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Combining Ability Studies for Yield and Yield Contributing Characters in Selected Sweet Corn Hybrids and their Parental Lines

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The investigation was undertaken in sweet corn to carry out the combining ability analysis of yield and yield contributing characters. Eight divergent parents were selected and crossed in diallel fashion excluding reciprocals during *kharif,* 2010. The resulting 28 crosses along with parents and a standard check Sugar 75 and Madhuri were evaluated. The data were collected on plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, green cob yield, 100 kernel (dry) weight and seed yield (wet) per plant. The combining ability analysis revealed importance of both additive and non-additive gene actions in governing the characters but non-additive gene action was found predominant. The parental lines 6100, 6100-2 and 6104 contributed maximum favourable genes for characters under study. Considering all the characters, the parental lines 6100, 6100-2 and 6122-1 can be considered as good general combiners. The hybrid combinations, 6104 x 6100, 6127 x 6100 and 6122-1 x 6100-2 performed well for seed yield (wet) per plant and yield contributing characters which may be used as single cross hybrids.

Key words: Sweet corn, General combining ability, Madhuri, Specific combining ability, Sugar75.

Sweet corn (*Zea mays* L. *saccharata*) is one of the most popular vegetables in USA and Canada. It is characterized by translucent, horny appearance of kernel when matures and wrinkled when it dries. The research reports indicate that the sweet corn has arisen as a mutant from field corn in the 19th century. Sweet corn is consumed in immature stage of the cob. Total sugar content in sweet corn at milky stage ranges from 25- 30 % as compared to 2- 5 % in normal corn.

Sweet corn varies from normal corn essentially for gene(s) that affect starch synthesis in the seed endosperm wherein one or more simple recessive mutant alleles in the seed endosperm elevate the level of water soluble polysaccharides (sugars) and decrease starch (Dinges *et al.,* 2001). Four most useful mutants are shrunken2 (*sh2*), brittle (*bt*), sugary (*su1*) and sugary enhancer (*se*). Sweet corn is popular in preparations like soups, jams. It is also consumed as raw or boiled. To establish a sound basis for any breeding programme aimed at achieving higher yield, breeders must have information on the nature of combining ability of parents *i.e.,* general and specific combining ability and their performance in hybrid combinations for yield and yield attributes. Keeping in view the growing importance of sweet corn in India, research was undertaken in this aspect by evaluation of germplasm and choosing elite parents for developing high potential single cross hybrids.

Materials and Methods

Eight elite sweet corn inbreds were raised at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad during *Kharif*, 2010. All the eight inbreds were crossed in a half diallel fashion to obtain 28 cross combinations. Reciprocal crosses were not attempted presuming that practically there are no cytoplasmic influences in the material concerned. Single cross hybrids, parents and check were evalvated in Rabi, 2010-11 at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad. Observations were recorded for plant height (cm), ear height (cm),ear length (cm),ear girth (cm),number of seed rows per cob, number of seeds per row, green cob yield (kg/ha),100 seed(dry) weight (g) and Seed yield per plant (g).

The data obtained from F_1s and parents were analyzed as per Method II (F_1s + parents) and Model - I (fixed effect) of Griffing (1956) for combining ability.

Results and Discussion

Studies on combining ability was carried out for eight inbreds and their 28 hybrids for grain yield and its contributing characters. The data for each trait were analyzed separately using diallel mating design for precise estimation of gene action.

