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Heterosis of Single Cross Sweet Corn Hybrids Developed with Inbreds of Domestic Genepool

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The sweet corn hybrids synthesized with inbreds of domestic gene pool were studied for heterosis, combining ability effects and nature of gene action involved in the expression of green cob yield and quality traits in a Line x Tester design involving eighteen lines and four testers. Totally twelve quantitative and six qualitative traits were considered in the study. Combining ability indicated the predominance of non-additive gene action for all the characters and the contribution of lines was greater than the testers for all the traits studied. Since non-additive gene action was predominant, heterosis breeding was suggested for the improvement of green cob yield as well as quality traits. Among the lines, B.No. 1421-5-1, SC 8324 -3, SC 7855-3-1 USC 10-3-2-3 and USC 10-2-2 and among testers USC 3-1-2-1 and USC 4 were identified as superior ones, as they possessed higher *per se* and significantly positive *gca* effects for green cob yield coupled with desirable percentage of total sugar and starch. Therefore, these parents may be utilized for development of heterotic sweet corn hybrids with enhanced green cob yield and total sugar.

Key words: sweet corn, green cob yield, combining ability, heterosis, total sugar.

Among the various types of specialty corns, sweet corn (*Zea mays* L. *saccharata*) has become popular, both as a fresh and processed vegetable in several countries worldwide including India. Present day sweet corn breeding primarily aims for more uniform maturity, improved quality and disease resistance besides identification of the separate gene mutations in corn that can be used in sweet corn improvement to increase sugar content and decrease the starch content (Tracy, 1997).

Although the sweet corn composites are popular among the farming community earlier, they have the inherent problem of low yielding potential compared to hybrids. One of the ways to break the productivity barrier in sweet corn is to develop high yielding single cross hybrids rather than breeding composites. The most striking advantage of single cross over double and three way cross is that single cross breeding is simpler and faster besides its highest yield potential. Though there is some concern about the stability in performance of single crosses, experience showed that stable single cross hybrids can be identified and commercially exploited (Dhillon, 1998). Among the many objectives of sweet corn breeding, most important one is to increase green cob yield potential with better quality.

A better understanding of the nature of gene action of each genetic trait is at most important for a breeder in identifying and using an appropriate breeding strategy. Knowledge on general combining ability is important because it can help in identifying suitable parents for use in subsequent breeding programmes. The Line x Tester analysis (Kempthorne,1957) helps the breeder to determine the nature of gene action for yield and yield contributing characters and reveals the magnitude of heterosis in the cross combinations evaluated.

Therefore, a study was designed to study the combining ability and gene action for yield contributing traits and quality traits of sweet corn utilizing the existing domestic inbred pools. The magnitude of heterosis in hybrids for green cob yield and quality was also assessed to identify superior sweet corn single cross hybrids with maximum heterotic potential for green cob yield and quality traits.

Materials and Methods

A total of 22 sweet corn germplasm lines derived from the domestic gene pool was utilized for the present study. Among the 22 genotypes, 18 genotypes were used as lines and four were used as testers. Details of germplasm lines used are given in Table 1.

All the sweet corn parents were raised during *Kharif* 2010 and crossing was done in a Line x Tester fashion. The resultant 72 hybrids along with their parents and a standard check, Madhuri were evaluated in randomized complete block design with two replications, during *Rabi* 2010-11. Each

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Table 1. Description of the sweet corn parents involved in the study.

