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Short Communication

Combining ability studies among the inbred lines of sweet corn (*Zea mays* L. *saccharata*)

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Several hybrids of sweet corn have been released world over mainly by incorporating *sugary1* (*su*) and *shrunken2* (*sh2*) mutants in the genetic background of elite genotypes. The present study is an attempt to develope suitable single cross hybrids and identification of potential inbreds in sweet corn.

Six sweet corn inbreds, three each of *sugary* (P_1, P_2 and P_3) and *shrunken2* (P_4, P_5 and P_6) types derived from different source populations were crossed in half diallel mating design. Twenty-three entries (six parental lines, fifteen crosses and two checks, Madhuri and Priya) were evaluated in *kharif* (2004) and *rabi* (2004-2005) seasons at IARI, New Delhi in three replications using RBD. Each experimental plot consisted of two rows of 5-m length with 75 × 25 cm spacing. All characters including ear attributes, maturity parameters and yield and yield components were recorded as per standard procedure. Field emergence (%) was recorded 30 days after seedling germination on plot basis and transformed values (using arc sine transformation) were used for data analysis. Combining ability analysis was done according to Griffing's [1] method 2 and model I.

Significant variation among the treatments implied possibility of the utilization of existing variability for further improvement of characters as well as identification of prospective combinations. Combined ANOVA over two seasons (Table 1) revealed that mean sum of square due to G × E interaction were highly significant for all the traits except number of kernel rows and 100 grain weight, which implied the importance of carrying out trials in different environments. Analysis of variance for combining ability manifested highly significant *sca* variance for all the traits, while significant *gca* variance for only eight characters (Table 1). Significance of both *gca* and *sca* variance for most of the characters implied that both additive as well as non-additive components are important. Similar results have been reported for maturity characters, plant characters and yield and yield components [2]. *gca* × E interaction was highly significant for all the traits except number of ears per plant, number of kernels row and 100 grain weight, while *sca* × E interaction was significant for only eight traits that can be attributed to the fact that being non-additive component of genetic variation, *sca* is less stable over environment. On the other hand, greater proposition of additive × additive type of epistasis in *gca* variance might have given rise to significant *gca* × E interaction.

The estimates of *gca* effect (Table 2) indicated inbred P_5 as the most promising parent because it was noticed as good general combiner for plant height, kernel rows, 100-grain weight, yield per plant, whereas P_1 and P_3 reflected significant *gca* effect for early maturity and plant height respectively. The parent P_4 was good general combiner across the individual as well as combined environment especially for number of ears/plant, advocating its utilization for baby corn production. The presence of additive gene action for most of the traits implied the necessity of improving the parental lines as an effective strategy. The *sca* effect revealed several crosses (5 at $p < 0.01$; 2 at $p < 0.05$) significant for grain yield/plant (Table 2). Among them $P_2 \times P_6$ was the best specific combiner followed by $P_2 \times P_5$ and $P_3 \times P_4$. Some of the crosses with high *sca* effect for yield were desirable for other traits also, such as early maturity ($P_4 \times P_5$ and $P_1 \times P_5$), ear parameters ($P_2 \times P_5$ and $P_1 \times P_5$)) and field emergence ($P_2 \times P_6$ and $P_4 \times P_5$). Significant differences among the *sca* effects of fifteen crosses indicate the importance of non-additive variance and prospects for hybrid breeding. Satyanarayana and Kumar [3] found non-additive gene effects along with dominant × dominant gene effects to be significant. Hence, the use of hybridization or reciprocal recurrent selection was suggested for the genetic improvement, which would exploit both additive and non-additive gene effects.