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Table 1. Mean performance of parents and hybrids

Parents / Hybrids	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows per ear	Number of kernels per ear	Seed yield per cob (g)	Green cob yield (kg/ha)	100 seed weight(g)
Parents									
6072-3	173.89	64.89	15.22	13.58	14.00	33.67	136.67	16285.00	10.33
6104	155.61	45.78	17.13	12.78	14.00	32.50	116.67	20499.33	11.03
6069	169.44	57.44	17.42	15.23	16.00	35.33	169.17	20904.00	11.73
6122-1	164.29	58.78	15.53	14.35	14.00	31.00	129.17	17261.00	11.30
6127	106.87	53.33	14.27	13.08	14.00	28.67	125.67	15577.00	12.27
6100	177.09	72.44	19.02	14.05	14.67	32.83	175.00	20004.00	10.83
6100-2	180.00	67.89	14.47	14.33	14.00	36.67	189.17	17880.33	10.57
6082	187.09	74.55	15.92	13.33	13.67	35.67	143.33	17642.00	10.20
Mean of parents	164.29	61.89	16.12	13.84	14.29	33.29	148.10	18256.58	11.03
Hybrids									
6072-3 x 6104	215.66	75.89	16.28	15.80	15.67	37.83	159.17	23046.67	15.73
6072-3 x 6069	187.33	65.22	14.87	13.05	12.33	33.00	167.50	18689.33	13.13
6072-3 x 6122-1	182.22	65.11	20.20	15.27	16.00	39.67	178.33	21594.33	14.73
6072-3 x 6127	187.11	69.66	20.00	15.95	14.00	34.50	160.83	19475.33	15.83
6072-3 x 6100	204.11	76.22	19.08	14.65	14.00	33.33	205.83	20309.00	15.60
6072-3 x 6100-2	189.44	71.50	20.28	14.88	14.33	35.33	198.33	20332.67	14.30
6072-3 x 6082	186.66	76.11	17.82	15.45	14.00	36.00	181.67	23341.67	15.17
6104 x 6069	208.77	75.64	18.05	15.08	14.00	35.33	150.83	22951.33	13.50
6104 x 6122-1	211.55	71.55	18.97	15.37	13.67	41.33	161.67	23546.67	16.10
6104 x 6127	212.11	71.10	19.88	15.40	16.00	30.67	187.50	23689.33	13.73
6104 x 6100	219.55	86.11	21.60	16.52	16.00	39.00	228.33	26165.67	16.17
6104 x 6100-2	199.61	84.11	16.03	14.33	14.00	35.50	183.33	21547.00	12.93
6104 x 6082	214.77	68.00	18.93	15.82	14.33	37.00	181.83	24047.00	14.20
6069 x 6122-1	185.66	61.55	18.07	14.12	13.33	33.33	139.17	19403.67	15.37
6069 x 6127	215.22	73.53	17.92	15.10	16.00	35.50	191.67	22570.67	14.80
6069 x 6100	202.78	81.11	18.17	14.23	12.33	32.67	162.50	20928.00	12.13
6069 x 6100-2	199.50	73.66	16.60	14.62	14.00	34.17	186.67	21499.00	16.03
6069 x 6082	199.22	82.89	18.42	15.02	14.00	35.33	190.00	22737.33	15.03
6122-1 x 6127	151.77	52.77	16.58	14.97	14.00	35.83	166.67	20451.67	12.90
6122-1 x 6100	209.11	88.67	19.25	15.18	14.00	35.50	177.50	21237.33	12.80
6122-1 x 6100-2	198.88	78.77	21.65	14.78	12.00	38.50	203.00	22761.00	18.33
6122-1 x 6082	202.33	73.66	16.38	15.27	14.00	36.50	177.50	22689.33	14.60
6127 x 6100	195.00	79.99	20.18	15.32	14.00	36.83	229.17	22785.00	14.90
6127 x 6100-2	202.00	87.33	20.28	15.30	14.67	40.00	197.50	21404.00	14.70
6127 x 6082	211.66	86.99	16.52	14.67	16.00	37.67	168.33	19499.33	12.90
6100 x 6100-2	175.33	79.22	17.90	14.07	13.67	33.83	203.33	20856.67	13.77
6100 x 6082	198.22	79.77	19.52	14.37	14.33	35.67	173.33	20242.00	13.17
6100-2 x 6082	192.99	78.11	17.95	14.12	13.67	37.33	175.83	21213.33	12.90
Mean of crosses	198.52	75.89	18.70	14.95	14.23	35.97	181.69	21750.51	14.48
Grand Mean	190.91	72.48	17.95	14.71	14.24	35.37	174.23	20974.08	13.71
Check(Madhuri)	188.55	68.44	18.40	14.15	14.00	36.83	190.83	20737.33	14.33
Check(Sugar75)	219.55	65.22	21.10	17.85	16.00	44.67	266.67	32880.00	17.03
S Ed	8.09	5.43	1.25	0.72	0.33	3.09	15.76	1632.60	0.77
CD (0.05)	16.16	10.84	2.51	1.44	0.66	N.S.	31.47	3259.66	1.54
CV (%)	5.17	9.21	8.53	6.01	2.85	10.63	10.90	9.39	6.86

