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COMBINING ABILITY ANALYSIS FOR YIELD AND YIELD COMPONENTS IN SINGLE CROSS HYBRIDS OF MAIZE (*ZEA MAYS* L.)

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ABSTRACT

Combining ability for grain yield and its component was studied in maize through half diallel mating design using ten parents. Analysis of variance for combining ability revealed that the both gca and sca variance were significant for all traits except ear length (cm) and Kernel rows number. The parents GPM-470 and GPM-405 had recorded high per se and gca effects for grain yield. The hybrids IC-328953 X GPM-405, IC-274556 X GPM-30 and IC-328953 X IC-541068 showed significant sca effects and superior performance for grain yield per plant. The hybrids GPM-470 X IC-541068, GPM-213 X GPM-210, IC-328883 X GPM-30 exhibited high sca effects for plant height and IC-328953 X GPM-210 and IC-274556 X IC-5441068 for day to 50 % tasseling and days to 50 % silking indicate the earliness in maturity.

Key words : *Combining ability analysis, GCA, Grain yield, maize, SCA.*

Maize is considered as the third most important cereal crop after rice and wheat in the world. This cereal is referred to as "Miracle Crop" and "Queen of the Cereals" due to its high productivity potential compared to other Graminae family members. Maize has become one of the important food, fodder and industrial crops of the world. In year 2010 the production of India is 21.40 MT (*kharif*-15.50 MT and *rabi*-5.90 MT) with increasing growth rate of area as per cent per annum is 2.98%. Several breeding procedures have been established to increase the grain yields of the maize populations and their hybrids. It would be a considerable advantage to be able to estimate the combining ability of parents and gene effects before making hybrids among selected inbreed lines. Diallel crossing programs have been applied to achieve this goal by providing a systematic approach for the detection of suitable parents and crosses for the investigated characters. In addition, diallel analysis gives plant breeder, the opportunity to choose the most efficient selection method by allowing them to estimate several genetic parameters.

MATERIALS AND METHODS

Ten inbred lines *viz*., IC-328883, GPM-213, IC-328953, IC-326865, GPM-470, GPM-405, IC-274556, GPM-210, GPM-30 and IC-541068 were crossed in half diallel mating design in s*ummer*-2011 to generate hybrids for study. All ten parents together with 45 crosses were evaluated during *kharif*-2011. Each genotype was grown in two rows of 5 meter length with 60 x 30 cm distance between row to row and plant to plant, adopting randomized block design with two replication at Experimental Farm, Department of Agril. Botany, College of Agriculture, Latur. The data were recorded from two replication on five randomly selected plant for the characters *viz*., Days to 50% tasseling, Days to 50% silking, plant height (cm), Ear length (cm), Kernel rows number, Number of grain per rows, 100-grain weight (gm), fodder yield per plant (gm) and grain yield per plant (gm). Combining ability analysis was done according to (1).

RESULTS AND DISCUSSION

The analysis of variance (Table-1) for all the traits studied was highly significant, indicating the existence of sufficient variation in the materials studied. The pertinent data on analysis for combining ability revealed that the variances due to general combining ability and specific combining ability highly significant for characters *viz.,* days to 50% tasseling, days to 50% silking, plant height, number of grains per rows, 100-grain weight, fodder yield and grain yield per plant. The variance due to sca is higher than gca for all the traits indicates presence of non additive gene action for all the traits under study (Table-2).

The estimate of gca effects (Table-3) indicated inbreds GPM-470 and GPM-405 as the most promising parents because it was noticed as good general combiner for grain yield per plant, number of grain per rows, ear length. The parent IC-328883 reflected good general combiner for day to 50 % tasseling, days to 50 % silking, and plant height, whereas inbreds GPM-405, GPM-210 and IC-541068 were found to be good general combiner for the trait fodder yield per plant, 100-grain weight and kernel rows number, respectively. Similar results were also reported by (2).

The estimated sca effects (Table-4) revealed several crosses significant for grain yield per plant. Among them IC-3328953 X GPM-405 was best specific combiner followed by IC-274556 X GPM-30 and IC-328953 X IC-541068. The hybrids IC-328953 X GPM-210 exhibited

Table-1 : Analysis of variance of Parents and Hybrids (crosses).

