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Categorization of Newly Derived Inbred Lines of Baby Corn (*Zea mays* L.) into Heterotic Groups Based on Combining Ability Status

Heena Kousar, Sanjeev K. Deshpande, Biradar B. D.

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ABSTRACT

Heterotic groups are relevant as they allow germplasms to be utilized in a hybrid breeding program. The heterotic gene pools are mainly developed and utilized for the creation of hybrid combinations with the respective testers. Hence the development of twenty-seven hybrid combinations was practiced through the crossing of nine lines and three testers following the Line × Tester mating design as given by Kempthorne. The experiment was carried during *kharif* 2019 at the Botanical Garden of the University of Agricultural Sciences Dharwad. The RCBD design was followed during the field layout and the sowing was carried following two replications. The resultant twenty-seven hybrid combinations were analyzed for their respective sca effects and mean performances. The respective hybrid performances and sca effects were utilized for classifying the parental inbred lines into different heterotic groups by following SCA-PY (Specific combining ability combined line pedigree and hybrid yield) and HSGCA (Heterotic group's specific and general combining ability) methods of classification for baby corn yield without husk per plant. Four inbred lines were assigned to heterotic group A (BBCH-51-2), five lines were assigned to heterotic group B (BBCH-120-1) and none of the line was placed in heterotic group AB following the SCA-PY method. Whereas, eight lines were assigned to heterotic group AB, a single line to heterotic group B and none of the lines were assigned to heterotic group A following the HSGCA method of classification.

Keywords Heterotic group, SCA-PY method, HSGCA method.

INTRODUCTION

Baby corn is a potential crop to generate income and employment for poor people, young people and women throughout the year, promoting human welfare, sustainable development and making the best use of the resources available in rural areas. Baby corn is not a separate race or type of maize, but a maize cultivar that is explicitly bred and grown for use as vegetable at an immature stage. Despite these enormous opportunities and penalties, research projects in India are very scares due to lack of knowledge of the product's economic potential, high production costs, pre and post-harvesting activities and more

Heena Kousar
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580005, India
Email: madinaheena@gmail.com

Sanjeev K. Deshpande*
Professor of Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580005, India
Email: sanjeevgpb@gmail.com

Biradar B. D.
Head of the Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580005, India
*Corresponding author

importantly, lack of information on suitable genetic material. The special features for use as a baby corn indicate desirability of a maize cultivar for use at the tender ear stage (Kumar and Kalloo 2000). Hence the current experiment aims at the development of genotypes solely bred for baby corn purpose. The line × tester analysis was carried for assessment of genetic potentialities of hybrids and inbreeds. Simultaneously the heterotic grouping of parental lines was carried out as they allow germplasm to be utilized in a hybrid breeding program. The improvement in heterozygosity, hybrid vigour and yield stability of new cultivars can be achieved by cross between genotypes from distinct heterotic groups (Terron *et al*. 1997).

MATERIALS AND METHODS

The parental material consists of nine lines and three testers which were crossed following Line × Tester mating design to generate twenty-seven single cross hybrids. The crossing was carried during *rabi* 2018 and the evaluation of the resultant twenty-seven hybrids was conducted during *kharif* 2019 along with two commercial check hybrids i.e., HM-4 (National check), CPB 468 (Private check). The sowing was carried following RCBD design with two replications. The row length was 3 m and 60 cm × 20 cm was the spacing followed. The mean data of 10 randomly selected plants of each genotype for seven quantitative traits viz., days to 50% silking, number of cobs per plant, cob weight with husk, cob weight without husk, ear length, ear diameter and baby corn yield without husk per plant formed the basis of analysis in WINDOSTAT (V 9.2) following the Kempthorne (1957) standard. The classification of nine parental lines into different heterotic groups was done following the two methods of heterotic grouping i.e., SCA-PY (Specific combining ability combined line pedigree and hybrid yield) method and HSGCA (Heterotic group's specific and general combining ability) method.

RESULTS AND DISCUSSION

The *per se* performance of all the nine lines and three testers involved in the crossing program is presented

Table 1. Per *se per*formance of parents involved in line × tester crossing of nine lines with three testers for different quantitative traits of baby corn.

