Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 483-488
Received: 11-05-2019
Accepted: 15-06-2019

Vinod Kumar Pattar
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad, Karnataka, India

Sanjeev K Deshpande
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
Vinod Kumar Pattar
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad, Karnataka, India

Exploitation of combining ability phenomena among elite inbred lines and crosses for baby corn speciality traits in maize (*Zea mays* L.)

Vinod Kumar Pattar and Sanjeev K Deshpande

Abstract

An investigation was carried out to assess the combining ability and nature of gene action in baby corn genotypes using a diallel mating design (without reciprocal crosses) using 12 homozygous lines namely, PDM 112-1, HKI 163, PDM 162-2, HKI 323, HKI 1105, PDM 260-2, PDM 105, PDM 24-3, PDM 53, PDM 4441, and PDM 260-1. The experiment was set up in a randomized complete block design (RCBD) with 3 replications along with two commercial baby corn check hybrids HM 4 and CPB 472 during summer season of 2016. General combining ability studies revealed that HKI 323 was the best combiner for major yield contributing characters including dehusked baby corn yield per hectare (DHBCY ha^{-1}), husked baby corn yield per hectare (HBCY ha^{-1}), husked baby corn yield per plant (HBCY $plant^{-1}$), dehusked baby corn yield per plant (DHBCY $plant^{-1}$), baby corn length (BCL), number of baby corns per plant (NBC $plant^{-1}$), dehusked baby corn weight (DHBCW). So it can be used as one of the parent in hybridization programme. However, the estimates of specific combining ability showed the desirable SCA effects for all traits studied except for baby corn girth (BCG) in PDM 53 × PDM 4441 and days to 50% silking (DFS), baby corn length (BCL), husked baby corn weight (HBCW) in HKI 323 × PDM 105. Gene action analysis revealed preponderance of both additive and non-additive genes for yield and its contributing characters suggesting recurrent selection could be adopted for the improvement of yield and yield related traits.

Keywords: Diallel, combining ability, baby corn

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 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 rapped with husk and well protected from insect and diseases. Despite manifold uses of baby corn, very little information on breeding strategies followed for improvement in baby corn (Chauhan and Mohan, 2010) [4]. It is a fact that selection of parents on the basis of their mean performance does not necessarily lead to desired results (Rai and Asati, 2011) [13]. Therefore, devising a sound breeding strategy to improve the yield of this crop is of paramount importance. Combining ability analysis help breeders in choosing suitable genotypes as parents for hybridization and superior cross combinations through GCA and SCA studies, respectively (Rodrigues and da Silva, 2002; Rai and Asati, 2011) [15, 13]. At the same time, it also elucidates the nature and magnitude of different types of gene action involved, which is essential for an effective breeding program. Hence, this investigation was undertaken to study the estimates of general and specific combining ability and gene action in baby corn for yield components and quality characters.

Material and Methods

The present experiment was carried out at Botanical garden of Department of Genetics and Plant Breeding University of Agricultural Sciences Dharwad, Karnataka, by involving 12 genetically diverse baby corn inbreds *viz*., PDM 112-1, HKI 163, PDM 162-2, HKI 323, HKI 1105, PDM 260-2, PDM 105, PDM 24-3, PDM 53, PDM 4441, PDM 260-1 and PDM 260; which were selected based on previous studies involving evaluation of 115 inbred were used as parents and crossed in diallel mating design following Model-I of Method-II of Griffing

(1956) [8]. This method of combining ability analysis includes one way crosses and their parents. This method is used when reciprocal differences are not significant. The parents and their resulting 21 F_1`s were raised in a randomized complete block design (RCBD) with 3 replications along with two commercial babycorn check hybrids HM 4 and CPB 472 during summer season of 2016. Each plot consisted of 2 rows of 3 m length and spacing between rows and plants adopted were 60 and 20 cm respectively. One plant per hill was maintained and recommended package of practices was followed to raise a healthy crop. Data on baby corn yield and its component and quality traits including days to 50% silking (DFS), number of baby corns per plant (NBC), baby corn length (BCL), baby corn girth (BCG), husked baby corn weight (HBCW), dehusked baby corn weight (DHBCW), husked baby corn yield per plant (HBCY plant^{-1}), dehusked baby corn yield per plant (DHBCY plant^{-1}), husked baby corn yield per hectare (HBCY ha^{-1}), dehusked baby corn yield per hectare (HBCY ha^{-1}) were recorded on 5 randomly selected plants from each plot. Mean data was subjected for analysis of general combining ability (GCA), specific combining ability (SCA) and gene action as per method given by Griffing (1956) [8] (model I of method II) using the software WINDOSTAT (V 9.2).