Mean performance

In the present investigation, based on the overall *per se* performance of parents, the inbred 6100 recorded higher mean performance for all the characters except 100 seed (dry) weight and ear girth followed by inbred 6069 which recorded higher mean performance for seed yield (wet) per plant, ear length, ear girth, number of kernel rows per ear and 100 seed (dry) weight.

Among the hybrids, the hybrid 6104 x 6100 recorded higher mean performance for seed yield per plant, green cob yield, 100 seed weight, ear length, ear girth and plant height followed by the hybrids 6072-3 x 6069 and 6069 x 6122-1 crosses. The overall results revealed that hybrids registered superior performances than parents. The hybrids in general, were tall and high yielding over the parents. The cross combinations, 6127 x 6100 (229.17g) and 6104 x 6100 (228.33g) exhibited relatively higher seed yield per plant compared to other cross combinations and the hybrids 6072-3 x 6100 (205.83g), 6100 x 6100-2 (203.33g), 6122-1 x 6100-2 (203g), 6072-3 x 6100-2 (198.33g), 6127 x 6100-2 (197.50g), 6069 x 6127 (191.67g) and 6104 x 6127 (187.50g) recorded better seed yield per plant

Table 2. Combining ability of grain yield and its components

Source	d.f	plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows per ear	Number of kernels per ear	Seed yield (wet) per cob (g)	Green cob yield (kg/ha)	100 seed (dry) weight(g)
GCA	7	440.86**	177.13**	2.95**	0.11	0.82**	5.72	1058.55**	6867597.00**	0.81*
SCA	28	514.56**	97.46**	4.01**	0.88**	1.09**	7.55	585.21**	4751088.00**	4.46**
Error	70	33.52	14.93	0.81	0.26	0.05	4.82	121.93	1387718.94	0.31
σ^2 gca		40.73	16.57	0.21	-0.01	0.07	0.09	93.66	547987.82	1.05
σ^2 sca		481.04	86.12	3.19	0.61	1.03	2.73	463.27	3363368.45	1.31
σ^2 gca/σ^2 sca		0.08	0.19	0.06	-0.02	0.07	0.03	0.20	0.16	0.79

*=Significant at 5%; **= Significant at 1%

Table 3. General combining ability effects for grain yield and its components in sweet corn inbreds

Parents	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows per ear	Seed yield (wet) per cob (g)	Green cob yield kg/ha	100 seed (dry) weight (g)
6072-3	-1.79	-2.53*	-0.26	-0.01	0.01	-4.30	-940.77**	0.17
6104	7.50**	-3.08**	0.24	0.15	0.35**	-8.20*	1722.55**	0.10
6069	1.92	-1.63	-0.46	-0.06	-0.01	-4.13	182.05	0.003
6122-1	-4.81**	-4.51**	0.05	0.12	-0.31**	-10.58**	-256.07	0.40*
6127	-12.96**	-2.67**	-0.16	0.05	0.45**	-1.50	-773.74*	0.08
6100	4.00*	7.11**	1.21**	0.008	-0.05	16.19**	376.49	-0.32
6100-2	-0.04	3.36**	-0.19	-0.15	-0.38**	15.82**	-339.24	0.06
6082	6.18**	3.98**	-0.42	-0.09	-0.05	-3.28	28.72	-0.50**
Range	-12.96 to 7.50	-4.51 to 7.11	-0.46 to 1.21	-0.15 to 0.15	-0.38 to 0.45	-10.58 to 16.19	-940.77 to 1722.55	-0.50 to 0.40
SE (gi)	1.71	0.99	0.26	0.15	0.07	3.26	348.46	0.16
SE (gi-gj)	2.58	1.50	0.40	0.23	0.10	4.93	526.82	0.24

