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Research Article

Studies on genetic potential of baby corn (*Zea mays* L.) hybrids for yield and quality traits

M. Dhasarathan*, C. Babu[1], K. Iyanar[1] and K. Velayudham[1]

*****Centre for Plant Breeding and Genetics,[1]Department of Forage Crops
*[1]Tamil Nadu Agricultural University (TNAU), Coimbatore -3, Tamil Nadu, India.
*****E- mail: maadhasarathan@gmail.com

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Abstract

Baby corn is a profitable crop that allows a diversification of production, aggregation of value and increased income, and estimation of heterosis is helpful in checking the performance of parents in hybrid combination. A set of 21 baby corn single crosses were developed through diallel mating design following Model-I, Method-II of Griffing (1956) and were evaluated along with their parental inbred lines and one check variety to assess the possibility of exploiting heterosis for baby corn yield in baby corn and to identify traits having high heritability for using as selection parameter in baby corn development. High heterotic effects were observed for plant height, number of baby corn per plant, baby corn weight, baby corn yield per plot, reducing sugars and non reducing sugars. Estimates of broad sense heritability also varied with characters. High heritability coupled with genetic advance as per cent of mean were shown by most of the traits *viz*., plant height, number of baby corns per plant, baby corn length, baby corn weight, total sugars, reducing sugars, non reducing sugars and baby corn yield per plot indicating a substantial amount of genetic variation in this population of hybrids and none of the traits showed low or negligible heritability. Based on the overall performance of the hybrids FDM 7 x FDM 14 was found to have high genetic potential as it exhibited heterosis for certain important characteristics of baby corn.

Key words: Baby corn, heterosis, heritability and quality traits

Introduction

Maize is unique among the cereals on account of its amenability to diverse uses and it has huge potential in the present era of crop diversification. India is emerging as one of the potential baby corn producing countries due to low cost of production and high demand within the country. Baby corn is a young finger like unfertilized cob of maize harvested early within 1-3 days of silk emergence. Baby corn is a good option for crop diversification (Dass *et al.*, 2008) and it suits to peri-urban agriculture. Further, there is a great potential to earn foreign exchange through export of fresh/canned baby corn and its processed products. Another important feature of baby corn is safe vegetable to eat as it is almost free from residual effects of pesticides as the young cob is wrapped with husk and well protected from insect and diseases.

Heterosis, the measure of the average superiority of a hybrid over its parental inbred lines is an important consideration in the development of hybrid varieties. Diversity among inbred source populations is an important factor in determining combining ability among inbred lines and heterosis revealed by hybrids, where a more diverse combination is expected to produce more superior hybrids (Prasad and Singh 1986). Heritability, the measureof the genetic variation in a population relative to the total phenotypic variation of a trait is very much influenced by methods of determination and the genotypes used. Its estimation is normally specific to the material used, and the place and time of evaluation.

Due to limited research initiatives till now, cultivars with high productivity in baby corn is not available. Currently some of the early maturing maize cultivars originally developed for grain usage are grown for baby corn purpose and limited efforts are being made towards assessment of specific parameters. In this context, the present research efforts encompass to estimate of heterosis and broad-sense heritability for baby corn yield, yield components and quality traits.

Material and Methods

The present experiment was carried out at Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore, by involving seven genetically homozygous baby corn inbreds *viz*., FDM 10, FDM 8, FDM 7, FDM 12, FDM 37, FDM 14 and

FDM 36 were crossed in diallel mating design following Model-I, Method-II of Griffing (1956) during the *Rabi* season in 2010-11. The resulting hybrids and their parents were raised in a Randamized Block Design (RBD) with two replications during *rabi* season of 2010-11. Each plot consisted of two rows of 5m length and spacing between rows and plants adopted were 30 and 20 cm respectively. One plant per hill was maintained and recommended package of practices was followed to raise a healthy crop.

Observations on baby corn yield and its component and quality traits *viz*., days to 50 % tasseling (DFT), plant height (PHT), number of leaves per plant (NOL), number of baby corns per plant (NBC), baby corn length (BCL), baby corn weight (BCW), baby corn yield per plot (BCY), total sugars (TSR): It was estimated using Anthrone reagent method as described by Sadasivam and Manickam (1996), reducing sugars (RSR): It was estimated according to the method described by Nelson and Somogyi (Nelson, 1944) and non reducing sugars (NRS): This was calculated by subtracting the amount of reducing sugars from total sugar content were recorded on five randomly selected plants from each plot.