Inbreds	Kernel shape	Kernel colour	Duration (Days)	Code
LINES				
72173-2-1-2	Shrunken	Orange	90-95	L_1
SC 11-1	Shrunken	Orange	85-90	L_2
SC 11-2	Shrunken	Yellow	85-90	L_3
SC 8324-3	Shrunken	Orange	90-95	L_4
B.NO. 1386	Shrunken	Orange	95-100	L_5
B.NO. 1457-6	Shrunken	Yellow	95-100	L_6
B.NO. 1413-6-2	Shrunken	Orange	95-100	L_7
B.NO. 1421-5-1	Shrunken	Orange	95-100	L_8
USC 10-3-1-1	Shrunken	Yellow	85-90	L_9
USC 10-3-2-1	Shrunken	Orange	85-90	L_{10}
B.NO.1378-5-1	Shrunken	Orange	95-100	L_{11}
72173-3-1	Shrunken	Orange	95-100	L-$_{12}$
B.NO.1396-4-1	Shrunken	Orange	95-100	L_{13}
USC 1-1-1	Shrunken	Orange	85-90	L_{14}
USC 10-2-2	Shrunken	Orange	85-90	L_{15}
USC 10-3-2-3	Shrunken	Yellow	85-90	L_{16}
SC 7855-3-1	Shrunken	Orange	85-90	L_{17}
USC 1-1-2	Shrunken	Yellow	85-90	L_{18}
TESTERS				
USC 4	Shrunken	Orange	85-90	T-$_1$
USC 3-1-2-2	Shrunken	Yellow	85-90	T_2
B.NO. 1394-6	Shrunken	Yellow	95-100	T_3
USC 1053-6	Shrunken	Orange	85-90	T_4
CHECK				
Madhuri	Shrunken	Orange	90-95	C

genotype was raised in two rows of a five meters length with the spacing 60 x 25 cm.

Biometrical data was recorded on plant height (cm), number of leaves per plant, leaf length (cm), leaf breadth (cm), days to 50% tasseling, days to 50% silking, days to green cob harvest, green cob length (cm), green cob girth (cm), number of kernel rows per cob, number of kernels per row and green cob yield (g). Quality of the green cob was ascertained by analyzing the quality traits.The immature kernels collected at milky stage from parents and hybrids were dried in hot air oven and this formed the sample for quality analysis. Total soluble solids were measured using hand refractometer (Olsen *et al.,* 1990) by taking juice directly by squeezing a grain at milky stage. Total sugars was estimated using Anthrone method (Yemm and Willis, 1954), reducing sugar by Nelson Somogyi method (Somogyi 1952), non-reducing sugar by subtracting reducing sugar from total sugar, starch by anthrone method (Clegg, 1956) and total carbohydrate by phenol-sulphuric acid method (Dubois *et al.,* 1956).

Statistical analysis

The mean data of 72 sweet corn hybrids and their 22 parents obtained for each trait was subjected to analysis of variance (Panse and Sukhatme, 1964). The data of twelve biometrical traits were subjected to analysis of variance for Line x Tester mating design as suggested by Kempthorne (1957).

Standard heterosis was estimated by using standard formula considering the mean performance of check and significance was tested by the formula

$$\text{'t' for standard heterosis} = \frac{F - C}{\sqrt{\sigma^2 e / rx2}}$$

(σ_{2e}=error variance, r=number of replication)

Results and Discussion

Analysis of variance showed significant differences among the genotypes for all the traits studied. Significant differences were found among the parents and hybrids for all the traits under consideration except for the green cob length.

Analysis of variance for combining ability

Variance due to lines was significant for all the traits under consideration. Variance due to testers highly significant for most of the traits studied except for leaf breadth, green cob length and number of kernels per row. Variance due to interaction effect of lines and testers were significant for all the characters except for the leaf breadth, green cob girth (Table 2).

Table 2. Mean Squares from analysis of variance for combining ability

Characters	Sources of variation			
	Lines	Testers	Line x Tester	Error
Plant height	1693.30**	903.34**	351.35**	66.68
Number of leaves/plant	4.56**	3.82**	1.33**	0.20
Leaf length	173.26**	112.42**	72.48**	10.78
Leaf breadth	1.27*	1.53	0.86	0.62
Days to 50% tasseling	40.44**	43.69**	3.73**	0.17
Days to 50% silking	33.88**	18.49**	3.71*	0.15
Days to green cob harvest	47.64**	25.77**	3.48**	0.16
Green cob length	3.21*	3.17	1.66	2.22
Green cob girth	2.81**	0.97	0.85	0.71
No. of kernel rows/cob	3.68**	3.30**	1.53**	0.5
No. of kernels/row	50.96**	7.30	11.42*	6.62
Green cob yield	2766.97**	3780.6**	923.70**	270.44
Total soluble solids	9.68**	4.76**	4.41**	0.32
Total sugar	11.02**	39.04**	4.63**	0.77
Reducing sugar	4.35**	1.98**	2.30**	0.056
Non reducing sugar	8.26**	39.42**	3.33**	0.69
Starch	158.14**	197.36**	95.34**	10.96
Total carbohydrate	167.63**	143.58**	109.33**	23.47