Results and discussion

Analysis of variance for GCA and SCA presented in Table 1 revealed that mean sum of squares of combining ability for various yield and yield contributing and quality characters were highly significant for all the characters. Significant estimates of GCA and SCA variances suggested the dominant role of both additive and non-additive gene actions for the expression of the characters studied (Amiruzzaman M *et al.*, 2010) [2]. This implied that there was scope for selecting for these traits among the entries used in present investigation.

The mean squares of SCA were larger than those of GCA in all the characters indicating the preponderance of non-additive gene action in the control of the characters. Involvement of non-additive gene action for the characters in present investigation is also in consonance with the findings of Rodrigues and da Silva 2002 [15]. Dhasarathan *et al.*, 2015 [6] and Hemalatha *et al.*, 2014 [9].

Estimates of general combining ability for various traits have been presented in Table 2. The estimates of GCA effects exhibited that the parent HKI 323 was the best general combiner since it recorded highest babycorn yield and significant GCA effects in desirable direction for most of the studied characters *i.e.* dehusked baby corn yield per hectare (DHBCY ha^{-1}), husked baby corn yield per hectare (HBCY ha^{-1}), husked baby corn yield per plant (HBCY plant^{-1}), dehusked baby corn yield per plant (DHBCY plant^{-1}), baby corn length (BCL), number of baby corns per plant (NBC plant^{-1}), dehusked baby corn weight (DHBCW) followed by parent PDM 4441,which exhibited desirable GCA effects for dehusked baby corn weight (DHBCW), dehusked baby corn yield per plant (DHBCY plant^{-1}), baby corn length (BCL), baby corn girth (BCG), dehusked baby corn yield per hectare (DHBCY ha^{-1}). So, these parents could be used extensively in hybrid breeding program to increase baby corn yield with quality. Similar to the present investigation were also reported for the following characters number of baby corns per plant, baby corn length, baby corn weight and baby corn yield per plot (Rodrigues and da Silva, 2002, Dhasarathan *et al.,* 2015, Kumari *et al.,* 2017, Camacho *et al.,* 2015, Izhar and Chakraborty 2013, Ramachandrappa *et al.,* 2004 and Ahmed *et al.* 2016) [15, 6, 11, 3, 10, 14, 1].

High positive estimates of specific combining ability in absolute values indicates that hybrid performance is relatively superior or inferior to parent lines general combining ability, showing the importance of non-additive interactions resulting from the complementation degree among parent lines in relation to frequency of alleles in loci with some dominance, while low estimates of specific combining ability in absolute value indicates that hybrids behave as expected in relation to general combining ability of parent lines (Vencovsky and Barriga, 1992) [16]. In the selection of parent lines used to produce hybrids, the effect of a specific combining ability analyzed in an isolated way has a limiting value. Thus, other parameters should be considered such as the average of hybrids and general combining ability of the respective parent lines (Oliveira *et al.,* 1998) [12]. Therefore, superior hybrid combinations, which are important for breeding, are involved with at least one parental line which has the most favorable effects of general combining ability (Cruz and Regazzi, 1997) [5]. Thus, it is possible to analyze the 2 hybrids that showed high performance for most of the yield and quality traits, such as PDM 53 × PDM 4441 and HKI 323 × PDM 105 (Table 3 and 4).

Hybrid PDM 53 × PDM 4441 was found to be 19 and 104 per cent superior to standard checks HM4 and CPB 472 in terms of dehusked babycorn yield (kg ha^{-1}). In this case high productivity is not due to dominant genetic effects of inbreds but due to high effects of general combining ability f both parental lines. In HKI 323 × PDM 105 hybrid, it is associated with high general combining ability effect of HKI 323 with one of the highest effects of the estimated specific combining ability, since PDM 105 showed negative general combining ability. In this case, the participation of a specific combining ability is significant for hybrid yield, contributing almost to the general combining ability from both inbreds, regarding the dominance and epistasis effects (Gardner, 1963) [7]. Similar trend has been observed in the next superior crosses such as PDM 162-2 × PDM 53 and PDM 112-1 × HKI 163 where the specific combining ability is contributing significantly towards hybrid yield. However, the hybrid PDM 162-2 × PDM 53 exhibited high specific combining ability for dehusked baby corn yield per hectare (DHBCY ha^{-1}), husked baby corn yield per hectare (HBCY ha^{-1}), husked baby corn yield per plant (HBCY plant^{-1}), dehusked baby corn yield per plant (DHBCY plant^{-1}), days to 50% silking (DFS), husked baby corn weight (HBCW), dehusked baby corn weight (DHBCW) and PDM 112-1 × HKI 163 recorded high specific combining ability for dehusked baby corn weight (DHBCW), baby corn length (BCL), baby corn girth (BCG). About four hybrids performed better than both check hybrids HM4 and CPB 472, but in respect of baby corn superiority it is decided by its quality. Hence, the hybrids PDM 53 × PDM 4441 and HKI 323 × PDM 105 recorded highest mean and SCA effects for yield and most of quality traits.