Mean data were subjected to analysis of variance to determine the effects of the genotypes involved. Both mid-parent (MP) and better parent (BP) heterosis were estimated as per cent increase of hybrids over the respective mid and better-parents for all crosses. Genotypic and phenotypic coefficients of variation were computed based on the method given by Burton (1952). Broad-sense heritability (h^2) was calculated according to Lush (1940) and genetic advance was expressed as percentage of mean (GAM) by using the formula suggested by Johnson *et al*. (1955).

Results and Discussion

Results of the analysis of variance showed highly significant effects among the genotypes evaluated for all the characters studied. All the traits responded differently in the expression of heterosis in their respective combinations (Table 1).

All the estimates of heterosis for days to 50 % tasseling were negative (Table 1), this clearly indicates that the hybrids flowered and matured significantly earlier than their respective inbred parents. The manifestation of negative estimates of heterosis for days to 50 % tasseling in these crosses could be either due to dominance at the same locus or different dominant genes which are closely linked and or pleotropic in their action. Hybrids FDM 12 x FDM 37 and FDM 37 x FDM 36 were among those giving highest heterosis, and estimates of mid-parent and better-parent heterosis ranging from -12.28 to -1.05 and -13.19 to -1.40 % respectively for days to tasseling. Takawale *et al*. (2009) suggested that negative heterosis was desirable for days to 50 % flowering. An early flowering hybrid like FDM 12 x FDM 37 (62.5 days) should be favourable and merits selection, as this would give early productivity. This result was similar to Iqbal *et al.* (2010). The mid-parental heterosis was ranging from 19.85 to 110.98 %, where FDM 12 x FDM 36 (110.98 %) and FDM 8 x FDM 12 (104.74 %) were among those giving the highest mid-parental and better-parental heterosis for plant height. The hybrids also showed good variation for plant height and all the hybrids were significantly taller than the open pollinated variety CO (BC) 1 except the cross FDM 10 x FDM 8, which is favourable for the control of lodging. The hybrids exhibited much higher magnitude of heterosis which indicate that higher frequencies of alleles with dominanance and dominance type of interaction effects could have been operative in the manifestation of such increased vigour for plant height compared to other characters. Similar findings were given by Iqbal *et al*. (2010), Hua *et al.* (2007) and Uzarowska *et al*. (2007). Mean heterosis estimates produced by most of the hybrids for plant height were high, indicating the preponderance of dominance and gene dispersion among the parental inbred lines (Saleh *et al*., 2002). The cross FDM 10 x FDM 37(26.55 and 22.73 %) manifested with highest estimates of mid-parental and better-parental heterosis for number of leaves per plant among crosses. Number of leaves would aid the production of higher leaf area, higher crop growth rate, and thus increase sink size, which in turn will increase the baby corn yield. Hence, positive heterosis for number of leaves per plant is therefore desirable. Similar result was reported by Sharanappa (2006).

For Number of baby corns per plant, most of the hybrids displayed negative values for over mid and better parent heterosis with respective ranges of -34.43 to 44.49 % and -38.71 to 38.10 %. However, some hybrids expressed positive significant values, most of which were those involving the line FDM 14. The hybrids *viz*., FDM 7 x FDM 14 and FDM 8 x FDM 14 showed high heterosis manifestation for both mid and better-parental heterosis. The range of mid and better parent heterosis estimates among the crosses varying from -24.66 to 34.81 and -25.44 to 34.81 for baby corn length and -38.39 to 56.99 and -40.00 to 46.04 % for baby corn weight observed in the present investigation were not unexpected since parental inbred line greatly varied in their genetic background. Similarly, with respect to baby corn yield per plot, most of the crosses were showed negative estimates of heterosis. The cross FDM 10 x FDM 12 showed high manifestation of mid-parent heterosis. Moreover, the hybrid FDM 7 x FDM 14 expressed the significant and high magnitude of mid and better-parent heterosis.