Specific combining ability variance (SCA) was found to be greater than general combining ability variance (GCA) for all the traits studied indicating non-additive gene action was higher than the additive component in the genotypes under study. Similar results were reported for plant height and leaf length Premlatha, 2006; Alam *et al.,* 2008; Kanagarasu, 2010), number of leaves per plant and leaf breadth (Premlatha, 2006; Kanagarasu, 2010), days to 50 per cent tasseling and days to 50 per cent silking (Premlatha, 2006; Jayakumar and Sundaram, 2007; Singh and Roy, 2007; Vijayabharathi *et al*., 2009 Kanagarasu, 2010), cob length (Kalla *et al.,* 2001; Singh and Roy, 2007; Jayakumar and Sundram, 2007; Prabhu, 2008; Kanagarasu, 2010), cob girth (Premlatha, 2006; Singh and Roy, 2007; Prabhu, 2008; Kanagarasu, 2010), kernel rows per cob

(Premlatha, 2006; Singh and Roy, 2007; Vijayabharathi *et al*., 2009; Kanagarasu, 2010), kernels per row (Premlatha, 2006; Jayakumar and Sundaram, 2007; Prabhu, 2008 and Kanagarasu, 2010), green cob yield (Dickert and Tracy, 2002), total soluble solids (Kashiani *et al.,* 2010), total sugars , reducing sugar, non reducing sugar, starch and total carbohydrate (Has, 1999 and Kumari *et al.,*2008). The ratio of variance due to general and specific combining ability ranged from 0.005 to 0.102.

Performance of parents

The knowledge of general combining ability coupled with high *per se* of parents would be of great value in single cross hybrid maize breeding. Authenticity of *gca* effect, guaranteed by matching *per se* performance facilitate the breeder in selecting suitable parents for hybrid development programme. In the present study, desirable mean value and *gca* effect were possessed by the lines *viz.,* L_{17} for leaf length, number of kernel rows per cob and number of kernels per row, L_7 for leaf breadth, L_{12} for days to green cob harvest, L_8 for green cob yield, L_{17} for total sugars and reducing sugar, and L_{18} for non reducing sugar.

Similarly, the tester T_1 had recorded lower mean values and *gca* effects for days to 50% tasseling, days to green cob harvest and higher mean and *gca* effects for the trait total carbohydrate. In case of tester T_2 , higher mean value and *gca* effects were found for the traits *viz.,* plant height, leaf length, leaf breadth, days to 50% silking, days to 50% tasseling, total sugars and non reducing sugar.The tester T_3 for had both *per se* performance and the *gca* effects in high order the traits *viz.,* for leaf length, days to green cob harvest, green cob girth and number of kernels per row The tester T_4 had recorded desirable mean and *gca* effect for the traits *viz.,* number of leaves per plant, number of kernel rows per cob, number of kernels per row, total sugar, reducing sugar and reduced starch content.

Considering the overall assessment of yield components for high *gca* and *per se* performance (Table 3), a close correspondence between mean performance and *gca* effect was observed among the parents. The line L_{17} possessed desirable mean and *gca* effects for many of the traits and the line L_8 for the most important trait green cob yield. The testers T_2, T_3 and T_4 also possessed higher *per se* and positive *gca* effects for many of the traits. Hence, the line L_8, $L_{17,}$ testers T_2, T_3 and T_4 can be utilized in future breeding programme to develop synthetics, populations *etc*.

Performance of hybrids

For exploiting hybrid vigour, *per se* performance, *sca* effects and the extent of heterosis of hybrids are important and hence, the hybrids were evaluated on the basis of the above said three parameters.

Among the 72 hybrids analyzed, the hybrid L_8 x T_2 was identified as the best hybrid since it possessed desirable *per se* performance, *sca* and standard heterosis for green cob yield, green cob length and number of kernel rows per cob (Table 3). The hybrid L_8 x T_1 was the next best hybrid for green cob yield followed by the hybrid L_{15} x T_1. The other hybrids which performed better in terms *per se, sca* and standard heterosis were L_4 x T_3 and L_{15} x T_2 for plant height, L_9 x T_4 for number of leaves per plant, L_{18} x T_4 for leaf breadth, L_7 x T_1 and L_{18} x T_1 for earliness, L_8 x T_2, L_{13} x T_3, L_{12} x T_3 for green cob length, L_{16} x T_1 and L_{18} x T_1 for green cob girth.