*=Significant at 5%; **= Significant at 1%

compared to check Madhuri and comparable to check Sugar 75. The mean performance of parents, hybrids and standard checks for 12 quantitative characters studied are presented in Table 1.

Combining ability analysis

The mean sum of squares of *gca* and *sca* were significant for the characters studied which showed that there existed considerable variation. The ratio of *gca* to *sca* for all the characters was less than one which indicates that all these characters were predominantly governed by non-additive gene effects (Table 2).

For seed yield per plant Nagda *et al.* (1995), reported that non-additive gene action was playing predominant role in governing seed yield per plant in sweet corn. Rodrigues *et al.* (2009) also conducted experiments in sweet corn to study combining ability effects and concluded that green cob yield was governed by non- additive gene action.

Considering the entire yield contributing characters, the inbreds 6100-2, 6100, and 6082 can be given the status of good general combiners and genetically worthy parents, as they contributed maximum favourable genes for seed yield and yield components. The parental line 6100-2 was

Table 4. Specific combining ability for grain yield and its components in sweet corn hybrids

Crosses	plant height (cm)	Ear height(cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows per ear	Seed yield (wet) per cob (g)	Green cob yield kg/ha	100 seed (dry) weight(g)
6072-3 x 6104	19.03**	8.75**	-1.65	0.95	1.05**	-2.55	1290.80	1.74**
6072-3 x 6069	-3.71	-3.36	-2.35**	-1.57**	-1.90**	1.7 1	-1526.03	-0.75
6072-3 x 6122-1	-2.09	-0.59	2.45**	0.44	2.05**	18.99	1817.10	0.44
6072-3 x 6127	10.94*	2.11	2.47**	1.20*	-0.70	-7.58	215.76	1.85**
6072-3 x 6100	10.98*	-1.11	0.17	-0.05	-0.20	19.71	-100.80	2.03**
6072-3 x 6100-2	0.36	-2.09	2.78**	0.35	0.45*	12.58	638.59	0.34
6072-3 x 6082	-8.64	1.90	0.54	0.85	-0.20	15.03	3279.63**	1.78**
6104 x 6069	8.43	7.60*	0.32	0.29	-0.57*	-11.05	72.63	-0.31
6104 x 6122-1	17.94**	6.39*	0.71	0.37	-0.60**	6.23	1106.09	1.88**
6104 x 6127	26.65**	4.10	1.85*	0.49	0.95**	22.98*	1766.43	-0.16
6104 x 6100	17.13**	9.32**	2.18*	1.65**	1.45**	46.11**	3092.53**	2.67**
6104 x 6100-2	1.23	11.07**	-1.96*	-0.36	-0.20	1.48	-810.40	-0.94
6104 x 6082	10.17	-5.65	1.15	1.05*	-0.20	19.09	1321.63	0.89
6069 x 6122-1	-2.35	-5.05	0.52	-0.65	-0.57*	-20.33	-1496.40	1.24*
6069 x 6127	35.34**	5.08	0.59	0.41	1.32**	23.08*	2188.26*	0.99
6069 x 6100	5.93	12.86**	-0.53	-0.41	-1.84**	-23.78*	-604.63	-1.26*
6069 x 6100-2	6.76	-0.82	-0.69	0.13	0.15	0.74	682.10	2.24**
6069 x 6082	0.20	7.78*	1.35	0.47	-0.17	23.19*	1552.46	1.82**
6122-1 x 6127	-21.36**	-12.78**	-1.26	0.08	-0.37	4.53	507.39	-1.30*
6122-1 x 6100	19.00**	13.31**	0.02	0.34	0.12	-2.33	142.83	-0.99
6122-1 x 6100-2	12.81*	7.17*	3.83**	0.10	-1.54**	23.53*	2382.23*	4.15**
6122-1 x 6082	10.04	1.44	-1.20	0.53	0.12	17.14	1942.59	0.99
6127 x 6100	13.04*	2.79	1.18	0.55	-0.64**	40.24**	2208.16*	-0.79
6127 x 6100-2	24.08**	13.88**	2.69**	0.70	0.35	8.94	1542.89	-1.05*
6127 x 6082	27.53**	12.93**	-0.84	0.009	1.35**	-1.10	-729.73	0.33
6100 x 6100-2	-19.54**	-4.01	-1.07	-0.48	-0.14	-2.91	-154.66	0.76
6100 x 6082	-2.88	-4.07	0.77	-0.24	0.19	-13.80	-1137.30	0.32
6100-2 x 6082	-4.05	-1.99	0.61	-0.33	-0.14	-10.93	549.76	-0.43
Range	-21.36 to 35.34	-12.78 to 13.88	-2.35 to 3.83	-1.57 to 1.65	-1.90 to 2.05	-23.78 to 46.11	-1526.03 to 3279.63	-1.30 to 4.15
SE (Sij)	5.25	3.05	0.82	0.47	0.21	10.01	1068.18	0.50
SE(Sii-Sjj)	6.34	3.68	0.99	0.56	0.26	12.09	1290.45	0.61
SE(Sji-Sik)	7.76	4.51	1.21	0.69	0.32	14.81	1580.47	0.74
SE(Sij-Skl)	7.32	4.25	1.14	0.65	0.30	13.96	1490.08	0.70