A total of 12 and 16 crosses exhibited significant positive heterosis estimates to the mid and better-parent heterosis respectively for total sugar content. The cross FDM 37 x FDM 36 (5.06 %) gave maximum of total sugar content followed by the hybrid FDM 10 x FDM 37 (4.89 %). Similar results were given by Singh *et al.* (2006), who reported that occurrence of total sugar content ranged from 2.99 to 3.84 % among the baby corn genotypes evaluated. Heterosis estimates for over mid and better parent ranged from -21.13 to 38.67 % and -89.00 to 133.33 % for reducing sugar content. The hybrid FDM 37 x FDM 36 (4.82 %) expressed high mid and better paren heterosis and also high *per se* than the check. The findings are in close agreement with Singh *et al*. (2006). Regarding non reducing sugars, the range of mid-parent heterosis was from -88.89 to 234.33 % and the range of better-parent heterosis was -89.00 to 133.3 %. Moreover, same cross itself showed high *per se* performance (1.68 %) over the check. This result is closely in congruity with the findings of singh *et al.* (2006).

Genotypic and phenotypic variances, and broad sense heritability estimates for baby corn yield and quality traits were measured among the 21 hybrids evaluated are shown in (Table 2). High genotypic variance was recorded for plant height, baby corn weight, reducing sugars and non reducing sugars, and moderate genotype variance was recorded for number of baby corns per plant, baby corn length, total sugars and baby corn yield per plot. Low genotypic variance was revealed by days to 50 % tasseling and number of leaves per plant. Ojo *et al*. (2006), Shakoor *et al*. (2007) and Saleh *et al.* (2002) also found low genotypic variance for days to 50 % tasseling. The coefficient of variation indicates only the extent of total variability present for a character and does not demarcate the variability into heritable and non heritable variation. Hence, the estimates of heritability indicate precisely the heritable variation of total variability. The extent of variability which could be transferred from parent to offspring would suggest how far the variation in heritable portion has close bearing on response to selection.

Broad sense heritability estimates were high for all the traits studied except baby corn weight which indicates that these traits were least influenced by environmental factors. The trait baby corn weight showed moderate level of heritability and none of the traits showed low or negligible heritability. However, Saleh *et al* (2002) reported that low heritability for days to 50 % tasseling. High heritability for the baby corn yield indicates that there was a substantial amount of genetic variation in the control of baby corn yield among the population of hybrids evaluated and all the traits except baby corn weight were highly heritable. Similar results were reported by Awasthi *et al*. (2009) and Ahmed and Malaviya (2010) for days to 50 % tasseling and plant height. Even though heritability gives information on the magnitude of inheritance of quantitative traits, formulation of suitable selection procedure can be done only with the help of genetic advance which measures and predicts genetic gain under selection. High heritability along with high genetic advance was recorded for all the traits except days to 50 % tasseling and number of leaves per plant, indicating the role of additive gene effect in heritability of the traits and these traits are suitable for selection. These results were in accordance with Mahmood *et al.* (2004) and Chauhan and Mohan (2010) for plant height. Moderate heritability and high genetic advance was found in baby corn weight indicating the role of both additive and non additive gene action. In contrast, Ojo *et al.* (2006) reported high heritability for baby corn weight.

Two hybrids viz., FDM 7 x FDM 14 and FDM 12 x FDM 14 exhibited higher mean performance and both mid and better-parent heterosis for baby corn yield. In respect of baby corn, superiority is decided by its quality. Hence, the crosses *viz*., FDM 37 x FDM 36 followed by FDM 7 x FDM 14 recorded superior performance for quality traits. Therefore, it is concluded that FDM 7 x FDM 14 was promising as it exhibited heterosis and high heritability coupled with genetic advance as per cent of mean for certain important characteristics of baby corn and this hybrid could be exploited as promising for baby corn yield with good quality after confirmative test.

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Table 1. Expression of mid-parent and better-parent heterosis for various charachters