Sl. No	Parents (Inbred lines)	Days to 50% silking	Number of cobs per plant	Cob weight with husk (g)	Cob weight without husk (g)	Ear length (cm)	Ear diameter (cm)	Baby corn yield without husk per plant (g)
	Lines							
1.	BBCP-8-2	58.50	3.20	25.81	4.16	7.37	0.99	13.29
2.	BBCP-27-1	56.50	3.10	26.32	6.18	7.84	1.08	19.25
3.	BBCP-37-2	58.00	3.40	22.95	2.92	6.64	0.96	9.92
4.	BBCP-49-1	58.00	3.20	22.57	8.48	7.48	1.27	27.17
5.	BBCP-27-2	55.50	3.75	22.15	4.74	6.75	1.07	17.82
6.	BBCP-11-1	60.00	2.00	27.15	4.12	7.23	1.02	8.25
7.	BBCP-41-1	56.00	2.40	32.79	4.05	5.62	1.08	9.73
8.	BBCP-15-3	56.00	2.40	39.38	7.80	7.39	1.25	18.68
9.	BBCP-10-1	53.50	2.10	23.38	3.39	3.98	0.86	7.13
	Line mean	56.88	2.83	26.94	5.09	6.70	1.06	14.58
	Minimum	53.5	2.00	22.15	2.92	3.98	0.86	7.13
	Maximum	60.00	3.75	39.38	8.48	7.84	1.27	27.17
	Testers							
1.	BBCH-95-2	57.50	3.20	23.52	6.10	7.91	1.08	19.50
2.	BBCH-51-2	55.00	2.30	23.32	3.25	7.05	0.94	7.48
3.	BBCH-120-1	53.00	3.90	22.25	4.42	7.03	1.10	17.30
	Tester mean	55.16	3.13	23.03	4.59	7.33	1.04	14.76
	Minimum	53.00	2.30	22.25	3.25	7.03	0.94	7.48
	Maximum	57.50	3.90	23.52	6.10	7.91	1.10	19.5
	Grand mean of lines and testers	56.45	2.91	25.96	4.96	6.85	1.05	14.62

Table 2. Per *se pe*rformance of 27 single cross hybrids derived from line × tester design with respect to important economic traits in baby corn.