Table 1: ANOVA for combining ability for baby corn yield and quality traits.

Source of Variations	*df*	Dehusked Baby corn Yield (kgha^{-1})	Husked Baby corn Yield (kg ha^{-1})	Dehusked Baby corn Yield per plant (g)	Husked Baby corn Yield per plant (g)	Days to 50% silking	Baby corn length (cm)	Baby corn girth (cm)	No. of baby corns per plant	Husked weight of baby corn (g)	Dehusked weight of baby corn (g)
GCA	11	360050.86**	1724684.03**	51.85**	274.16**	19.86**	2.60**	0.056**	0.30**	85.14**	10.38**
SCA	66	170615.20**	1137344.33**	24.57**	161.10**	10.66**	1.65**	0.01**	0.09**	39.75**	5.74**
Error	154	11083.18	107980.67	1.60	16.97	0.55	0.16	0.00	0.01	3.17	0.32
GCA Variance		24926.26	115478.80	3.59	18.37	1.38	0.17	0.00	0.02	5.86	0.72
SCA Variance		159532.00	1029364.00	22.97	144.13	10.11	1.49	0.01	0.08	36.58	5.42
GCA/SCA Var. Ratio		0.16	0.11	0.16	0.13	0.14	0.12	0.38	0.25	0.16	0.13
Parental Means		768.50	2821.23	9.22	33.85	62.11	6.72	1.163	1.11	30.19	8.14

Table 2: Estimates of mean and general combining ability effects (GCA) of the parents for baby corn yield and quality traits

Sl. No	Parents	Dehusked Baby corn Yield (kg ha^{-1})		Husked Baby corn Yield (kg ha^{-1})		Dehusked Baby corn Yield per plant (g)		Husked Baby corn Yield per plant (g)		Days to 50% silking		Baby corn length (cm)	
		Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
1	HKI 323	1430.56	289.52**	4655.56	724.24**	17.17	3.47**	55.87	8.56**	65.67	0.07	7.52	0.27**
2	PDM 4441	1143.34	170.43**	3797.78	-100.29	13.72	2.04**	45.57	-0.59	58.67	0.21	9.93	0.78**
3	HKI 1105	866.67	17.54	3350.00	-34.54	10.40	-0.21	40.20	-0.25	59.33	0.78**	5.87	0.18
4	PDM 260-2	761.11	115.04**	2455.56	-449.70**	9.13	-1.38**	29.47	-6.22**	60.00	0.23	8.93	-0.26*
5	PDM 53	750.00	213.53**	2583.33	617.16**	9.00	2.56**	31.00	7.96**	70.33	-0.84**	4.93	0.47**
6	PDM 112-1	742.50	79.14**	3162.50	112.02	8.91	0.95**	37.95	1.71	68.67	-0.62**	6.00	-0.16
7	PDM 24-3	688.89	151.30**	2583.33	-265.32**	8.27	-1.82**	31.00	-2.99**	59.33	0.28	5.87	-0.81**
8	PDM 162-2	686.11	203.50**	1794.45	-133.74	8.23	2.44**	21.53	-1.21	63.33	1.64**	7.90	0.1
9	HKI 163	675.00	115.69**	2288.89	-113.14	8.10	-1.39**	27.47	-1.95	68.00	1.90**	5.57	-0.20
10	PDM 260	608.33	-24.72	2411.11	-267.79**	7.30	-0.30	28.93	-3.43**	52.67	-0.57**	6.50	0.12
11	PDM 105	475.00	158.70**	1750.00	-197.62*	5.70	-1.90**	21.00	-2.98**	61.67	-0.46*	6.97	-0.53**
12	PDM 260-1	394.45	33.87	3022.22	108.72	4.73	0.41	36.27	1.40	57.67	-2.62**	4.70	0.03
	Mean	768.50		2821.23		9.22		33.85		62.11		6.72	
	SE(gi)		26.94		84.08		0.32		1.05		0.19		0.10
	SEd (gi-gj)	39.79		124.20		0.48		1.56		0.28		0.15	
	CD at 5%	78.61		245.36		0.94		3.08		0.55		0.30	

