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DEVELOPMENT OF HETEROTIC HYBRIDS OF SWEET CORN FOR GREEN EAR YIELD AND OTHER COMPONENT TRAITS

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Abstract

Forty two experimental hybrids generated through full diallel mating were evaluated in Randomized Block Design during *kharif* 2019 to study the magnitude of heterosis in sweet corn. Mid-parent heterosis ranged from -21 to 258 for DEW; -25 to 2 for GFW; 3 to 229 for GEY and standard heterosis ranged from 2.13 to 134.95 for DEW; 82.93 to 317.07 for GFW; -15.70 to 68.40 for GEY. Green ear yield exhibited positive significant correlation of mid-parent and commercial heterosis with NKPR, DEW and GFW in common, while no significant association between GEY and TSS was observed. The crosses KH1831 × SC Syn, SC Syn × SC Sel 2 and SC Sel 2 × SC Syn manifested highest mid-parent heterosis for de-husked ear weight, green ear yield and green fodder weight thus utilizing these hybrids in breeding programmes will serve for dual purpose of yield with fodder.

Introduction

Sweet corn (*Zea mays* L.)is a variant of field corn having sweeter kernels. It has become popular both as a fresh dual processed vegetable in several countries of the world (Khanduri *et al.* 2011). Globally it is grown on 1.44 million hectare, with a production of 18.84 million tons, and yield is 13.03 tons per hectare. The production of sweet corn has dramatically increased by 250% in the last 30 years (Ozata 2019). It is grown for fresh consumption, frozen, and canned food markets. It is soldas a farm product at farmers markets and other direct-to-consumer outlets (Ozlem *et al.* 2014). The sugar content at milky stage ranges from 14-24% as compared to 2-5% in normal corn(Wahba *et al.* 2016). Unlike normal corn, sweet corn has been extensively improved in terms of quality and appearance, but yields have received little attention (Worrajinda *et al.* 2013). Thus, green ear yield, de-husked ear weight along with quality traits such as tenderness and sweetness aremost important in its breeding programs. Present sweet corn breeding programme 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 1994).This reflects the importance of developing sweet corn hybrid breeding program to achieve continuous development of new high yielding hybrids to meet the ever-increasing market demand. The mid-parent heterosis (MPH) can be understood as increase in yield or other traits of a hybrid relative to the mean of the parents, is an estimate of the mean directional dominance of alleles for a trait under consideration(Akinwale 2021). Therefore, efforts were made in the present study to estimate themid-parent and commercial heterosis of 42 experimental hybrids for yield traits and their correlation to identify superior hybrid cross combinations in sweet corn.

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Materials and Methods

A full diallel mating design with seven sweet corn inbred lines sourced from ICAR-Indian Institute of Maize Research, Ludhiana selected based on synchronisation in flowering were used to produce 42 F_1 hybrids including reciprocals during *rabi* 2018. In total, 42 F_1s, 7 inbred lines, and 1 check (Madhuri) were evaluated in Randomized Block Design (RBD) with three replications to understand the magnitude of heterosis in respect of green ear yield and its attributing traits during *kharif* 2019. Each plot consisted of two 4m rows spaced 0.60m apart, two seeds were dibbled per hill in each row and thinned and retained one seedling per hill after 15 of sowing. All other standard cultural practices were followed to rise a healthy crop. A separate set of all hybrids were sown in RBD with two replications to study the reaction of hybrids to Turcicum leaf blight (TLB). The traits days to 50% tasseling (DFT), days to 50% silking (DFS), plant height (PH), ear height (EH), ear length (EL), ear girth (EG), number of kernel rows per ear (NKR), number of kernels per row (NKPR), de-husked ear weight (DEW), green fodder weight (GFW), resistance to Turcicum leaf blight, total soluble solids (TSS) and green ear yield (GEY) were recorded as per the standard procedures.The magnitude of heterosis was estimated in relation to mid-parent and the commercial check hybrid (standard heterosis) using the methods suggested by Turner (1953) and Hayes *et al.* (1955). Correlation studies between mid-parent and standard heterosis were computed using SPSS software.

Results and Discussion

In the present study, the patterns of mid-parent heterosis, standard heterosis and heterotic correlations for different yield and yield related traits in sweet corn were investigated.There was a notable level of MPH with varying degrees of significance, observed in the direction favourable for the traits. The mean of MPH for important traits DEW, GFW, GEY, TSS and TLB were 115.0, 57.0, 116.0, -0.79 and -22.0%, respectively (Fig.1) andover 90% of hybrids showed significant heterosis in positive direction (Table 1). Significant positive MPH for EL in most of the crosses generated was reported in earlier investigations (Hundera *et al.* 2017, Tolera *et al.* 2017). The hybrid combinations with significant MPH for EL and EG can be used for further genetic improvement programmesin sweet corn (Gemechu*et al.* 2021).The similar trend of significant MPH in positive direction for DEW, GFW and GEY was noticed which proved the presence of increased vigor in the crosses (Wolko *et al.* 2019). High positive mid-parent heterosis observed for yield trait can be correlated with high heterosis observed for yield attributing traits *viz.,* EH, EL, EG, NKR, NKPR (Dan *et al.* 2014).However, TSS content of ears varied from -15 to 24 and only 35% of the crosses manifested MPH in positive direction reflecting limited genetic variability and revealing the need for accumulating favourable alleles in parents to achieve positive heterosis for the trait (Khanduri *et al.* 2011).