Characters	Replication	Treatment	Error	SE
	d.f.=1	d.f.=57	d.f.=57	
Days to 50% tasseling	1.17	7.89**	0.611	0.55
Days to 50% silking	2.07	8.56**	0.751	0.61
Plant height (cm)	19.18	431.10**	6.345	1.78
Ear length (cm)	0.30	2.05**	0.228	0.33
Kernel row numbers	0.00	1.52*	0.196	0.31
No. of Grain per row	2.23	17.65**	1.126	0.75
100 grain weight (g)	0.44	9.75**	1.744	0.93
Fodder yield (g/plant)	15.93	130.18**	11.566	2.40
Grain yield (g / plant)	0.37	308.30**	7.424	1.92

*, ** indicated significance at 5 and 1 per cent, respectively.

Table-2 : Analysis of variance for combining ability effects for yield and yield components.

Character	GCA DF-9	SCA DF-45	Erroe DF-54	62gca	62sca	62gca /62sca	Gene action	h^2(ns) per cent
Days to 50% tasseling	3.56**	6.27**	0.319	0.496	3.245	0.153	Non-additive	24.69
Days to 50% silking	3.53**	7.14**	0.380	0.563	3.158	0.178	Non-additive	25.97
Plant height (cm)	193.62**	199.86**	2.759	16.425	190.861	0.086	Non-additive	18.89
Ear length (cm)	0.76	2.05	0.117	0.161	0.649	0.248	Non-additive	27.65
Kernel rows numbers	0.97	0.74	0.101	0.072	0.642	0.113	Non-additive	18.23
No. of Grain per row	9.78**	3.74**	0.563	0.265	9.223	0.028	Non-additive	04.00
100-grain weight (g)	4.53**	4.77**	0.905	0.302	3.865	0.078	Non-additive	11.19
Fodder yield (g/plant)	57.87**	101.90**	5.873	8.002	52.004	0.153	Non-additive	24.20
Grain yield (g/plant)	140.54**	161.65**	3.872	13.148	136.670	0.096	Non-additive	15.34

*, ** indicated significance at 5 and 1 per cent, respectively.

Table-3 : Estimates of General Combining Ability of parents for yield and yield components.

Parents	Days to 50% tasseling	Days to 50% Silking	Plant height (cm)	Ear length (cm)	Kernel row (No.)	Grain per row (No.)	100-Grain weight (g)	Fodder yield (g/plant)	Grain yield per plant (g)
IC-328883	-0.85**	-0.73**	7.58**	-0.50**	-0.45**	-0.02	0.50	-1.52*	0.39
GPM-213	-0.43**	-0.40*	-1.29*	-0.35**	0.31**	-0.36	-0.28	-1.81**	0.41
IC-328953	-0.77**	-0.77**	2.17**	-0.13	-0.10	-1.24**	0.70**	1.84**	-4.75**
IC-326865	0.32*	0.18	-7.29**	0.06	-0.31**	0.07	0.18	-2.06**	-4.05**
GPM-470	1.27**	1.68**	-3.33**	0.99**	-0.21*	0.55**	-0.40	-2.88**	6.45**
GPM-405	0.19	0.18	-2.04**	0.25**	0.09	0.56**	-0.30	6.65**	4.73**
IC-274556	0.48**	0.39*	2.50**	-0.25**	0.32**	-0.25	-0.43	-1.48*	-3.67**
GPM-210	0.82**	0.60**	1.46**	0.03	0.02	0.65**	1.18**	-1.60*	0.24
GPM-30	-0.60**	-0.61**	1.21**	0.09	-0.09	-0.13	-0.39	-0.52	1.62**
IC-541068	-0.43**	-0.52**	-0.46	0.17	0.41**	0.18	-0.76**	-2.39**	-1.37*
SE(±)	0.1548	0.1689	0.4549	0.0938	0.0872	0.2055	0.2606	0.6637	0.5389

significant and negative sca effects for the character days to 50% tasseling and days to 50 % silking. The significant sca effect in the desired positive direction for plant height exhibited by the hybrids GPM-407 X IC-541068, GPM-213 X GPM-210 and IC-328883 X GPM-30, for ear length GPM-470 X GPM-405 and GPM-210 X GPM-30, for number of kernel rows IC-328953 X GPM-210, for number of grains per row GPM-213 X IC-274556 and IC-328883 X IC-328953. The hybrids GPM-213 X GPM-210 and IC-328883 X GPM-30 reported significant and positive sca effect for 100-grain weight, IC-328883 X IC-326865, IC-274556 X GPM-210 and GPM-213 X IC-541068 for fodder yield per plant. The highly significant sca effects in the desired positive direction for grain yield per plant exhibited by the hybrids IC-328953 X GPM-405, IC-274556 X GPM-30 and IC-328953 X IC-541068. The

Table-4 : Estimates of Specific Combining Ability effects of Hybrids (crosses) in maize (*Zea mays* L.).