Sl. No	Parents	Baby corn girth (cm)		No. of baby corns per plant		Husked weight of baby corn (g)		Dehusked weight of baby corn (g)	
		Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
1	HKI 323	1.14	0.02	1.83	0.25**	30.43	0.59	9.40	0.75**
2	PDM 4441	1.57	0.11**	1.27	0.04	36.13	-1.02*	10.73	1.08**
3	HKI 1105	1.47	0.09**	1.13	-0.11**	35.53	2.84**	9.20	0.73**
4	PDM 260-2	1.35	-0.01	1.00	-0.11**	29.47	-2.22**	9.13	0.04
5	PDM 53	1.00	-0.01	1.00	0.12**	31.00	2.21**	9.00	0.77**
6	PDM 112-1	1.03	-0.06**	1.13	0.18**	33.61	-1.80**	7.89	-0.27
7	PDM 24-3	1.00	-0.08**	1.00	-0.02	31.00	-1.48**	8.27	-1.14**
8	PDM 162-2	1.37	0.02	1.00	-0.23**	21.53	4.03**	8.23	-0.35*
9	HKI 163	1.13	-0.01	1.00	-0.18**	27.47	2.37**	8.10	0.31*
10	PDM 260	1.07	0.04*	1.00	-0.06*	28.93	-1.59**	7.30	0.18
11	PDM 105	0.93	-0.11**	1.00	0.08**	21.00	-4.21**	5.70	-1.91**
12	PDM 260-1	0.90	-0.02	1.00	0.04	36.27	0.28	4.73	-0.18
	Mean	1.16		1.11		30.20		8.14	
	SE(GI)		0.02		0.02		0.46		0.14
	SEd (GI-GJ)	0.02		0.04		0.67		0.21	
	CD at 5%	0.05		0.07		1.33		0.42	

Table 3: Estimates of yield improvement over checks, means and specific combining ability effects (SCA) with respect to top 25 hybrids out of 66 hybrids for baby corn yield.

Sl. No	Hybrids	Baby corn yield improvement over CPB472 (%)	Dehusked Baby corn Yield (kg ha^{-1})		Husked Baby corn Yield (kg ha^{-1})		Dehusked Baby corn Yield per plant (g)		Husked Baby corn Yield per plant (g)	
			Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
1	PDM 53×PDM 4441	104	2443.61	921.20**	6003.61	1504.57**	29.32	11.05**	72.04	21.27**
2	HKI 323×PDM 105	89	2262.22	992.95**	6374.22	2263.47**	27.15	11.91**	76.49	27.51**
3	PDM 162-2×PDM 53	82	2175.11	1026.63**	7393.93	3200.76**	26.10	12.32**	88.73	38.58**
4	PDM 112-1×HKI 163	74	2089.44	987.54**	4620.93	1041.91**	25.07	11.85**	55.45	12.29**
5	HKI 323×PDM 4441	67	2000.89	402.49**	3692.44	-677.19*	24.01	4.83**	44.31	-7.06
6	HKI 323×PDM 260	49	1788.19	384.94***	4754.32	547.99	21.46	4.62**	57.05	8.52*