Sl. No	F_1 hybrids	Days to 50% silking	Number of cobs per plant	Cob weight with husk (g)	Cob weight without husk (g)	Ear length (cm)	Ear diameter (cm)	Baby corn yield without husk per plant (g)
1	BBCP-8-2 × BBCH-95-2	54.50	3.00	39.9	9.00	10.18	1.38	27.00
1.	BBCP-8-2 × BBCH-51-2	54.50	3.20	42.95	8.97	9.38	1.18	28.66
2.	BBCP-8-2 × BBCH-120-1	54.00	3.30	36.52	8.25	8.34	1.20	27.22
3.	BBCP-27-1 × BBCH-95-2	57.00	3.00	34.48	8.40	8.47	1.33	25.20
4.	BBCP-27-1 × BBCH-51-2	53.50	5.35	40.15	7.91	8.39	1.19	42.33
5.	BBCP-27-1 × BBCH-120-1	55.50	4.00	47.05	8.30	8.72	1.24	33.20
6.	BBCP-37-2 × BBCH-95-2	57.00	3.00	46.30	9.33	9.58	1.38	27.99
7.	BBCP-37-2 × BBCH-51-2	58.00	3.30	28.21	8.45	8.69	1.27	27.88
8.	BBCP-37-2 × BBCH-120-1	55.00	2.30	39.60	5.90	9.38	1.13	13.58
9.	BBCP-49-1 × BBCH-95-2	56.50	2.60	35.00	5.37	7.23	1.35	13.99
10.	BBCP-49-1 × BBCH-51-2	55.00	2.30	36.68	3.35	4.17	1.05	7.70
11.	BBCP-49-1 × BBCH-120-1	55.50	4.25	32.44	7.18	8.31	1.29	30.72
12.	BBCP-27-2 × BBCH-95-2	53.50	3.65	47.94	8.59	8.78	1.38	31.35
13.	BBCP-27-2 × BBCH-51-2	58.50	4.00	36.31	6.70	8.47	1.18	26.82
14.	BBCP-27-2 × BBCH-120-1	57.00	4.50	44.31	7.88	9.02	1.23	35.50
15.	BBCP-11-1 × BBCH-95-2	57.50	2.70	30.08	2.72	5.32	1.09	7.35
16.	BBCP-11-1 × BBCH-51-2	57.00	4.00	42.28	7.90	8.63	1.24	31.60
17.	BBCP-11-1 × BBCH-120-1	54.50	3.60	44.50	6.47	9.22	1.17	23.31
18.	BBCP-41-1 × BBCH-95-2	57.00	3.10	41.48	6.93	8.80	1.28	21.66
19.	BBCP-41-1 × BBCH-51-2	54.50	3.10	33.33	4.25	6.52	1.14	13.16
20.	BBCP-41-1 × BBCH-120-1	57.00	3.75	37.30	8.95	9.12	1.31	33.65
21.	BBCP-15-3 × BBCH-95-2	59.00	3.20	38.69	5.25	5.52	1.19	16.76
22.	BBCP-15-3 × BBCH-51-2	58.00	2.90	47.05	7.90	7.92	1.16	22.74
23.	BBCP-15-3 × BBCH-120-1	56.00	2.40	39.88	6.45	7.95	1.23	15.33
24.	BBCP-10-1 × BBCH-95-2	53.50	3.00	41.99	5.90	8.78	1.16	17.65
25.	BBCP-10-1 × BBCH-51-2	59.00	3.65	43.04	5.53	7.52	1.24	20.16
26.	BBCP-10-1 × BBCH-120-1	60.00	3.30	38.63	8.69	8.71	1.32	28.38
Mean		56.22	3.35	39.48	7.05	8.18	1.23	24.10
Minimum		53.50	2.30	28.21	2.72	4.17	1.05	7.35
Maximum		60.00	5.35	47.94	9.33	10.18	1.38	42.33

in Table 1 for all the seven quantitative traits of baby corn. Table 2 represents the per se performance of all the twenty-seven hybrids for various traits of baby corn viz., days to 50% silking, number of cobs per plant, cob weight with husk, cob weight without husk, ear length, ear diameter, baby corn yield without husk per plant. Combining lines from various diverse heterotic types leads to hybrid combinations having a higher level of hybrid vigour (Birchler et al. 2003, Ricci *et al*. 2007). Genetic diversity between groups in a population is often associated with the good gca and sca of lines. In the current study, the heterotic classification was based on two approaches namely SCA-PY and HSGCA method for baby corn yield without husk per plant.

SCA-PY (Specific combining ability combined line pedigree and hybrid yield) method

SCA-PY method: (Menkir *et al*. 2004)
SCA = Cross mean (Xij) – Line mean (Xi.) – Tester mean (X.j) + Overall mean (X..).

The guidelines of Menkir et al. (2004) were implemented along with slight modifications. The specific combining ability effects along with mean baby corn yield without husk per plant of the inbred lines with two testers were used. The lines showing negative sca effect with the tester BBCH-51-2 along with test cross mean yield equal to or greater than 10

% of the mean yield of the hybrid between the two testers but had positive sca effect were assigned to the heterotic group “A”. Whereas, the inbred lines showing negative sca effects with the tester BBCH-120-1 along with test cross mean yield equal to or greater than 10% of the mean yield of the hybrid between the two testers but had positive sca effects with the tester BBCH-51-2 were allotted to heterotic group “B”. Lines with test cross mean yields with both the testers, equal to or greater than 10 % of the mean yield of the hybrid between the two testers were grouped into the “AB” group. The classification of inbred lines into heterotic groups is presented in Table 3. Four inbred lines were assigned to heterotic group A (BBCH-51-2) whereas, five lines were assigned to heterotic group B (BBCH-120-1). While none of the lines was placed in heterotic group AB.

Table 3. Heterotic grouping of parents using SCA-PY method for baby corn yield without husk per plant.