Seven crosses were found promising in each season based on heterosis (%) over the check Madhuri (Table 3), among which four crosses ($P_1 \times P_5$, $P_2 \times P_5$, $P_3 \times P_5$ and $P_3 \times P_6$) were significant in both the environments. Sweet corn hybrid, $P_1 \times P_5$ (L × H *gca*) was the best combination across the seasons as well as over both the checks, followed by $P_2 \times P_5$ and $P_3 \times P_5$ for grain yield per hectare. Further, two combinations ($P_2 \times P_4$ and P_5) were found superior specifically under *rabi* season, implying their suitability

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Table 1. Analysis of variance and combining ability ANOVA for various traits in sweet corn evaluated in two seasons

Source	df	Mean sum of squares											
		Field emergence (%)	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Ear height (cm)	#Ears/ plant	Ear length (cm)	Ear girth (cm)	#Kernel rows/ear	#Kernels/ row	100 grain wt. (g)	Grain yield/plant (g)
Environment (E)	1	275.35**	151354.68**	158720.51**	47444.64**	13933.53**	0.42	2.41	0.06	0.43	9.82	0.07	23.14
Replication (R)	2	37.58	7.05	10.30	173.02	180.95*	0.35	3.25	0.03	2.19	1.70	76.69**	393.36*
E × R	2	108.74	6.48	1.34	118.02*	129.36	0.05	0.75	0.05	0.02	4.79	2.38	34.95
Treatment (T)	20	300.94**	34.47**	24.36**	2157.4**	355.23**	0.40**	7.29**	0.23**	6.76**	102.28**	13.29**	1096.82**
E × T	20	210.54**	10.79*	13.74*	932.09**	206.03**	0.41**	6.33**	0.17*	1.85	53.32*	6.15	598.22**
Error	80	36.66	6.31	4.80	131.36	48.49	0.16	2.59	0.09	2.47	26.79	4.64	116.97
gca	5	33.33**	15.22**	6.58**	534.18**	168.27**	0.10	2.45*	0.015	1.05	17.27	3.41*	62.71
sca	15	122.26**	10.24**	8.63**	780.78**	101.79**	0.14**	2.42**	0.10**	2.65**	39.70**	4.76**	466.57**
Environment (E)	1	91.80**	50451.45**	52906.85**	15814.75**	4644.53**	0.24*	0.79	0.013	0.14	33.27*	2.02	7.68
gca × E	5	99.65**	4.66	7.09**	468.82**	98.85**	0.05	2.70*	0.08*	1.66	31.58**	2.32	233.97**
sca × E	15	60.35**	3.24	3.74*	257.99**	58.61**	0.07	1.91*	0.06*	0.26	13.17	1.96	187.88**
Error	80	16.32	2.10	1.60	43.78	16.16	0.05	0.86	0.03	0.82	8.93	1.54	38.99

