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Studies on general and specific combining ability effects in sweet corn (*Zea mays* L. Ssp. *saccharata*) hybrids for green cob yield and TSS content

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Abstract
The present study was conducted to estimate general and specific combining ability effects in sweet corn (*Zea mays* L. Ssp. *saccharata*) hybrids and to screen out superior performing hybrids and parents. In present study, total 66 genotypes comprising of 45 sweet corn hybrids, 18 parental lines and 3 standard checks (Priya, Madhuri and Sugar-75) were evaluated in RBD in three different environments (E_1 at Instructional Farm, RCA, Udaipur during Kharif-2019, E_2 at ARS, Banswara during Kharif-2019 and E_3 at Instructional Farm, RCA, Udaipur during Rabi-2019-20) in RBD with three replications for twenty diverse traits. The extent of variances due to specific combining ability was more than that of general combining ability variances for most of the characters under study, thus reflecting towards the pre-dominance of non-addative type of gene action in controlling the expression these characters. On the basis of specific combining ability effects, among the selected best five hybrids, sweet corn hybrids L_5 x T_2 and L_6 x T_3 were best for green cob yield, green fodder yield and green cob weight plant^{-1} while the hybrid L_{10} x T_1 was best for green cob yield, green cob weight plant^{-1} and TSS content of green grain. Among the parents, lines L_7, L_{11}, L_{13} and tester T_1 were identified as good combiners for the same.

Keywords: General combining ability, specific combining ability, green cob yield, sweet corn, TSS

Introduction

Sweet corn has high nutritional values, delicate texture and sweet taste within pericarp and endosperm, it is treated as vegetable. The flavor, texture and sweetness of sweet corn kernels is due to presence of some endosperm mutant genes *viz., brittle1 (bt1), brittle2 (bt2), shrunken2 (sh2), amylase extender (ae1), dull1 (du1), sugary1 (su1), sugary enhancer (se)* and *waxy1 (wx1)* (Hassan *et al.*, 2019) [3] which alter the starch biosynthesis pathway in endosperm. Total sugar content in sweet corn at milky stage ranges from 25-30% as compared to 2-5% of normal corn (Sadaiah *et al*., 2013) [8]. Popularity of sweet corn is increasing in the national and international market due to the sweetness and tenderness of its kernels and its appetizing taste, which has in turn resulted in its increased cultivation in the country, ensuring good return to the farmers. Further, the left over plant after the harvest of cobs can be used as fresh or dry fodder for the animals. However, development of superior hybrids is more difficult in sweet corn because the heterotic patterns are poorly defined (Revilla and Tracy, 1997) [11]. Recombining the same inbreds repeatedly without infusion of new heterotic combinations may lead to the depletion of heterosis (Revilla *et al*., 2000) [7]. Sweet corn breeders have often focused on improving quality and ear appearance, rather than on enhancing yield (Tracy, 1993) [11]. But emphasis on kernel sweetness along with yield needs to be considered as the major objective of sweet corn improvement. Keeping in view the above facts and the growing demand of sweet corn in the domestic and international market, development of hybrids using parents with superior combining ability has been taken as objective of first importance of the research.

Material and Methods

Eighteen diverse sweet corn inbred lines, collected from different parts of the country were used as parents (fifteen females and three testers) (Table 1). The crosses were made in line x tester matting design at Instructional Farm, RCA, Udaipur during *kharif* 2018. Total 66 genotypes comprising of 45 sweet corn hybrids, 18 parental lines and 3 standard checks (Priya, Madhuri and Sugar-75) were evaluated in RBD in three different environments (E_1 at Instructional Farm, RCA, Udaipur during Kharif-2019, E_2 at ARS, Banswara during Kharif-

2019 and E_3 at Instructional Farm, RCA, Udaipur during Rabi-2019-20) in RBD with three replications.

Recommended agronomic practices were used to raise a healthy crop. Observations were recorded for 20 yield attributing quantitative and qualitative characters like days to 50 per cent tasseling, days to 50 per cent silking, plant height, ear height, number of leaves/ plant, length of leaf, breadth of leaf, days to green cob harvest, number of ear/ plant, ear length, ear girth, number of grain rows/ ear, number of grains/ row, 100 fresh seed weight, green cob weight/ plant, moisture per cent of green grain, green cob yield, green fodder yield, TSS content of green grain and protein content.Ten plants were taken from each row for recording observations from each replication. TSS content was recorded using hand refrectrometer.

Estimation was done over the three environments on pooled basis. The concept of combining ability was proposed by Sprague and Tatum (1942) [9]. The analysis of variance for general and specific combining ability effects over the environments and in three individual environments was done for different characters under the study using line x tester mating design provided by Kempthorne (1957).