Hybrids	Days to 50 % tasseling		Plant height (cm)		Number of leaves per plant	
	MP	BP	MP	BP	MP	BP
FDM 10 x FDM 8	-4.20*	-4.86*	46.08 **	39.33*	15.31 *	11.24
FDM 10 x FDM 7	-3.18	-3.52	64.65 **	48.58 **	7.70	0.00
FDM 10 x FDM 12	-3.14	-4.14*	87.91 **	66.86 **	16.79*	12.67
FDM 10 x FDM 37	-6.01 **	-6.34 **	62.45 **	38.56 **	26.55 **	22.73 **
FDM 10 x FDM 14	-2.72	-5.92 **	19.85*	-16.86 *	13.57*	-1.11
FDM 10 x FDM 36	-1.05	-1.4	77.35 **	73.58 **	9.87	2.65
FDM 8 x FDM 7	-1.05	-2.08	58.10 **	49.03 **	11.42	7.79
FDM 8 x FDM 12	-3.11	-3.45	104.74**	74.58 **	16.09*	15.29*
FDM 8 x FDM 37	-3.86*	-4.86 *	59.09 **	41.31 **	16.41 *	8.33
FDM 8 x FDM 14	-8.11 **	-10.53 **	25.35 **	-10.62	8.07	-2.26
FDM 8 x FDM 36	-6.62 **	-6.94 **	75.65 **	71.21 **	13.52*	10.54
FDM 7 x FDM 12	-8.07 **	-9.66 **	95.60 **	58.78 **	10.09	5.15
FDM 7 x FDM 37	-8.90 **	-9.22 **	63.39 **	53.46 **	25.69 **	12.81 *
FDM 7 x FDM 14	-5.48 **	-9.21 **	30.40**	-3.37	13.74*	6.71
FDM 7 x FDM 36	-2.47	-3.50	79.45 **	65.03 **	20.79 **	19.23 **
FDM 12 x FDM 37	-12.28**	-13.19 **	90.72 **	47.71 **	23.89 **	15.29*
FDM 12 x FDM 14	-6.08 **	-8.55 **	38.04 **	-10.19	14.29*	3.37
FDM 12 x FDM 36	-3.83 *	-4.17 *	110.98**	84.04 **	8.13	5.29
FDM 37 x FDM 14	-3.42	-7.24 **	31.08 **	1.65	18.10 **	-1.15
FDM 37 x FDM 36	-11.66 **	-12.59 **	78.83 **	55.08 **	24.99 **	11.84
FDM 14 x FDM 36	-7.12 **	-9.87 **	23.31 *	-13.36	6.02	-2.23
SE_d	1.24	1.43	14.58	16.83	0.70	0.81

*and** indicates the significance at the 5 % and 1 % level respectively; MP- mid parent; BP- better parent;

Table 1. contd..

Hybrids	Number of baby corns/plant		Baby corn length (cm)		Baby corn weight (g)	
	MP	BP	MP	BP	MP	BP
FDM 10 x FDM 8	-19.23**	-30**	-14.03	-19.70	-38.39	-40.00
FDM 10 x FDM 7	9.80	-6.67	0.00	-2.50	-20.00	-22.86
FDM 10 x FDM 12	44.19**	3.33	34.81 **	34.81 **	36.11	26.61
FDM 10 x FDM 37	-30.16**	-32.34**	19.99	18.75	35.98	28.36
FDM 10 x FDM 14	-6.80	-22.33**	6.97	-9.30	-1.59	-20.10
FDM 10 x FDM 36	-34.43**	-35.48**	6.57	3.35	18.03	16.64
FDM 8 x FDM 7	-11.63	-13.64	2.83	-5.17	-0.96	-4.50
FDM 8 x FDM 12	25.71*	0.00	29.06 **	21.89*	56.99 **	46.04*
FDM 8 x FDM 37	-19.81**	-32.34**	-13.45	-19.06	1.63	-4.07
FDM 8 x FDM 14	38.1**	31.82**	8.63	-3.17	21.68	-1.20
FDM 8 x FDM 36	-28.3**	-38.71**	32.46 **	28.89 **	22.88	21.43
FDM 7 x FDM 12	27.35**	3.10	14.37	14.37	12.70	-2.09
FDM 7 x FDM 37	-16.98*	-31.25**	-24.66*	-25.44*	-20.59	-21.96
FDM 7 x FDM 14	41.46**	38.1**	16.26	-1.43	39.02	6.68
FDM 7 x FDM 36	-15.38*	-29.03**	3.36	0.23	2.06	-4.17
FDM 12 x FDM 37	-11.11	-37.5**	7.80	6.69	21.91	8.31
FDM 12 x FDM 14	33.33**	10.00	-4.62	-19.13 *	-2.55	-16.53
FDM 12 x FDM 36	4.55	-25.81**	17.29	13.74	13.92	5.63
FDM 37 x FDM 14	23.08**	0.00	5.13	-10.87	22.30	-6.15
FDM 37 x FDM 36	-31.11**	-32.19**	4.93	1.76	22.87	15.36
FDM 14 x FDM 36	-13.73*	-29.03**	-4.75	-18.58 *	-16. 29	-32.14*
SE_d	0.1634	0.1886	0.81	0.93	1.48	1.71

*and** indicates the significance at the 5 % and 1 % level respectively; MP- mid parent; BP- better parent;

Table 1. Contd.