* and ** indicate significance at 5% and 1% respectively

Table 2. Estimation of *gca* and *sca* effects for various traits in sweet corn

	Field emergence	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Ear height (cm)	$Ears/ plant	Ear length (cm)	Ear girth (cm)	#kernel rows/ear	#kernels/ row	100 grain weight (grn)	Grain yield/plant (gm)
Parents												
P_1	0.02	-0.42	−0.17	6.75**	4.90**	0.05	0.17	−0.10	−0.25	−0.11	0.30	1.65
P_2	1.60*	−0.76*	−0.50	2.83	0.63	−0.01	−0.56**	0.23	0.45*	−1.03	−0.14	0.15
P_3	0.84	−1.13**	−0.63*	1.25	−2.08*	−0.13*	0.39*	−0.16	−0.09	0.88	−0.68*	−2.51
P_3	−2.42**	1.03**	0.81**	−8.44**	−2.92**	0.10*	−0.42*	0.23	0.01	−1.13	0.30	−1.47
P_5	0.79	−0.01	−0.31	3.15*	2.50**	0.04	0.24	−0.08	0.11	1.51*	0.55*	2.82*
P_6	−0.82	1.28**	0.79**	−5.54**	−3.02**	−0.04	0.19	−0.12	−0.22	−0.11	−0.33	−0.64
CD (g_i) at 5%	1.56	0.62	0.56	2.96	1.80	0.10	0.39	0.28	0.39	1.33	0.55	2.79
CD (g_i) at 1%	2.05	0.82	0.74	3.90	2.36	0.14	0.52	0.36	0.52	1.75	0.73	3.68
Crosses												
$P_1 \times P_2$	1.60	0.82	0.17	7.99	6.62**	0.37*	0.37	0.16	0.15	−0.76	0.51**	1.46
$P_1 \times P_3$	2.36	0.19	0.29	6.40	2.66	−0.11	−1.23*	0.05	−0.35	−3.87*	1.06**	10.80**
$P_1 \times P_4$	3.99	−0.98	0.02	6.09	1.83	0.22	0.88	0.10	0.19	−0.29	0.58**	5.09
$P_1 \times P_5$	−2.67	−2.77**	−2.69**	10.34*	4.75*	−0.28*	1.32*	0.02	0.86	8.02**	−0.67**	8.80*
$P_1 \times P_6$	4.47*	−2.89**	−2.79**	9.03*	6.10*	0.03	0.95	0.07	0.32	3.66*	2.37**	7.92*
$P_2 \times P_3$	1.28	0.19	0.46	11.15**	5.27*	0.05	−0.06	0.07	0.18	0.32	−0.84**	−5.70
$P_2 \times P_4$	0.90	−1.64	−1.98*	0.84	−4.73	0.48**	−1.44*	0.09	2.43**	−0.96	0.35*	−0.08
$P_2 \times P_5$	4.01	−0.10	−0.19	19.76**	8.18**	−0.29*	1.66**	0.40**	0.66	5.15**	1.26**	16.30**
$P_2 \times P_6$	11.32**	−1.89*	−1.46	17.11**	4.54	−0.01	−0.05	0.07	0.45	1.71	0.81**	23.09**
$P_3 \times P_4$	2.18	−1.60	−1.35	21.59**	5.48*	−0.20	0.61	0.03	1.29*	6.69**	−0.61**	16.26**
$P_3 \times P_5$	12.17**	−2.23**	−1.73*	11.68**	3.39	0.16	0.68	0.11	−0.04	1.05	2.47**	0.96
$P_3 \times P_6$	1.92	−1.68	−1.83*	10.36*	0.58	0.17	1.15*	0.08	1.02	5.59**	1.18**	2.42
$P_4 \times P_5$	10.75**	−2.06*	−1.83*	8.03	5.89*	0.10	0.48	0.11	−0.17	−0.24	0.33*	15.92**
$P_4 \times P_6$	−0.97	2.48**	2.73**	−19.12**	−4.42	−0.33*	−0.60	0.08	−0.68	−1.85	−0.13	−5.95
$P_5 \times P_6$	−2.90	1.19	0.85	12.63**	−1.50	0.37**	−0.45	0.17	0.46	−3.29**	0.45**	4.76
CD (S_{ij}) at 5%	4.29	1.77	1.54	8.13	4.94	0.28	1.13	0.20	1.11	3.67	0.28	7.67
CD (S_{ij}) at 1%	5.65	2.34	2.03	10.70	6.50	0.36	1.48	0.26	1.46	4.83	0.36	10.10

* and ** indicate significance at 5% and 1% respectively

Table 3. Identified prospective hybrid combinations showing consistent performance across seasons based on superiority over check Madhuri

Crosses	Seasons	Superiority over check	Days to 50% tasseling	Days to 50% silking	Grain yield/ha (kg)
$P_1 \times P_5$	K@	100.00	50.33	54.00	4533
	R$	93.39	111.67	124.33	4174
$P_2 \times P_5$	K	73.33	50.00	54.33	3929
	R	34.55	122.67	128.33	2904
$P_3 \times P_5$	K	42.67	48.33	53.33	3234
	R	83.83	119.33	126.00	3968
$P_4 \times P_5$	K	34.67	51.00	54.67	3052
	R	57.67	120.33	126.67	3404

@K = *Kharif* season, $R = *rabi* season

in winter conditions. Thus, all these superior hybrids need to be evaluated in multi-location trial for identifying prospective sweet corn hybrids.

It is concluded from the present study that development of elite inbred lines and identification of prospective cross combinations will be the major strategy, while hybrid breeding is suggested as main focus in sweet corn breeding because non-additive variation is significant for all traits. Many other quality traits and ear appearance traits *viz.*, row configuration, tip fill, kernel width and depth, ear shape and ear size [4] demand attention in sweet corn breeding.

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