Ten experimental hybrids KH1831 × SC Syn, SC Sel 2 × SC Syn, SC Syn × KH1831, SC Syn × SC Sel 2, SCSel 2 × MRCSC9, SC Sel 2 × SC Sel 3, SC Sel 2 × SC Sel 1, KH1831 × SC Sel 3, MRCSC9 × SC Sel 2 and SC Sel 1 × SC Syn with greater than 100% MPH superiorityforthe economic trait green ear yield were identified as promising hybrids for green ear yield (Table 2).Although the cross SC Sel 2 × MRCSC9 registered highest de-husked ear weight with relatively higher GEY, the TSS was not in desirable direction. Similarly, the GEY of the cross SC Sel 2 × KH 1831 was low, in spite of its highest TSS in positive direction. Sweet corn is more susceptible to Turcicum leaf blight and hence breeding for TLB resistant cultivars help to reduce significant yield losses. The green fodder after harvest of green ears serves as a palatable feed to cattle. Among 42 crosses, the combinations *viz.*, KH1831 × SC Syn, SC Syn × SC Sel 2 and SC Sel 2 × SC Syn manifested higher MPH for GEY along with high TSS, higher DEW, GFY and resistance to TLB; thus utilization of these hybrids in breeding programmes will serve for dual purpose of GEY and green fodder. Abera *et al.* (2016) and Bucheyeki *et al.* (2017) reported higher average heterosis of green ear yield and other components in sweet corn.

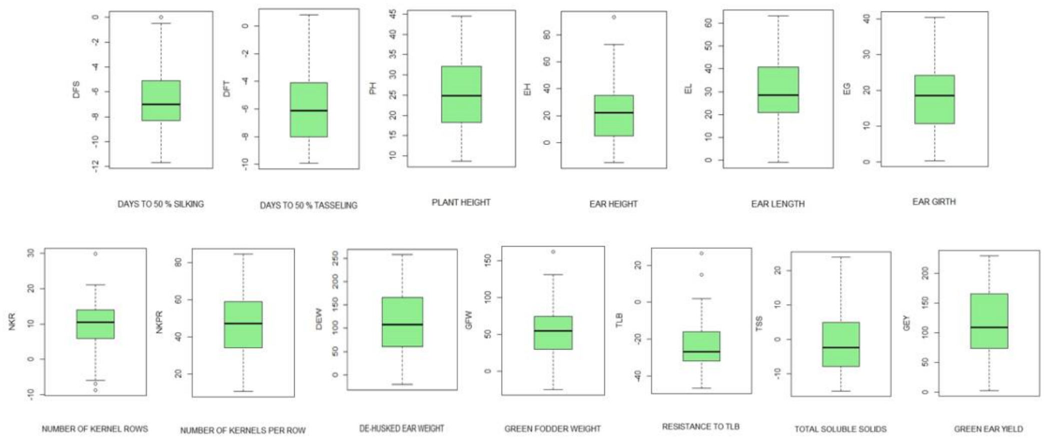

Fig.1. Trait-wise box plots depicting mean and range for mid-parent heterosis of experimental crosses.

Table 1. Frequencies of F_1 hybrids for heterosis in desirable direction for important yield component traits.

Traits	Frequencies of average heterosis of F_1s in desirable direction	Frequencies of standard heterosis of F_1s over the check Madhuri
EL	38	23
EG	42	39
TSS	15	13
DEW	41	42
GEY	41	36
GFW	41	42

Less than 10% of hybrids reported significantly negative standard heterosis for DFT and DFS indicating that majority of crosses matured late when compared with checks (Fig. 2). Over 50 per cent hybrids for EL; over 85% for GEY and EG and all crosses for DEW and GFW manifested positive heterosis.These observations are in line with the findings of Zeleke(2015) who reported highly significant heterosis for ear length. Wahba *et al.* (2016) observed significant standard heterosis for husked ear weight, de-husked ear weight and total soluble solids in 14crosses. Positive heterosis for green ear yield indicates the yield advantage of hybrids over the check Madhuri. Previous workers reported significant heterosis for GEY in positive direction (Melani and Carena 2005, Nepir *et al.* 2015, Patel and Kathiria 2016, Ghosh *et al.* 2018, Tulu *et al.* 2018, Ali *et al.* 2019). Whereas, only 13 hybrids showed significant positive standard heterosis for sugar content indicating the scope for use of more genetically divergent parents for better realization of higher heterosis for this trait(Table 1). Among top 10crosses which showed superior MPH, the crosses SC Sel 2 × MRCSC9, SC Sel 2 × SC Sel 3, SC Sel 2 × SC Syn, and SC Syn × SC Sel 2 manifested highest standard heterosis for green ear yield over the check Madhuri indicating the yield advantage of these hybrids compared to others and these can be used for commercial cultivation after looking for stable performance across locations.