Besides *per se, sca* effect and standard heterosis, the hybrid should have both the parents as good combiners and at least any one of the parent as a good combiner. Hence going by above statement, it was noticed that the hybrids showed good *per se, sca* and standard heterosis, L_8 x T_2, L_8 x T_1, L_{15} x T_1, L_{17} x T_1 had one of the parent as a good combiner. It is understood from the above that the crosses which showed high *sca* mostly involved high x low *gca* effects which indicates the presence of additive x dominance type of interaction. Hence, advance generation of these crosses may be grown for isolation of new inbred with desirable traits.

Quality traits revealed the predominance of SCA variance over GCA variance indicating the involvement of non additive gene action which could be exploited through heterosis breeding. The trait TSS being an indicator of sugar concentration in the immature kernels can be used as a harvest index. The hybrids *viz.,* L_{17} x T_1, L_{17} x T_3, L_{11} x T_1 and L_2 x T_4 showed superior mean values for this trait which can be attributed to higher *per se* and standard heterosis. This is in accordance with the reports of Kashiani *et al.* (2010).

The hybrids L_{13} x T_4, L_{17} x T_4, L_{10} x T_2 and L_9 x T_4 possessed higher concentration of total sugar with higher *sca* effects and standard heterosis. The similar results were obtained by Has (1999); Tracy (1994); Wong *et al.*,(1994); Azanza *et al.,*(1996a, 1996b) and Kumari *et al.* (2008). Among the 72 hybrids evaluated, L_8 x T_1, L_4 x T_3, L_{13} x T_1 and L_{17} x T_4 showed higher concentration of reducing sugar and L_{16} x T_2, L_{10} x T_2, L_{13} x T_4 and L_9 x T_4 registered higher amount of non reducing sugar. These results may be attributed to higher *sca* and standard heterosis in one or the other above crosses as reported earlier by Has (1999) and Kumari *et al.* (2008).

In sweet corn breeding, lower amount of starch content is preferred in the hybrids since it has negative correlation with total sugar. The hybrids L_{11} x T_1, L_{10} x T_3, L_{12} x T_4 and L_3 x T_1 recorded lower concentration of starch which can be attributed to high negative *sca* effects and negative standard heterosis. Similary, the hybrids L_4 x T_2, L_5 x T_4, L_{17} x T_2 and L_6 x T_2 exhibited higher concentration of total carbohydrate as a result of high positive *sca* effects