Sl. No.	Inbreds	*sca* with tester T_1 (BBCH-51-2)	*sca* with tester T_2 (BBCH-120-1)	Group
1.	BBCP-8-2	0.58	-3.06	B
2.	BBCP-27-1	8.29	-3.03	B
3.	BBCP-37-2	4.27	-12.22	B
4.	BBCP-49-1	-10.22	10.59	A
5.	BBCP-27-2	-4.85	1.61	A
6.	BBCP-11-1	10.39	-0.1	B
7.	BBCP-41-1	-10.11	8.17	A
8.	BBCP-15-3	4.00	-5.6	B
9.	BBCP-10-1	-2.35	3.65	A

HSGCA (Heterotic group’s specific and general combining ability) method

SCA = Cross mean (X_{ij}) - Line mean ($X_{.j}$) – Tester mean ($X_{i.}$) + Overall mean (X..),
GCA = Line mean ($X_{.j}$) – Overall mean (X..),
HSGCA = Cross mean (X_{ij}) – Tester mean ($X_{i.}$) = GCA + SCA.

Where,

X_{ij} is the mean yield of the cross between the i^{th} tester and j^{th} line,
$X_{i.}$ is the mean yield of the i^{th} tester,
$X_{.j}$ is the mean yield of the j^{th} line,

The innovative approach of using the specific and general combining ability (HSGCA) method as a more appropriate method for allotting inbred lines into heterotic groups was suggested by Fan *et al.* (2009). This technique is more reliable than using sca effects alone or molecular markers to distinguish inbred lines into different heterotic groups (Akinwale 2012). The lines showing negative HSGCA effects with tester BBCH-51-2 were classified into the same heterotic group as their tester (BBCH-51-2 or group A). Lines showing negative HSGCA effects with the tester BBCH-120-1 were assigned to the same heterotic group as their tester (BBCH-120-1 or group B). The results of HSGCA grouping are presented in Table 4. Eight lines were grouped under heterotic group AB as all of them showed positive HSGCA values with respect to both the testers. While single line BBCP-37-2 was assigned to heterotic group B. None of the lines was classified under heterotic group A.

Table 4. Heterotic grouping of parents using HSGCA method for baby corn yield without husk per plant.

Sl. No	Inbreds	Crosses with tester 1	Cross mean	Tester mean	HSGCA	Crosses with tester 2	Cross mean	Tester mean	HSGCA	Group
1.	BBCP-8-2	BBCP-8-2 × BBCH-51-2	28.66	7.48	21.18	BBCP-8-2 × BBCH-120-1	20.16	17.3	2.86	AB
2.	BBCP-27-1	BBCP-27-1 × BBCH-51-2	42.33	7.48	34.85	BBCP-27-1 × BBCH-120-1	33.2	17.3	15.9	AB
3.	BBCP-37-2	BBCP-37-2 × BBCH-51-2	42.33	7.48	34.85	BBCP-37-2 × BBCH-120-1	13.58	17.3	-3.72	B
4.	BBCP-49-1	BBCP-49-1 × BBCH-51-2	7.7	7.48	0.22	BBCP-49-1 × BBCH-120-1	30.72	17.3	13.42	AB
5.	BBCP-27-2	BBCP-27-2 × BBCH-51-2	26.82	7.48	19.34	BBCP-27-2 × BBCH-120-1	35.5	17.3	18.2	AB
6.	BBCP-11-1	BBCP-11-1 × BBCH-51-2	31.6	7.48	24.12	BBCP-11-1 × BBCH-120-1	23.31	17.3	6.01	AB
7.	BBCP-41-1	BBCP-41-1 × BBCH-51-2	13.16	7.48	5.68	BBCP-41-1 × BBCH-120-1	33.65	17.3	16.35	AB
8.	BBCP-15-3	BBCP-15-3 × BBCH-51-2	22.74	7.48	15.26	BBCP-15-3 × BBCH-120-1	33.65	17.3	16.35	AB
9.	BBCP-10-1	BBCP-10-1 × BBCH-51-2	20.16	7.48	12.68	BBCP-10-1 × BBCH-120-1	28.38	17.3	11.08	AB

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