Table 2. Top ten experimental hybrids with high mid-parent heterosis for green ear yield along with corresponding heterosis values for other important traits in sweet corn.

Hybrid code	Hybrid combination	Green ear yield	De-husked ear weight	Green fodder yield	TSS	Resistance to Turcicum leaf blight
GSCH-1811	KH1831 × SC Syn	229.17	237.21	108.63	14.55	-26.96
GSCH-1823	SC Sel 2 × SC Syn	225.97	231.88	103.16	6.76	-26.96
GSCH-1832	SC Syn × KH1831	213.86	163.96	162.35	7.45	-33.67
GSCH-1834	SC Syn × SC Sel 2	209.39	235.76	111.89	13.1	-30.18
GSCH-1819	SC Sel 2 × MRCSC9	196.51	257.72	103.50	-4.29	-26.85
GSCH-1822	SC Sel 2 × SC Sel 3	185.68	183.98	66.29	-7.37	-22.51
GSCH-1821	SC Sel 2 × SC Sel 1	183.42	176.75	60.94	-2.3	-30.87
GSCH-1810	KH1831 × SC Sel 3	165.51	166.11	69.82	9.41	-28.94
GSCH-1803	MRCSC9 × SC Sel 2	152.30	192.10	111.54	-4.58	-39.85
GSCH-1817	SC Sel 1 × SC Syn	123.32	113.96	111.56	3.95	1.89
SEm±		9.21	10.98	5.99	1.27	2.24
CD@0.05		1.52	1.26	1.20	0.54	4.68

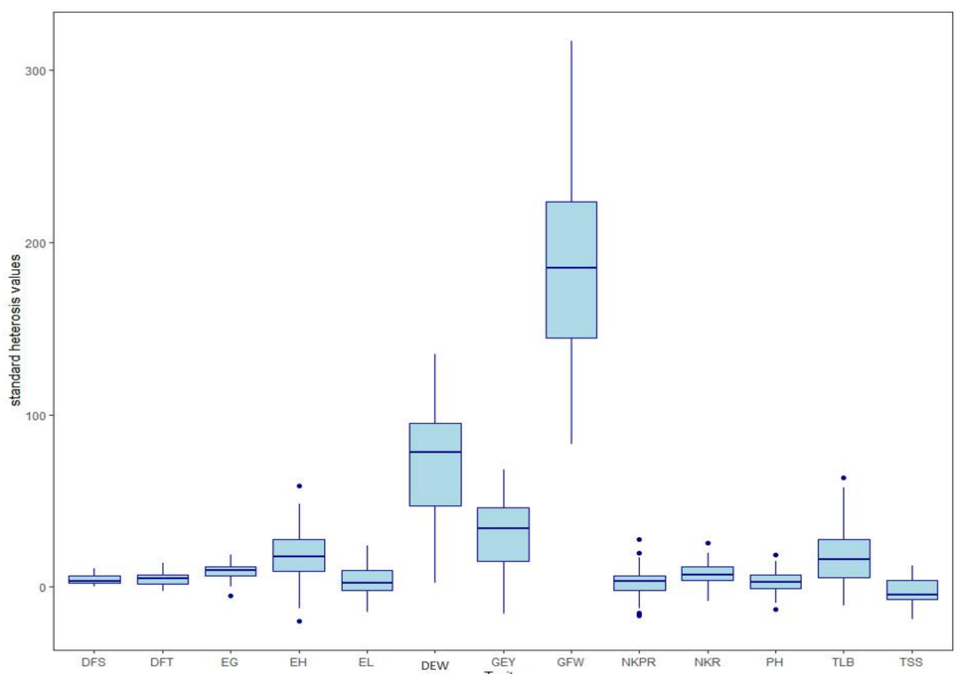

Fig. 2. Box plots showing genetic variation for standard heterosis of experimental crosses over check Madhuri for green ear yield and its components.

