.172	-0.022	-6.723**	-3.731**	-0.928**	-0.095**	-0.388**	-1.828**	0.016	-1.166**
8.	IC (Y) 0110	-4.153**	1.061**	0.217	-0.300	0.813	1.230**	-0.228	-0.061**	0.771**	-1.792**	-0.532	-0.518*
9.	IC (Y) 0111	3.742**	0.533*	-0.283	-0.189	0.429	-1.203**	0.333*	0.096**	0.171	0.897**	-1.455**	0.511*
10.	BM-1 composite	5.203**	0.394	-0.117	0.922**	8.791**	2.024**	0.440	0.057**	0.271**	1.383**	1.448**	2.039**

*, ** Significant at 5 per cent and 1 per cent level, respectively.

Table 3. Crosses with desirable *sca*, *gca* and *per se* effects of the parents

Characters	Significant crosses	*sca* effects	*gca* effects		*Per se* performance		
			Female parent	Male parent	Fl	Female parent	Male parent
1	2	3	4	5	6	7	8
Grain yield per plant	IC 019 x IC 011	21.90**	3.881**	3.139**	64.20	28.20	36.02
	IC 0116 x IC (Y) 0111	20.80**	-1.663*	3.742**	58.17	31.60	22.37
	IC 013 x BM-1 Composite	13.91**	-2.577**	5.203**	51.81	32.23	41.17
Days to 50% tasseling	IC 0116 x IC (Y) 0111	-2.97**	0.172	0.533*	43.00	47.33	45.67
	IC 014 x IC 019	-2.72**	-2.439**	3.228**	43.33	42.00	53.00
	IC 019 x IC 018	-2.50**	3.228*	-0.339	46.33	53.00	48.67
Days to silk	IC 014 x IC 019	-4.66**	-1.006**	3.689	49.67	47.00	58.33
	IC 013 x IC (Y) 0111	-3.58**	-1.117*	-0.283	46.67	51.67	53.67
	IC 014 x IC 018	-3.24**	-1.006**	-3.394*	47.00	47.00	54.33
Days to maturity	IC 018 x IC 015	-4.92**	0.006	-2.022	76.67	83.33	84.33
	IC 014 x BM-1 Composite	-4.11**	-2.078**	0.922**	76.33	76.33	84.00
	IC 0116 x IC 015	-3.81**	0.894*	-0.022	78.67	82.33	84.33
Plant height	IC 015 x BM-1 Composite	-21.400**	6.721**	8.791**	94.77	116.20	137.27
	IC 013 x IC 0116	-20.29**	-5.026**	1.182*	90.07	112.60	112.42
	IC (Y) 0111 x BM-1 Composite	-15.70**	0.813	8.791**	107.90	112.77	137.27
Ear height	IC 015 x BM-1 Composite	-11.26**	-3.731**	2.024**	36.41	46.37	55.27
	IC 013 x IC 0116	-10.35**	-1.492**	3.177**	40.80	51.23	50.90
	IC 014 x IC 011	-9.56**	-3.984**	-3.387**	32.50	43.67	44.07
Ear length	IC 019 x BM-1 Composite	1.91**	1.456**	0.440**	14.53	12.72	11.65
	IC 013 x IC (Y) 0110	1.40**	-0.542**	-0.228	11.36	9.87	9.28
	IC (Y) 0110 x IC (Y) 0111	1.23**	-0.228	0.333*	12.06	9.28	0.01

Table 3. Continued.....