7	PDM 24-3×PDM 53	49	1785.84	585.16**	4503.71	358.56	21.43	7.02**	54.04	5.68
8	PDM 260-1×PDM 260	46	1744.42	596.82**	5296.58	1947.24**	20.93	7.16**	63.56	22.18**
9	HKI 163×PDM 53	42	1701.19	464.89**	7062.31	2989.05**	20.41	5.58**	84.75	35.34**
10	HKI 1105×PDM 260-1	42	1697.89	543.11**	3667.78	-271.20	20.37	6.52**	44.01	-0.55
11	PDM 4441×PDM 260-1	38	1658.89	316.13**	4067.78	614.55*	19.91	3.79**	48.81	4.60
12	PDM 53×PDM 260-1	38	1658.52	272.67**	5321.78	682.21*	19.90	3.27**	63.86	11.09**
13	PDM 112-1×HKI 323	36	1624.83	117.72	4870.17	497.16	19.50	1.41	58.44	4.77
14	HKI 1105×PDM 53	35	1615.11	280.67**	3964.89	-181.64	19.38	3.37**	47.58	-3.54
15	HKI 323×HKI 1105	34	1604.17	193.74	5578.56	1253.50**	19.25	2.32	66.94	15.23**
16	HKI 1105×PDM 260-2	26	1505.83	499.96**	2593.11	-499.39	18.07	6.00**	31.12	-5.82
17	PDM 4441×PDM 260	23	1471.94	187.78	4180.56	962.17**	17.66	2.25	50.17	10.78**
18	PDM 112-1×PDM 260-2	22	1457.00	354.44**	4531.44	801.21**	17.48	4.25**	54.38	15.48**
19	PDM 112-1×PDM 260	19	1421.11	228.24*	3921.11	366.52	17.05	2.74*	47.05	5.37
20	PDM 112-1×PDM 260-1	16	1384.89	133.43	3462.22	-452.21	16.62	1.60	41.55	-4.97
21	PDM 162-2×HKI 323	11	1327.28	102.81	5012.78	786.92*	15.93	1.23	60.15	9.41*
22	PDM 260-2×PDM 4441	10	1319.44	125.60	3118.17	213.64	15.83	1.51	37.42	0.82
23	HKI 1105×PDM 4441	10	1316.11	24.77	3739.44	141.70	15.79	030	44.87	2.31
24	PDM 260-2×PDM 260-1	9	1305.56	248.27*	3177.67	156.74	15.67	2.98*	38.13	-0.45
25	PDM 24-3×PDM 260-1	6	1271.56	250.53*	3761.89	257.24	15.26	3.00*	45.14	3.33
	SE (Sij)			89.66		279.85		1.08	5.39	3.51
	SEd (Sij-Skm)		137.84		430.24		1.65			
	CDE at 5%		272.30		849.94		3.27		10.66	

Table 4: Estimates of means and specific combining ability effects (SCA) of 66 hybrids for yield attributing quality traits

Sl. No.	Hybrids	Days to 50% silking		Baby corn length (cm)		Baby corn girth (cm)		No. of baby corns per plant		Husked weight of baby corn (g)		Dehusked weight of baby corn (g)	
		Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
1	PDM 53×PDM 4441	60.67	-2.04**	11.07	1.67**	1.40	0.06	1.93	0.38**	37.32	4.83**	15.19	3.68**
2	HKI 323×PDM 105	62.67	-0.28	8.38	0.49	1.29	0.14*	2.73	1.01**	27.95	0.26	9.93	1.42**
3	PDM 162-2×PDM 53	61.00	-3.14**	10.35	1.64**	1.30	0.03	1.67	0.38**	53.28	15.74**	15.61	5.53**
4	PDM 112-1×HKI 163	65.00	0.39	10.87	3.08**	1.40	0.21**	1.33	-0.06	41.57	9.70**	18.90	9.20**
5	HKI 323×PDM 4441	63.33	-0.28	9.21	0.01	1.38	0.01	1.60	-0.08	27.69	-3.18	15.01	3.51**
6	HKI 323×PDM 260	62.00	-0.83	9.26	0.73	1.35	0.05	1.87	0.28**	30.52	0.22	11.51	0.91
7	PDM 24-3×PDM 53	59.00	-3.78**	8.23	0.43	1.23	0.07	2.20	0.71**	24.57	-7.46**	9.74	0.45
8	PDM 260-1×PDM 260	61.00	0.86	8.15	-0.13	1.34	0.08	1.60	0.22*	39.69	9.71**	12.96	3.31**
9	HKI 163×PDM 53	63.67	-0.73	8.75	0.34	1.35	0.11	1.73	0.40**	48.91	13.03**	11.81	1.07*
10	HKI 1105×PDM 260-1	60.67	-0.83	9.42	1.06**	1.34	0.03	1.53	0.21*	28.65	-5.77**	13.36	3.15**
11	PDM 4441×PDM 260-1	60.67	-0.26	9.05	0.10	1.20	-0.13*	2.00	0.52**	24.41	-6.16**	9.95	-0.60
12	PDM 53×PDM 260-1	59.00	-0.87	10.53	1.89**	1.33	0.11	1.80	0.24**	35.28	1.49	11.00	0.75
13	PDM 112-1×HKI 323	64.67	1.88**	8.19	-0.07	1.23	0.02	1.80	-0.02	32.47	2.38	10.83	0.69
14	HKI 1105×PDM 53	60.33	-2.95**	9.34	0.54	1.32	-0.01	1.60	0.20*	29.74	-6.61**	12.11	0.95
15	HKI 323×HKI 1105	63.00	-1.19	7.87	-0.73	1.41	0.06	1.53	0.01	43.69	8.96**	12.55	1.41**
16	HKI 1105×PDM 260-2	62.00	-2.35**	9.76	1.69**	1.30	-0.04	1.07	-0.11	29.10	-2.81	17.00	6.57**
17	PDM 4441×PDM 260	66.00	3.03**	10.34	1.30**	1.46	0.07	1.27	-0.11	39.51	10.82**	13.92	3.00**
18	PDM 112-1×PDM 260-2	59.33	-3.61**	7.44	-0.28	1.09	-0.10	1.93	0.47**	28.30	1.02	9.08	-0.35
19	PDM 112-1×PDM 260	57.67	-4.47**	7.48	-0.62	1.24	0.02	2.00	0.48**	23.53	-4.38**	8.53	-1.04*
20	PDM 112-1×PDM 260-1	60.67	0.58	8.62	0.61	1.19	0.03	1.67	0.05	24.97	-4.81**	10.04	0.83
21	PDM 162-2×HKI 323	63.00	-2.04**	10.07	1.55**	1.31	0.02	1.40	-0.01	42.97	7.04**	11.38	1.31*
22	PDM 260-2×PDM 4441	66.67	2.88**	5.97	-2.70**	1.30	-0.05	1.47	0.14	25.66	-2.40	10.83	0.05
23	HKI 1105×PDM 4441	68.67	4.34**	9.79	0.68	1.39	-0.05	1.33	0.01	33.74	0.61	11.61	0.14
24	PDM 260-2×PDM 260-1	61.67	0.72	8.79	0.88*	1.15	-0.07	1.33	0.01	28.53	-0.83	11.76	2.24**
25	PDM 24-3×PDM 260-1	60.67	-0.33	8.31	0.95*	1.24	0.10	1.40	-0.02	31.99	1.89	10.79	2.45**
26	PDM 105×PDM 24-3	62.00	-1.16	6.67	-0.13	1.13	0.07	1.67	0.21*	35.02	9.41***	9.01	2.40**