Table 3. The top performing lines, testers and hybrids

	per se			Combining ability effects			Heterosis		
	Line	Tester	Hybrid	Line	Tester	Hybrid	di	dii	diii
PH	L_{18} (168.30)	T_4 (141.15)	L_4 x T_3 (229.40)	L_{17} (25.51)	T_2 (5.38)	L_{14} x T_4 20.77)	L_{13} x T_1 (99.63)	L_{13} x T_1 (90.41)	L_4 x T_3 (56.96)
NL/P	L_{18} (12.80)	T_4 (11.2)	L_8 x T_2, L_8 x T_4 (14)	L_8 (1.88)	T_4 (0.27)	L_{10} x T_4 (1.45)	L_{11} x T_1 (58.17)	L_{11} x T_1 (34.44)	L_9 x T_4, L_{10} x T_4, L_{13} x T_4, (16.81)
LL	L_{18} (71.51)	T_2 (67.80)	L_{17} x T_2 (91.05)	L_{15} (7.84)	T_2 (1.40)	L_9 x T_4 (8.74)	L_{15} x T_1 (79.58)	L_{13} x T_1 (70.61)	L_{17} x T_2 (45.54)
LB	L_8 (9.46)	T_2 (7.22)	L_6 x T_2 (9.82)	L_7 (0.75)	T_2 (0.2)	L_8 x T_4 (1.42)	L_{14} x T_1 (50.71)	L_3 x T_3, L_{14} x T_1 (47.47)	L_6 x T_2 (18.10)
DFT (high)	L_{17} (55.00)	T_2 (49.50)	L_{12} x T_2 (54.00)	L_{12} (5.00)	T_2 (0.97)	L_7 x T_3 (4.42)	L_7 x T_1 (11.34)	L_7 x T_1 (9.47)	L_{12} x T_2 (13.68)
(low)	L_3 (47.00)	T_1 (46.50)	L_{14} x T_1 (41.00)	L_{14} (-4.63)	T_1 (-1.58)	L_7 x T_1 (-3.17)	L_7 x T_1 (-16.42)	L_7 x T_1 (-22.22)	L_{14} x T_1 (-13.68)
DFS (high)	L_1 (58.00)	T_4 (51.50)	L_{12} x T_4 (54.50)	L_{12} (3.63)	T_2 (0.46)	L_7 x T_3 (2.93)	L_7 x T_1 (7.46)	L_{12} x T_2 (6.93)	L_{12} x T_4 (10.10)
(low)	L_2, L_3, L_{12}, (50.00)	T_2 (50.50)	L_{18} x T_1 (43.00)	L_{14} (-4.50)	T_1 (-1.07)	L_{18} x T_1 (-3.43)	L_{18} x T_2 (-17.31)	L_{18} x T_1 (-18.87)	L_{18} x T_1 (-13.13)
DGH (high)	L_{17} (79.50)	T_3 (74.00)	many (77.00)	L_{13} (4.15)	T_3 (0.58)	L_{18} x T_4 (2.70)	L_{12} x T_4 (5.84)	L_{12} x T_4 (4.76)	Many (6.94)
(low)	L_{12} (72.00)	T_1 (72.00)	L_{18} x T_1 (65.00)	L_{14} (-5.73)	T_1 (-1.26)	L_{18} x T_1 (-2.74)	L_{14} x T_4 (-10.51)	L_7 x T_1 (-11.69)	L_{18} x T_1 (-9.72)
GCL	L_{14} (14.76)	T_4 (13.24)	L_8 x T_2 (21.78)	L_{17} (1.15)	T_2 (0.40)	L_{12} x T_3 (2.07)	L_{12} x T_3 (92.77)	L_5 x T_1 (86.82)	L_8 x T_2 (30.00)
GCG	L_8 (12.97)	T_2 (11.34)	L_8 x T_2 (17.38)	L_{16} (1.07)	T_4 (0.15)	L_8 x T_2 (1.41)	L_{16} x T_1 (73.13)	L_{16} x T_1 (64.91)	L_8 x T_3 (30.05)
R/C	L_5, L_{12}, L_{13}, L_{14}, L_{17} (14.00)	T_3 ,T_4 (14.00)	many (14.00)	L_{10}, L_{17}, L_{18} (0.81)	T_1 (0.25)	L_8 x T_2 (1.67)	L_9 x T_2 (40.00)	Many (33.33)	L_{17} x T_1 (49.03)
K/R	L_{17} (28.90)	T_4 (27.00)	L_{17} x T_1 (38.10)	L_{17} (4.38)	T_3 (0.48)	L_{10} x T_2 (3.91)	L_{16} x T_1 (92.43)	L_{16} x T_1 (90.37)	L_{17} x T_1 (49.03)
GCY	L_8 (128.70)	T_4 (113.00)	L_8 x T_2 (288.60)	L_8 (35.43)	T_1 (8.36)	L_6 x T_2 (34.41)	L_{15} x T_1 (259.03)	L_{15} x T_1 (257.00)	L_8 x T_2 (58.05)
TSS	L_{10} (21.50)	T_2 (19.00)	L_{17} xT_1, L_3 x T_2, L_{17} x T_3 (21.00)	L_{16}, L_{17} (1.57)	T_1 (0.47)	L_3 x T_2 (3.26)	L_{13} x T_3 (25.00)	L_{813} x T_3 (25.00)	L_3 x T_2, L_{17} x T_1, (16.67)
TS	L_{17} (14.79)	T_4 (11.12)	L_{13} x T_4 (17.85)	L_{17} (2.77)	T_4 (1.33)	L_{10} x T_2 (4.07)	L_{15} x T_1 (49.92)	L_{10} x T_2 (45.79)	L_{13} x T_4 (41.67)
RS	L_{13} (3.5)	T_4 (2.70)	L_8 x T_1 (5.11)	L_8 (1.58)	T_4 (0.21)	L_{10} x T_2 (3.31)	L_8 x T_1 (228.82)	L_{15} x T_3 (228.57)	L_{10} x T_2 (79.84)
NRS	L_{18} (12.36)	T_2 (10.00)	L_{16} x T_2 (13.59)	L_{17} (1.65)	T_4 (1.12)	L_{11} x T_1 (2.51)	L_{13} x T_4 (55.76)	L_{13} x T_4 (50.36)	L_{16} x T_2 (42.30)
STA (lowest)	L_8 (32.49)	T_4 (38.33)	L_{11} x T_1 (23.29)	L_{11} (-11.19)	T_4 (-2.31)	L_{10} x T_3 (-12.51)	L_8 x T_2 (37.49)	L_6 x T_2 (23.73)	L_6 x T_2 (91.50)
TC	L_8 (78.79)	T_3 (73.60)	L_4 x T_2 (79.31)	L_{17} (10.10)	T_2 (2.43)	L_{13} x T_4 (10.64)	L_8 x T_1 (26.87)	L_{18} x T_2 (14.97)	L_4 x T_2 (54.14)