Ear girth	IC 019 x IC 011	0.26**	0.002	0.071**	3.59	3.14	3.25
	IC 0116 x IC (Y) 0111	0.22**	0.001	0.096**	3.57	3.32	3.02
	IC 013 x BM-1 Composite	0.17*	-0.022	0.057**	3.13	3.27	3.43
Kernel rows per ear	IC 0110 x IC (Y) 0111	1.88**	0.771**	0.171	13.87	12.33	10.13
	IC 014 x IC 013	1.87**	0.134	-0.313**	12.73	11.57	10.40
	IC 0116 x IC (Y) 0111	1.14**	-0.410**	0.171	11.93	10.47	10.13
Kernels per row	IC 013 x BM-1 Composite	5.69**	-1.148**	1.383**	25.10	16.70	20.93
	IC (Y) 0110 x IC (Y) 0111	4.72**	-1.792**	0.897**	23.03	14.73	15.20
	IC 0116 x IC (Y) 0111	4.74**	-1.402**	0.897**	24.43	18.60	15.20
Shelling percentage	IC 015 x IC (Y) 0111	4.45**	0.016	-1.453	83.51	77.68	74.48
	IC 019 x IC 018	3.92**	-0.137	-1.048*	83.24	78.22	75.50
	IC 0116 x IC 015	3.67*	-1.402*	0.016	82.78	79.61	77.68
100 grains weight (g)	IC 013 x IC (Y) 0110	4.61**	-1.778**	-0.518**	22.04	17.99	12.89
	IC 018 x IC (Y) 0111	4.13**	-0.727**	-0.511*	21.23	15.24	16.86
	IC 0116 x IC 015	2.63**	-0.083**	-1.166**	18.73	17.66	14.93

additive variance showed that non-additive genetic components were relatively more important than additive components in the inheritance of these traits except days to 50 per cent tasseling and ear length as reported by Nawar *et al.* (1979) for grain yield and De (1996) for plant and ear height.

Four parental lines *viz.* BM -1 composite, IC 019, IC(Y) 0111 and IC 011 had good *gca* effects for grain yield (Table 2). IC 014 and IC 013 had good gca effects for earliness and reduced plant height. The parental lines IC 019, IC (Y) 0111, IC (Y) 0110 and IC 019 had good combiners for ear length, ear girth, number of kernel rows/ear and number of kernels/row respectively. With respect to shelling percentage IC 014 and BM -1 composite were observed to be good combiners. Similarly BM -1 composite and IC 013 were the best combiners for 100-" grain weight. None of the single parent evidenced good *gca* effects for all the characters. However, three parental lines IC 011, IC(Y) 0111 and BM-1 composite were found to be common good general combiners for grain yield and various ear characters. These lines can be utilized in further breeding programme.

Three best crosses with significant *sca* effects for various traits along with *per se* performance and *gca* effects of parents involved in the crosses are listed in Table 3. Most of the crosses selected on the basis of significant *sca* effects also had high *per se* performance. Out of 45 crosses, 13 crosses had shown highly significant positive *sca* effects for grain yield. Among them IC 019 x IC 011 (21.90), IC 0116 x IC (Y) 0111 (20.80) and IC 013 x BM-1 composite (13.91) expressed maximum *sca* effects along with high *per se* performance for grain yield/ plant and many other yield contributing characters. The crosses which exhibited significant desirable *sca* effects were IC 0116 x IC (Y) 0111 for days to 50%

tasseling, IC 014 x IC 019 for days to silk, IC 018 x IC 015 for days to maturity and IC 015 x BM-1 composite for reduced plant and ear height. Similarly for various ear and kernel characters, IC 019 x BM-1 composite for ear length, IC 019 x IC 011 for ear girth, IC(Y) 0110 x IC(Y) 0111 for kernel rows/ ear, IC 013 x BM -1 composite for kernels/ row, IC 015 x IC(Y) 0111 for shelling percentage and IC 013 x IC(Y) 0110 for 100-grain weight. The results, thus obtained in the present study are mostly in conformity with the findings of Satyanarayana *et al.* (1990), Pal and Prodhan (1994) and Rao *et al.* (1996) for grain yield and other component characters. It was evident that the best three crosses exhibiting desirable *sca* effects for grain yield involved parent with high x high and low x high, *gca* effects.

Thus three crosses namely, IC 019 x IC 011, IC 0116 x IC (Y) 0111 and IC 013 x BM -1 composite which have shown high *sca* effects for grain yield and for a few other yield component characters involving parents of good *gca* effect can be exploited for the development of single cross varietal hybrid and also through the population improvement programme in the development of suitable early composite varieties after knowing the inbreeding depression in F_2 and subsequent generations.

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