Characters	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Ear length (cm)	Kernel rows number	No. of grains per row	100 grain weight (g)	Fodder Yield per plant (g)	Grain yield per plant (g)
Crosses	1	2	3	4	5	6	7	8	9
IC-328883 X GPM-213	3.04**	2.47**	-2.43**	1.36**	-0.14	0.55	2.00**	1.31	9.48**
IC-328883 X IC-328953	0.37	-0.16	-15.39**	0.34**	-0.08	4.82**	2.26**	-12.34**	1.13
IC-328883 X IC-326865	-2.71**	-2.61**	-11.43**	-0.08	-0.88**	4.11**	-0.82**	12.56**	-5.57**
IC-328883 X GPM-470	-0.17	0.39	-7.39**	0.72**	0.53**	-3.36**	0.66	5.62**	-6.32**
IC-328883 X GPM-405	-2.09**	-1.61**	12.32**	-0.50**	0.58**	-2.87**	0.11	-1.15	7.15**
IC-328883 X IC-274556	2.12**	1.68**	10.78**	-0.30**	0.80**	-3.06**	-1.60**	6.97**	9.05**
IC-328883 X GPM-210	-0.21	-0.03	12.32**	0.73**	0.45**	0.53	-0.91**	-15.40**	-7.21**
IC-328883 X GPM-30	-2.30**	-2.32**	14.57**	-0.61**	-0.55**	-2.64**	4.35**	4.52**	-9.24**
IC-328883 X IC-541068	-0.96**	-1.41**	-9.76**	1.04**	0.66**	1.51**	0.33	0.89	8.45**
GPM-213 X IC-328953	-2.05**	-1.49**	8.49**	-0.21	0.31**	-0.69*	0.35	2.92**	0.12
GPM-213 X IC-326865	-0.63**	-0.95**	9.95**	-0.08	0.72**	-1.05**	-1.13**	-1.15	-9.29**
GPM-213 X GPM-470	0.41	0.05	-6.01**	0.62**	0.03	-4.72**	-2.60**	0.41	0.42
GPM-213 X GPM-405	0.50*	0.55*	-14.80**	-0.90**	-0.57**	-4.53**	0.55	-1.86*	4.23**
GPM-213 X IC-274556	-0.80**	-1.16**	-5.84**	0.15	0.39**	8.43**	0.18	-4.73**	6.53**
GPM-213 X GPM-210	-1.13**	-0.86**	14.70**	0.48**	1.34**	2.13**	4.58**	-12.11**	-7.38**
GPM-213 X GPM-30	0.29	-0.16	-0.05	-0.16	0.35**	-0.35	2.04**	-1.19	2.24**
GPM-213 X IC-541068	-1.88**	-1.74**	-12.89**	0.44**	-1.15**	-0.05	2.86**	7.18**	-24.27**
IC-328953 X IC-326865	0.70**	0.43	1.99**	0.39**	1.12**	6.13**	-0.51	2.70**	-5.93**
IC-328953 X GPM-470	3.75**	3.43**	-18.47**	0.34**	0.33**	1.95**	-2.19**	-3.48**	1.58**
IC-328953 X GPM-405	1.83**	2.43**	-1.76**	-0.47**	-0.62**	3.80**	1.06**	5.49**	21.79**
IC-328953 X IC-274556	0.54*	0.22	-5.30**	-0.67**	-0.55**	-3.85**	3.20**	-11.88**	-5.81**
IC-328953 X GPM-210	-3.30**	-3.49**	7.24**	0.51**	2.05**	-2.85**	-1.16**	4.24**	-24.22**
IC-328953 X GPM-30	-0.88**	-0.78**	-12.01**	0.17	-1.50**	-1.97**	-2.84**	5.16**	7.90**
IC-328953 X IC-541068	4.45**	4.64**	0.16	0.77**	-0.89**	-3.02**	-0.72*	5.54**	18.89**
IC-326865 X GPM-470	-0.34	-1.03**	-7.51**	-0.18	-1.01**	0.55	2.13**	6.16**	14.72**
IC-326865 X GPM-405	1.25**	0.97**	-6.30**	-0.69**	-1.16**	-3.96**	-0.67	-1.11	-7.91**
IC-326865 X IC-274556	-1.05**	-1.24**	-12.84**	0.76**	-0.15	-1.90**	1.12**	-12.98**	4.48**
IC-326865 X GPM-210	0.12	0.05	-5.80**	-0.76**	-1.20**	-5.06**	-0.59	5.64**	14.88**
IC-326865 X GPM-30	-0.96**	-1.24**	5.95**	0.25	1.31**	0.22	-1.87**	-12.44**	-9.30**
IC-326865 X IC-541068	-1.63**	-0.32	-7.89**	1.34**	-1.13**	-2.08**	0.30	-11.57**	-18.82**
GPM-470 X GPM-405	-1.21**	-1.53**	-11.26**	2.01**	0.69**	0.66*	-3.84**	-8.05**	-11.26**
GPM-470 X IC-274556	2.50**	2.26**	9.70**	-0.19	0.06	-0.38	1.15**	-14.92**	-12.96**
GPM-470 X GPM-210	-0.84**	-1.45**	-15.76**	-1.21**	-0.49**	1.97**	-0.21	2.20*	-2.82**
GPM-470 X GPM-30	-0.92**	-0.74**	-2.51**	-1.90**	-0.03	-1.25**	3.10**	-4.88**	-6.30**
GPM-470 X IC-541068	-0.59**	-1.32**	46.16**	-1.06**	0.12	2.44**	-0.72*	5.49**	6.19**
GPM-405 X IC-274556	0.08	-0.24	-4.09**	-0.55**	0.96**	1.86**	1.40**	4.81**	-19.80**
GPM-405 X GPM-210	2.25**	2.05**	5.95**	-0.12	-0.14	-1.44**	2.64**	-3.07**	1.30
GPM-405 X GPM-30	0.16	0.26	-6.30**	0.69**	0.72**	0.74**	0.75*	0.85	11.92**
GPM-405 X IC-541068	-1.50**	-1.82**	-19.64**	0.23	-1.13**	-0.57*	0.88*	4.72**	-11.55**
IC-274556 X GPM-210	0.45*	0.84**	4.41**	0.38**	-0.48**	4.27**	-2.77**	7.75**	12.19**
IC-274556 X GPM-30	-0.63**	-0.45	-17.84**	-0.86**	-0.22	-4.95**	-0.61	5.47**	21.31**
IC-274556 X IC-541068	-2.80**	-3.03**	-13.68**	0.88**	0.74**	-0.66*	1.26**	-1.65	12.80**
GPM-210 X GPM-30	1.04**	0.84**	-2.30**	1.87**	-1.07**	0.64*	-3.92**	5.60**	1.40
GPM-210 X IC-541068	-1.63**	-1.24**	-18.64**	-0.59**	0.19	-0.91**	0.01	-10.03**	2.29**
GPM-30 X IC-541068	2.29**	2.47**	8.61**	-0.08	0.80**	1.72**	-0.68	-5.11**	1.01
SE (±)	0.2087	0.2277	0.6134	0.1265	0.1175	0.2771	0.3514	0.8949	0.7266