Sl. No.	Hybrids	Days to 50% silking		Baby corn length (cm)		Baby corn girth (cm)		No. of baby corns per plant		Husked weight of baby corn (g)		Dehusked weight of baby corn (g)	
		Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
27	HKI 163×HKI 323	63.33	-1.97**	7.51	-0.70	1.22	-0.04	1.40	-0.06	35.57	1.31	10.63	-0.09
28	PDM 24-3×PDM 4441	66.33	2.50**	8.63	0.51	1.44	0.17**	1.47	0.05	28.37	-0.43	10.00	0.40
29	PDM 112-1×PDM 105	59.33	-2.92**	7.77	0.31	1.18	0.10	1.93	0.28**	23.46	-1.83	7.53	0.05
30	PDM 105×PDM 260	63.00	0.69	8.54	0.81*	1.27	0.10	1.47	0.05	24.77	-0.73	9.82	1.88**
31	PDM 112-1×HKI 1105	64.33	0.84	9.05	0.89*	1.32	0.04	1.73	0.27**	25.30	-7.04**	8.27	-1.85**
32	HKI 323×PDM 260-2	63.33	-0.31	8.47	0.32	1.23	-0.03	1.47	-0.06	30.87	1.20	9.69	-0.77
33	HKI 323×PDM 260-1	61.00	0.22	9.08	0.63	1.23	-0.01	1.53	-0.15	25.51	-6.66**	8.99	-1.25*
34	PDM 24-3×PDM 260	70.00	6.96**	8.13	0.70	1.33	0.13*	1.33	0.02	31.21	2.99	10.28	1.59**
35	PDM 112-1×PDM 4441	59.00	-3.92**	8.10	-0.66	1.19	-0.10	1.67	0.05	16.55	-11.93**	7.79	-2.68**
36	PDM 112-1×PDM 53	61.67	-0.21	8.84	0.39	1.19	0.01	1.40	-0.29**	30.09	-1.61	8.94	-1.22*
37	HKI 323×PDM 53	61.67	-0.90	9.08	0.20	1.28	0.02	1.47	-0.29**	30.79	-3.31*	8.42	-2.76**
38	HKI 1105×PDM 260	68.67	5.12**	10.07	1.63**	1.46	0.08	1.13	-0.09	31.42	-1.13	11.00	0.43