PH=Plant height, NL/P= No. of leaves per plant, LL= Leaf length, LB= Leaf breadth, DFT= Days to 50% tasseling, DFS= Days to 50% silking, DGH= Days to green cob harvest, GCL= Green cob length, GCG= Green cob girth, R/C= No. of kernel rows per cob, K/R= No. of kernels per row, TSS= Total soluble solids, TS= Total sugars, RS= Reducing sugar, NRS= Non reducing sugar, STA= Starch, TC= Total carbohydrate.

in one of the crosses and standard heterosis in all the crosses. These findings were similar to the findings of Has (1999) and Kumari *et al.* (2008).

The potential sweet corn hybrid should possess high *per se* performance, *sca* effects and the higher magnitude of standard heterosis. Among the 72 hybrids analyzed, the hybrid L_8 x T_2 was identified as the best hybrid since it possessed desirable per se performance, sca and standard heterosis for green cob yield, green cob length and number of kernel rows per cob. The hybrid L_8 x T_1 was the next best hybrid for green cob yield followed by the hybrid L_{15} x T_1. The other hybrids which performed better in terms *per se, sca* and standard heterosis were L_4 x T_3 and L_{15} x T_2 for plant height, L_9 x T_4 for number of leaves per plant, L_{18} x T_4 for leaf breadth, L_7 x T_1 and L_{18} x T_1 for earliness, L_8 x T_2, L_{13} x T_3, L_{12} x T_3 for green cob length, L_{16} x T_1 and L_{18} x T_1 for green cob girth. Similar results of desirable *sca* effects have been reported for green cob yield and yield component traits by Dickert and Tracy, 2002 and Kumari *et al.*, 2008.

Considering the quality, the hybrids *viz*., L_{13} x T_4, L_{10} x T_2 and L_9 x T_4 have exhibited high per se performance, sca effect and heterosis for total sugars. Hence, these crosses may be utilized for developing new sweet corn inbreds with increased sugar content through pedigree breeding for further utilization.

Results of the present study was encouraging for increasing the green cob yield in most of the hybrids even with the inbred of domestic gene pool in origin. For more effective selection of a hybrid, besides *per se*, *sca* effect and standard heterosis, the hybrid should have both the parents as good combiners or atleast any one of the parent as a good combiner. Hence, the hybrids showed good *per se, sca* and standard heterosis *viz.*, L_8 x T_2, L_8 x T_1, L_{15} x T_1 and L_{17} x T_1 had one of the parent as a good combiner. However, the performances of these hybrids need to be evaluated in on farm and multi location trials under different agro cilimatical situations prior to commercial exploitation. Further, the results of the study indicates that combining exotic gene pool derived inbreds with locally adapted sweet corn inbreds will through a jump in heterotic potential of sweet corn single cross hybrids and subsequently on the productivity.

References

Alam, A.K.M.M., Ahmed, S., Begum, M. and Sultan, M. K. 2008. Heterosis and combining ability for grain yield and its contributing characters in maize. *Bangladesh J. Agric. Res.,* **33:** 375-379.

Azanza F., Avri Bar-Zur and Juvik. J. A. 1996a. Variation in sweet corn, kernel characteristics associated with stand establishment and eating quality. *Euphytica,* **87:** 7-18.