Hybrids	Baby corn yield/plot		Total sugars (%)		Reducing sugars (%)		Non reducing sugars (%)	
	MP	BP	MP	BP	MP	BP	MP	BP
FDM 10 x FDM 8	-16.46**	-25.00**	-17.12**	-25.89 **	-21.13**	-28.76 **	-32.00	-58.54*
FDM 10 x FDM 7	2.63	-11.36**	-12.40 **	-22.46 **	-11.41 **	-16.62 **	-58.24**	-62.00**
FDM 10 x FDM 12	45.36**	6.82*	-2.49	-2.97	-10.73**	-21.00 **	1.77	-20.14
FDM 10 x FDM 37	-30.00**	-33.78**	35.22 **	15.45 **	38.67 **	24.80 **	-52.22*	-56.12*
FDM 10 x FDM 14	10.91**	-7.58*	12.69 **	7.33 *	7.92 **	-2.33	-17.99	-30.49
FDM 10 x FDM 36	-37.77**	-39.13**	-4.99	-20.18 **	-5.33 **	-13.92 **	-37.93*	-52.00**
FDM 8 x FDM 7	-19.40**	-22.86**	-3.48	-4.75 *	-1.35	-8.75 **	-45.76	-68.00**
FDM 8 x FDM 12	20.96**	-3.81	-8.96 **	-20.00 **	-16.48**	-34.13 **	39.51	-21.53
FDM 8 x FDM 37	-20.95**	-32.43**	3.40	0.47	1.68	-1.50	10.34	-34.69
FDM 8 x FDM 14	33.68**	22.86**	5.29	-11.63 **	1.87	-18.12 **	38.67	-8.77
FDM 8 x FDM 36	-30.37**	-38.70**	2.50	-2.27	4.50 **	0.13	-26.19	-58.67**
FDM 7 x FDM 12	30.38**	7.29	6.97 **	-6.00 **	-13.94 **	-23.83 **	140.16**	103.47**
FDM 7 x FDM 37	-9.84**	-25.68**	-7.65 **	-10.26 **	10.96 **	-0.13	-88.89**	-89.00**
FDM 7 x FDM 14	36.96**	31.25**	7.67 **	-9.63 **	23.57 **	11.83 **	-32.48	-47.00*
FDM 7 x FDM 36	-11.97**	-25.36**	4.52	-0.34	14.78 **	4.37 **	-8.80	-24.00
FDM 12 x FDM 37	-13.33**	-38.51**	-8.15 **	-21.58 **	2.78	-21.20 **	-38.84*	-48.61**
FDM 12 x FDM 14	40.00**	19.32**	30.88 **	24.67 **	-7.00 **	-15.23 **	234.33**	133.33**
FDM 12 x FDM 36	15.00**	-16.67**	-2.56	-18.14 **	21.27 **	-6.28 **	-76.19**	-76.67**
FDM 37 x FDM 14	29.66**	3.38	21.97 **	2.38	18.97 **	-4.38 **	-29.03	-43.88*
FDM 37 x FDM 36	-31.47**	-33.78**	20.21 **	14.63 **	25.77 **	20.50 **	-63.71**	-70.00**
FDM 14 x FDM 36	-12.39**	-28.26**	0. 94	-15.19 **	10.68 **	-14.46 **	16.91	-19.33
SE_d	3.7024	4.2751	0.07	0.08	0.04	0.05	0.09	0.10

*and** indicates the significance at the 5 % and 1 % level respectively; MP- mid parent; BP- better parent;

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Table 2. Genetic variability, broad-sense heritability and genetic advance as percentage of mean estimates for yield and other characters measured on baby corn hybrid populations studied

Characters	GCV	PCV	$h^2_{(b)}$	GA as per cent of mean
Days to 50 % tasseling	3.9984	4.5055	78.76	7.3096
PHT Plant height (cm)	25.0876	27.0195	86.21	47.9854
Number of leaves per plant	8.4216	10.3001	66.85	14.1847
Number of baby corns/plant	19.3072	20.9004	85.34	36.7409
Baby corn length (cm)	14.1764	17.468	65.86	23.7004
Baby corn weight (g)	20.4547	29.3546	48.55	29.3614
Baby corn yield/plot	16.0054	16.1567	98.14	32.6624
Total sugars (%)	21.4424	21.4912	99.55	44.0708
Reducing sugars (%)	82.0871	85.4225	92.34	162.4967
Non reducing sugars (%)	19.7981	20.1889	96.17	39.9948