39	PDM 162-2×PDM 260-1	60.67	-1.69*	8.65	0.38	1.57	0.32**	1.33	0.12	34.18	-1.43	8.97	-0.16
40	PDM 260-2×PDM 53	60.00	-2.73**	9.43	1.07**	1.22	-0.02	1.27	-0.14	30.37	-0.92	9.39	-1.09*
41	HKI 163×PDM 24-3	65.33	-0.19	7.09	-0.04	1.17	0.01	1.60	0.40**	24.75	-7.43**	7.36	-1.47**
42	PDM 105×PDM 4441	66.00	2.91**	8.11	-0.28	1.27	0.03	1.47	-0.05	24.82	-1.25	8.01	-0.83
43	PDM 112-1×PDM 162-2	65.33	0.98	7.99	-0.09	1.18	-0.03	1.27	-0.08	40.67	7.14**	9.21	0.17
44	PDM 112-1×PDM 24-3	60.33	-2.66**	7.24	0.07	1.11	0.01	1.67	0.11	27.55	-0.46	6.95	-1.30*
45	PDM 53×PDM 260	63.67	1.74*	9.07	0.34	1.34	0.06	1.33	-0.12	28.36	-3.55*	8.37	-2.24**
46	HKI 163×PDM 260	64.67	0.01	8.51	0.45	1.31	0.03	1.20	0.04	28.27	-3.81*	9.30	-0.85
47	PDM 105×PDM 53	60.33	-1.71*	7.90	-0.19	1.17	0.04	1.40	-0.19*	27.12	-2.18	7.82	-0.71
48	PDM 162-2×PDM 260-2	66.00	0.79	7.45	-0.53	1.24	-0.02	1.13	0.08	38.05	4.94**	9.67	0.31
49	HKI 163×PDM 260-1	63.00	0.39	7.48	-0.49	1.23	0.01	1.13	-0.13	35.24	1.29	9.17	-0.61
50	PDM 162-2×PDM 260	66.33	1.93**	8.40	0.04	1.20	-0.11	1.13	0.02	26.62	-7.12**	9.07	-0.42
51	HKI 163×PDM 4441	62.00	-3.4**	8.39	-0.33	1.20	-0.15*	1.00	-0.26**	25.23	-7.42**	10.12	-0.92
52	HKI 163×PDM 260-2	68.67	3.19**	7.57	-0.11	1.52	0.28**	1.00	-0.11	30.67	-0.78	10.00	-0.01
53	HKI 1105×PDM 105	63.67	0.01	6.91	-0.88*	1.22	-0.01	1.40	0.03	30.74	0.81	7.14	-1.34

Sl. No	Hybrids	Days to 50% silking		Baby corn length (cm)		Baby corn girth (cm)		No. of baby corns per plant	
		Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
54	HKI 163×HKI 1105	68.67	2.65**	9.07	0.94*	1.30	-0.03	1.00	-0.11
55	HKI 323×PDM 24-3	65.00	1.31	7.49	-0.11	1.20	0.02	1.13	-0.49**
56	HKI 163×PDM 162-2	65.67	-1.21	8.30	0.26	1.17	-0.10	1.00	0.01
57	PDM 105×PDM 260-1	62.33	2.07**	8.73	1.09**	1.20	0.09	1.40	-0.12
58	PDM 260-2×PDM 105	65.67	2.55**	6.12	-1.23**	1.00	-0.14*	1.53	0.17
59	PDM 162-2×PDM 105	64.67	0.15	7.00	-0.71	1.04	-0.11	1.00	-0.25**
60	PDM 260-2×PDM 260	67.00	4.00**	6.50	-1.49**	1.29	0.01	1.00	-0.23*
61	HKI 163×PDM 105	64.00	-0.78	8.38	0.96*	1.02	-0.12	1.27	-0.03
62	PDM 260-2×PDM 24-3	66.33	2.48**	6.81	-0.26	1.12	-0.04	1.40	0.13
63	PDM 162-2×PDM 24-3	67.67	2.41**	6.83	-0.60	1.03	-0.15*	1.00	-0.15
64	PDM 162-2×HKI 1105	69.67	3.91**	8.10	-0.32	1.42	0.06	1.00	-0.06
65	HKI 1105×PDM 24-3	66.00	1.60*	7.30	-0.21	1.06	-0.20**	1.00	-0.26**
66	PDM 162-2×PDM 4441	69.67	4.48**	8.28	-0.75*	1.30	-0.07	1.00	-0.21*
SE (Sij)			0.63		0.34		0.06		0.08
SEd (Sij-Skm)		0.97		0.48		0.09		0.13	
CD at 5%		1.91		0.95		0.17		0.25	

days to 50% silking (DFS), number of baby corns per plant (NBC $plant^{-1}$), baby corn length (BCL), baby corn girth (BCG husked baby corn weight (HBCW), dehusked baby corn weight (DHBCW), husked baby corn yield per plant (HBCY $plant^{-1}$), dehusked baby corn yield per plant (DHBCY $plant^{-1}$), husked baby corn yield per hectare (HBCY ha^{-1}), dehusked baby corn yield per hectare (DHBCY ha^{-1})

Conclusion

Out of 12 parents HKI 323 and PDM 4441were the best general combiners as they exhibited desirable mean and GCA effects for most of contributing traits and yield and quality traits respectively. Therefore these parents could be used extensively in hybrid breeding program with a view to increase baby corn yield with quality. Furthermore, based on mean and SCA effects 2 hybrids PDM 53 × PDM 4441 and HKI 323 × PDM 105 were proved to be the best to increase the baby corn yield with better quality. For varietal improvement, these crosses could also be utilized for exploiting promising recombinants and it could be useful towards enhancing baby corn yield and quality.