*, ** indicated significance at 5 and 1 per cent, respectively.

differences among sca and gca effects of hybrids indicates the importance of non-additive gene action for all the characters. Similar results were also reported early by (3, 4, 5, 6, 7).

CONCLUSIONS

After comparison of sca effects and *per se* performance for various characters, observed that the crosses showing high sca effect and high *per se* performance involved the parents possessing either high x low and low x low combining ability parents indicating importance of non-additive genetic variance. Among the parent GPM-470 and GPM-405 found to be the best general combiner for grain yield and exhibited significant GCA effects in parents for the characters ear length and number of grains per row. The parent IC-328883 found best general combiner for plant height, days to tasseling, silking and maturity. Among the crosses, IC-328953 X GPM-405 had shown the highest significant SCA effects for grain yield and it also exhibited significant SCA effects for the traits number of grains per row, 100- grain weight, fodder yield and the cross IC-274556 X GPM-30 showed the significant SCA for days to tasseling, days to maturity and fodder yield. The crosses IC-328953 X GPM-405, IC-328883 X GPM-405 and IC-326865 X GPM-470 showed the highest *per se* performance for grain yield and one parent showed high GCA effects, similar performance was also found in cross GPM-213 X GPM-405, implying their suitability prospective cross combination will be the major strategy, while hybrid breeding is suggested as main focus in maize breeding because non additive variation is significant for all traits.

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