Azanza, F., Klein, B.P. and Juvik, J.A. 1996b. Sensory characterization of sweet corn lines differing in physical and chemical composition. *Journal of Food Science,* **61:** 253-257.

Clegg, K.M. 1956. Application of anthrone reagent for estimation of starch content in cereals. *Theor. Appl. Genet.,* **49:** 117-122.

Dhillon, B.S. 1998. Maize *In***:** Hybrid cultivar development. S.S. Banga and S.A. Banga, Narosa publishing House, New Delhi. p 282.

Dickert, T.E. and Tracy, W.F. 2002. Heterosis for flowering time and agronomic traits among early open-pollinated sweet corn cultivars. *J. American Soc. Hort. Sci.,* **127:** 793-797

Dubois, M., Gilles, K.A., Hamilton, J.K., Rebers, P.A. and Smith, F. 1956. *Anal. Chem.,* **26**: 350.

Has, V. 1999. Genetic analysis of some yield components and kernel quality in sweet corn. *Rom. Agri. Res.,* **11:** 9-15.

Jayakumar, J. and Sundaram, T. 2007. Combining ability studies for grain yield and other yield components in maize. *Crop Res.,* **33:** 179-186.

Kalla, V., Kumar, R. and Basandrai, A. K. 2001. Combining ability analysis and gene action estimates of yield and yield contributing characters in maize. *Crop Res.,* **22:** 102-106.

Kanagarasu, S. 2010. Genetic studies on single cross hybrids and molecular diversity of maize inbreds (*Zea mays* L.). M.Sc., Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Kashiani, P., Saleh, G., Abdullah, N.A.P. and Abdullah, S. N. 2010. Variation and genetic studies on selected sweet corn inbred lines. *Asian J. Crop Sci.,* **2:** 78-84.

Kempthorne, O. 1957. An Introduction to Genetic Statistics. New York: John Willey & Sons.

Kumari, J., Gadag, R. N., Jha, G. K., Joshi, H. C. and Singh, R. D. 2008. Combining ability for field emergence, kernel quality traits and certain yield components in Sweet corn (*Zea mays* L.). *J .Crop improv.* **22**: 1, 66-81.

Olsen, J.K., Blightand, G.W. and Gillespie, D. 1990. Comparison of yield, cob characteristics, and sensory quality of six supersweet (sh2) corn cultivars grown in a subtropical environment. *Aust. J. Exp. Agric.,* **30**: 387–393.

Panse, V. G. and Sukhatme, P. V. 1964. Statistical methods for agricultural workers. 3rd Ed., Indian Council of Agricultural Research. New Delhi. p 58.

Prabhu, S. 2008. Genetic analysis of inbreds and hybrids to yield components and resistance to sorghum downy mildew disease in maize (*Zea mays* L.). *M.Sc., Thesis,* Tamil Nadu Agricultural University, Coimbatore, India.

Premlatha, M. 2006. Combining ability and heterosis analysis for grain yield components and quality traits in maize (*Zea mays* L.). *M.Sc., Thesis,* Tamil Nadu Agricultural University, Coimbatore, India.

Singh, P. K. and Roy, A. K. 2007. Diallel analysis of inbred lines in maize. *Int. J. Agric. Sci.,* **3**: 213-216.

Somogyi, M. 1952. A new reagent for the determination of sugar. *J. Biol. Chem.,* **200**: 245.

Tracy, W.F. 1997. History, genetics and breeding of super sweet corn. In: Janick J (Ed) *Plant breeding reviews,* **14**:189-236.

Tracy, W.F. 1994. Sweet corn. Speciality types of maize CRC, pp.147-187.

Vijayabharathi, A., Anandakumar, C. R. and Gnanamalar, R. P. 2009. Combining ability analysis for yield and its components in popcorn (*Zea mays* var. everta Sturt.). *Electronic J. Plant Breed.,* **1**: 28-32.

Wong, A.D., Juvik, J. A., Breeden, D. C. and Swiader, J. M. 1994. Shrunken-2 sweet corn, yield and chemical components of quality. *J. Amer. Soc. Hort. Sci.,* **119** : 747-755.

Yemm,E.W. and Willis, A.J. 1954. The estimation of carbohydrate in plant extracts by anthrone. *Biochem. J.,* **57**: 508-514.

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