Acknowledgements

Authors are highly thankful to the College of Agriculture, Dharwad (UASD), Karnataka and IARI-RRC, Dharwad, Karnataka for providing all assistance and research material. We are also grateful to Dr. Shreekanth S Patil, Former Director of Research, University of Agricultural Sciences, Dharwad, Karnataka, India and Dr. Jayant Bhat, Senior Scientist, IARI-RRC, Dharwad, Karnataka for their assistance during the study period.

References

1. Ahmed A, Begum S, Omy HS, Rohman MM, Amiruzzaman M. Evaluation of inbred lines of baby corn through line × tester method. Bangladesh Journal of Agricultural Research. 2016; 41(2):311-321.
2. Amiruzzaman M, Islam MA, Hassan L, Rohman MM. Combining Ability and Heterosis for Yield and Component Characters in Maize (*Zea mays* L). Academic Journal of Plant Sciences. 2010; 3(2):79-84.
3. Camacho LR, de S, Scapim CA, Senhorinho HJC, Conrado TV. Diallel analysis of popcorn lines and hybrids for baby corn production. Crop Breeding and Applied Biotechnology. 2015; 15:33-39.
4. Chauhan SK, Mohan J. Estimates of variability, heritability and genetic advance in baby corn. Indian Journal of Horticulture (Special Issue). 2010; 67:238-241.
5. Cruz CD, Regazzi AJ. Modelos Biometricos Aplicados Ao melhoramento genetic. Imprensa universitaria, Vicosa, 1997.
6. Dhasarathan M, Babu C, Iyanar K. Combining ability and gene action studies for yield and quality traits in baby corn (*Zea mays* L.). SABRAO Journal of Breeding and Genetics. 2015; 47(1):60-69.
7. Gardner CO. Estimates of genetic parameters in cross fertilizing plants and their importance in plant breeding. In: Hanson WD, Robinson HF, editors. Statistical genetics and plant breeding. NAS-NRC Publications. Washington, 1963, 225-252.
8. Griffing B. Concept of general and specific combining ability in relation to diallel crossing system. Australian Journal of Biological Sciences. 1956; 9:463-98.
9. Hemalatha V, Sai Kumar R, Swarnalatha V, Suresh J. Combining ability and gene action for morphological

parameters in quality protein maize (*Zea Mays* L.) International Journal of Plant, Animal and Environmental Sciences. 2014; 4(2):230-235.

10. Izhar T, Chakraborty M. Genetic analysis of yield and quality parameters in baby corn (*Zea mays* L.). Current Advances in Agricultural Scinces. 2013; 5(1):27-31.
11. Kumari H, Kumar N, Nikhil, Kumar M, Nirala RBP, Mishra A. Studies on Baby Corn (*Zea mays* L.) genotypes for their combining ability and heterosis based on Pre and postharvest traits. Bulletin of Environment, Pharmacology and Life Sciences. 2017; 6(1):486-491.
12. Oliveira VR, Casali VMD, Cruz CD, Pereira PRG, Scapim CA. Capacidae de combinacao entre linhagens de pimentao diferindo na tolerancia ao baixo teor de fosforo no solo. Bragantia. 1998; 57:203-214.
13. Rai N, Asati BS. Combining ability and gene action studies for fruit yield and yield contributing traits in brinjal. Indian Journal of Horticulture. 2011; 68(2):212-215.
14. Ramachandrappa BK, Nanjappa HV, Shivakumar HK. Yield and quality of baby corn (*Zea mays* L.) as influenced by spacing and fertilization levels. Acta Agronomica Hungarica. 2004; 52:237-243.
15. Rodrigues LRF, da Silva N. Combining ability in baby corn inbred lines (*Zea mays* L.). Crop Breeding and Applied Biotechnology. 2002; 2(3):361-368.
16. Vencovsky R, Barriga P. Genetic biometrica no Fitomelhoramento. Sociedade Brasileira de Genetica, Ribeirao Preto, 1992.