*=Significant at 1%; **= Significant at 5%

good general combiner for ear height, and seed yield per plant. whereas, the inbred 6100 was good general combiner for plant height, ear height, ear length and seed yield (wet) per plant. Whereas, the inbred 6082 was good general combiner for plant height and ear height. Hence, these high yielding parents with good attributes for different yield components may be inter crossed to exploit the genes in desirable direction to improve the yield potential. The general combining ability (*gca)* effects for yield and yield contributing characters were presented in Table 3.

In case of specific combining ability when the yield contributing characters were considered the crosses 6104 x 6100, 6127 x 6082 and 6072 -3 x 6069 were found to be good specific combiners and genetically worthy crosses, as they were superior for most of the grain yield and yield components (Table 4). The cross combination, 6104 x 6100 was good specific combiner for ear girth, number of kernel rows per ear, seed yield per plant and

for green cob yield. Asbish Khanduri *et al.* (2010), Zhao YuanZeng *et al.* (2002), Bordallo *et al.* (2005) observed predominant role of specific combining ability for plant height, height up to ear, ear length, ear girth and carbohydrate accumulation pattern in kernel.

Hence, these high yielding hybrids with good attributes can be checked under different field trials and can be developed as commercial hybrids.

Considering the results in the present investigation, high general combining ability effects for seed yield per plant was noticed in the inbred lines 6100 (16.19) and 6100-2 (15.82). The inbreds 6127, 6100-2, 6104 and 6100 have resulted in the production of superior single crosses 6104 x 6100, 6127 x 6100 and 6122-1 x 6100-2 for seed yield. These inbreds also resulted in the production of high grain yield; hence have potential application in the crop improvement programmes.

The mean performance and *sca* effects revealed the superiority of the cross combinations (6122-1 x 6127, 6069 x 6100-2, 6104 x 6100, 6127 x 6100 and 6100 x 6100-2) for seed yield and other important yield contributing characters observed. These crosses may be advanced for isolation of transgressive segregants or homozygous lines for use in breeding programmes.

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