Table 1: List of genotypes used

S. No	Symbol	Pedigree	S. No	Symbol	Pedigree
1.	L_1	SC-7-2-1-2-6-1	10.	L_{10}	BAJ-SC-17-2
2.	L_2	SC-18728	11.	L_{11}	BAJ-SC-17-1
3.	L_3	BAJ-SC-17-6	12.	L_{12}	DMSC-28
4.	L_4	BAJ-SC-17-10	13.	L_{13}	Mas Madu (sh2 sh2)
5.	L_5	BAJ-SC-17-12	14.	L_{14}	MRCSC-12
6.	L_6	BAJ-SC-17-9	15.	L_{15}	SC-33
7.	L_7	BAJ-SC-17-11	16.	T_1	SC-35
8.	L_8	BAJ-SC-17-8	17.	T_2	SC-32
9.	L_9	BAJ-SC-17-4	18.	T_3	DMRSC-1

Result and Discussion

Estimates On the basis of general combining ability effects parental material possessing significant general combining ability effects in desirable direction were classified as good combiners where as parental material possessing non significant general combining ability effects in desirable direction were grouped into average combiners. Parents with undesirable general combining ability effects were classified as poor combiners. Over the three environments, analysis of variance for combining ability reflected the significance of mean sum of squares due to environments for all the characters. The variances due to crosses over the environments were found significant for all the characters except for protein content while the variances due to environment x crosses interaction were found significant for all the characters except for moisture per cent of green grain and protein content. Significance of variances due to tester were reported for all the characters except for number of leaves plant^{-1}, ear length, number of grain rows ear^{-1}, 100 fresh seed weight, moisture per cent of green grain, green cob yield and green fodder yield. The mean sums of squares due to line x tester interaction were found significant for all the characters except for protein content. Apart from moisture percent of green grain and protein content, rest all the characters possessed significant mean sum of squares due to environment x line x tester interaction. Significance of variances due to environment x line x tester interaction for the characters reflects towards influence of environment on the expression of these characters.

The general combining ability effects are considered to be the function of the additive gene effects and additive x additive type of non allelic interactions. Combining ability analysis for green cob yield and green cob weight/ plant revealed that lines L_2, L_3, L_7, L_8, L_{11}, L_{12} and L_{13} were good general combiners over the three environments. Similarly, for green fodder yield, lines L_1, L_2, L_3, L_4, L_7, L_{11}, L_{12} and L_{13}, for TSS content of green grain, lines L_1, L_5, L_7, L_{10}, L_{11}, L_{13} and L_{14} and for protein content, line L_{12} were identified as superior general combiners over the three environments on the basis of general combining ability analysis. Among the testers, T_1 was identified as good general combiner for green cob yield, green cob weight plant^{-1} and TSS content of green grain on the basis of general combining ability estimates over the three environments.

Sweet corn hybrid L_5 x T_2 was identified to exhibit highest and positively significant specific combining ability effect for green cob yield (4090.05) over the three environments. The five best sweet corn crosses which possessed significantly positive specific combining ability effects for green cob yield on pooled basis were L_5 x T_2, L_{15} x T_3, L_{10} x T_1, L_6 x T_3, and L_9 x T_1. The sweet corn hybrids L_5 x T_2, L_{15} x T_3 and L_6 x T_3 were cross between poor general combining ability effects parents, while the hybrids L_{10} x T_1 and L_9 x T_1 were cross between poor x good and average x good general combining ability effects parents. For green fodder yield, the best five sweet corn hybrids that showed maximum and positively significant specific combining ability effects were L_4 x T_2 followed by L_{13} x T_1, L_5 x T_2, L_6 x T_3 and L_8 x T_3 on pooled basis. The sweet corn hybrids L_4 x T_2 and L_{13} x T_1 were cross between parents with good general combining ability effects while the hybrids L_6 x T_3 and L_8 x T_3 were cross between parents with poor general combining ability effects. Hybrid L_5 x T_2 was cross between the parents with poor x good general combining ability effects. Analysis for green cob weight plant^{-1} identified L_5 x T_2, L_{10} x T_1, L_{15} x T_3, L_6 x T_3 and L_7 x T_1 as top five sweet corn hybrids to exhibit highest and positively significant specific combining ability effects on pooled basis. Hybrids L_5 x T_2, L_{15} x T_3 and L_6 x T_3 were produced by crossing both parents with poor general combining ability effects, while L_{10} x T_1 was cross between parents with poor x good general ability combining ability effects. The hybrid L_7 x T_1 was cross between both parents with good general combining ability effects. Analysis for TSS content of green grain over the three environments identified L_{14} x T_2, L_{12} x T_1, L_2 x T_3, L_1 x T_3 and L_{10} x T_3 as the best five sweet corn hybrids possessing highest and significantly positive specific combining ability effects. The sweet corn hybrids L_{14} x T_2, L_1 x T_3 and L_{10} x T_3 were cross between good x poor general combining ability effects parents, L_{12} x T_1 between poor x good general combining ability effects parents while L_2 x T_3 between parents with average x poor combining ability effects. Elayaraja *et al.* (2018) [2], Chinthiya *et al.* (2019) [1], Kumar *et al.* (2019) [4], Nanditha *et al.* (2019) [5] and Tesfaye *et al.* (2019) [10] reported similar results for combining ability analysis on maize.

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Authors' contribution

Conceptualization of research (Divya Chouhan); Designing of

the experiments (Dr. R. B. Dubey); Contribution of experimental materials (Dr. Dilip Singh); Execution of field/lab experiments and data collection (Divya Chouhan and Piyush Choudhary); Analysis of data and interpretation (Divya Chouhan); Preparation of the manuscript (Divya Chouhan and Dr. R. B. Dubey).

Declaration: The authors do not have any conflict of interest.

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