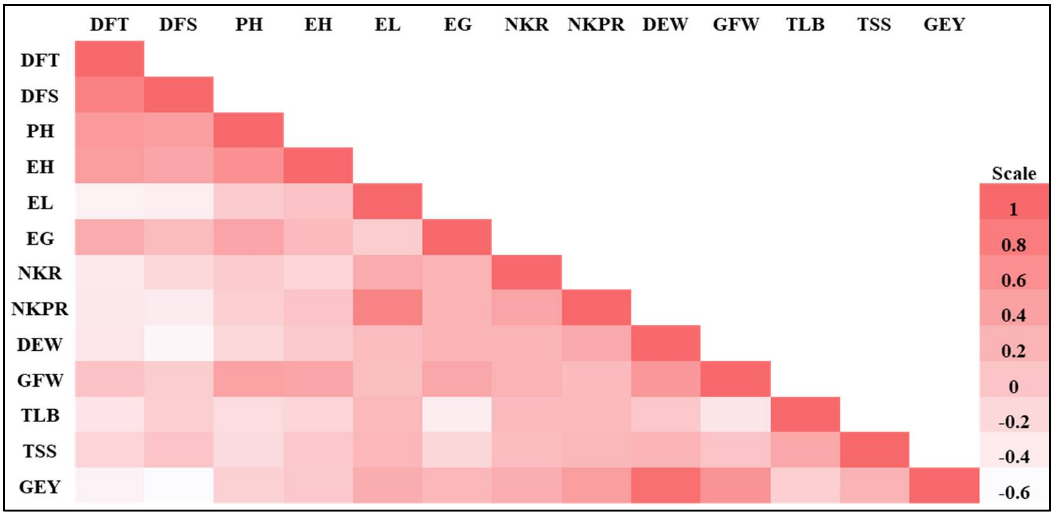

Fig. 3. Heat map showing association between heterosis values of standard check (Madhuri) for green ear yield and its component traits.

Table 3. Association between mid-parent heterosis values for green ear yield and its component traits.

Traits	DFT	DFS	PH	EH	EL	EG	NKR	NKPR	DEW	GFW	TLB	TSS	GEY
DFT	**1.00**	0.75**	-0.10	0.10	-0.17	-0.27	-0.42**	-0.15	-0.29	-0.11	0.12	-0.03	0.31*
DFS		**1.00**	-0.34*	-0.07	-0.33	-0.27	-0.28	-0.36*	-0.36*	-0.22	0.36*	0.03	-0.34*
PH			**1.00**	-0.16	0.72**	0.61**	0.34*	0.85**	0.64**	0.54**	-0.30*	0.33*	0.68**
EH				**1.00**	-0.20	-0.43**	-0.05	-0.31*	-0.43**	-0.22	-0.05	-0.18	-0.41**
EL					**1.00**	0.55**	0.36*	0.81**	0.48**	0.43**	-0.21	0.50**	0.62**
EG						**1.00**	0.45**	0.71**	0.69**	0.23	-0.33	0.33*	0.58**
NKR							**1.00**	0.39*	0.32*	0.29	-0.06	0.09	0.35*
NKPR								**1.00**	0.69**	0.48**	-0.31*	0.33*	0.75**
DEW									**1.00**	0.61**	-0.29	0.37*	0.93**
GFW										**1.00**	-0.24	0.22	0.74**
TLB											**1.00**	0.02	-0.24
TSS												**1.00**	0.42**
GEY													**1.00**

*Significance at P=0.05 and **Significance at P = 0.01.

Green ear yield in sweet corn is a complex trait. Significant heterosis for more than one yield attributing characters can be correlated with high heterosis for yield (Ilker 2011, Gemechu *et al.* 2021). The correlation of mid-parent and standard heterosis for distinct characters revealed several trends. Mid-parent heterosis for GEY is significantly and positively correlated with all the traits except DFS, EH and TLB (Table 3). Almost similar results were observed for GFW and DEW. Green fodder weight is positively correlated with PH, EL, NKPR, DEW and GEY. Mid-parent heterosis for PH, EL, EG, NKPR and GEWH were positive and significantly correlated with important quality parameter *i.e.*, TSS. Turcicum leaf blight manifested significant correlation in positive direction with DFS, while it is negatively correlated with PH and NKPR. The commercial heterosis for green ear yield manifested significantly positive correlation with NKPR, DEW and GFW (Fig. 3). Green fodder weight is significantly and positively correlated with PH, EH, EG, DEW and GEY. On the other hand, no favourable correlation was observed with GEY and TSS indicating the presence of weaker association between quality traits and yield like in any other crop.The correlation of mid-parent heterosis GEY and commercial heterosis is significantly and positively correlated with EL, EG, and DEW in common, suggesting considering these traits to breed for higher GEY in sweet corn. It was also substantially reported by earlier workers that GEY is influenced by cob characters.Positive correlation of yield with cob length (Thanga Hemavathy *et al.* 2008),with ear length, ear girth, number of kernels per row and number of kernel rows per ear (Nemati *et al.* 2009, Abebe *et al.* 2020) was observed.

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