Original Research Article

Genetic analysis for popping traits in tropical inbred lines of popcorn(*Zea mays* var. everta)

ABSTRACT

Aim: Combining ability studies in popcorn to identify superior parents for commercial hybrid breeding.

Study design: line x tester mating fashion

Place and Duration of study: MRC, PJTSAU, RajendranagarHyderabad, between 2023-2024.

Methodology: Popcorn (*Zea mays* var. everta) is a popular snack item both in India and other countries, the genetic base of popcorn germplasm is very narrow, and they resulted in few popcorn hybrids. In this study, a set of 44 popcorn hybrids obtained by crossing 22 inbred lines with two testers in line x tester fashion were evaluated along with parents and two standard checks *i.e.* Amber popcorn and BPCH-6.

Results: Combining ability analysis implied significant differencesamongparents, crosses, parent's v/s crosses for all the traits indicating variation in the selected lines of popcorn. For grain yield, lines PC 1, PC 116, PC 6-1, PC 12-2, PC 25, PC 201-1 and tester CML 451 were identified as good general combiners, whereas crosses, PC 1 x CML 451, PC 25-1 x CML 451, PC 71-1 x CML 451 and PC 5 x CML 286 showed high desirable *sca* effects for grain yield. The popping expansion trait in crosses*viz.,* PC 22 x CML 451, PC 5 x CML 286, PC 72-2 x CML 451 displayed desirable sca effects. In addition to these hybrids PC 5 x CML 286 exhibited positive significant *sca*values along with high *per se* performance for both the traits.

Conclusion: The lines which show desirable performance for yield and popping traits will be utilized in further development of popcorn hybrids.

Keywords: Popcorn, Zea mays var. everta, line x tester,Combining ability, Good general combiners, Specific combining ability.

INTRODUCTION

popcorn is one of the most popular snack foods in larger parts of the world. Popcorn [*Zea mays* L. ssp*everta*] is a form of flint corn and differs from dent and other soft corns in two ways. The first is that it contains almost entirely hard starch. The second is that it has a very hard pericarp and outer layers of endosperm, which permit the internal pressure and temperature to rise high enough to pop (Cretors, 2001). Indian popcorn market is estimated to be worth of $209 million by 2025 (https://www.researchandmarkets.com). India is the topmost popcorn importer in the world, and it imports majorly from Argentina and USA. During 2020-21, total value of popcorn imported in India was $5.09 Million.

The surge in popcorn consumption over the last decade, is mainly due to the proliferation of multiplexes, malls, and food courts in both major cities and Tier-II locations. Despite this growth, the market still offers a very limited variety of popcorn. Very few popcorn varieties i.e., Pearl Popcorn variety of PAU, Amber Popcorn and BPCH 6 hybrid from PJTSAU, Hyderabad, Jawahar Popcorn from JNKVV, Bajaura Popcorn from CSK, Palampur, and Pant Popcorn 1 from GBPUA & T, Pantnagar are predominantly under cultivation.

However, these existing popcorn varieties and hybrids have low popping volume and yield. Hence, there is need to develop high-yielding popcorn hybrids with increased popping volume. Popping traits are majorly governed by polygenes (Clary 1954; Ziegler 2001) and are influenced by environmental factors (Li *et al.* 2003) as well as popping techniques (Dofing*et al.* 1990). Hence, both genetic and environmental factors should be considered for enhancing popping traits in popcorn varieties and hybrids. Genetical factors include balancing high yield with desirable popping traits, with efforts focused on developing hybrids that excel both in productivity and popping quality (Amaral *et al*., 2016; Srdic and Pajic, 2011). Introducing traits like popping expansion represents a strategic approach in breeding high yielding pop corn hybrids with good popping expansion.

In popcorn, to exploit maximum heterotic potential for yield and quality, where in parental selection plays a key role for a sound hybrid breeding programme. In this context, line × Tester analysis by Kempthome (1957) has widely been used for identification of promising inbred lines by crossing lines them with testers. The value of any inbred line in hybrid breeding ultimately depends on its ability to combine very well with other lines to produce superior hybrid combinations. The present study involving a Line × Tester analysis was aimed at to determine both the general combining ability (GCA) of inbreds and specific combining ability (SCA) of crosses for grain yield, its components and quality in popcorn and to identify promising inbred lines and high heterotic combinations for grain yield coupling with popping volume.

Material and Methods

Experimental material consisted of 22 popcorn inbred lines collected from diverse populations. In *kharif*, 2023a total of 44 F_1 crosses were generated by mating 22 popcorn lines with two designated maize testers*i.e.,*CML 286 and CML 451 following a Line × Tester mating design. These hybrids along with parents two standard checks *viz.,*Amber popcorn and BPCH 6were evaluated during the *rabi*, 2023-2024 in RBD in two replications at MRC, ARI, PJTSAU, Rajendranagar, Hyderabad under the specific environmental conditions of Hyderabad, characterized by an altitude of 542.6 m and coordinates approximately 79º23'E longitude and 17º19'N latitude. For each entry, row length of 4 m was maintained and row-row and plant-plant distance of 60cm and 20 cm were followed, respectively.All the recommended package of practiceswerefollowed to raise a good crop. Data were recorded on eight yield and yielding attributing traits *viz.,* days to 50 percenttasseling, days to 50% silking, plant height (cm), number of kernel rows per ear, number of kernels per row, starch content, popping expansion (%), and grain yield (kg/ha). Popping expansion ratio was recorded as per the guidelines of ICAR Indian Institute of Maize Research, Ludhiana(https://iimr.icar.gov.in). The data analysis was conducted using R software, following standard procedures for analysis of variance by (Panse and Sukhatme, 1985) and Line × Tester analysis (Kempthorne, 1957).

Results and Discussion

Analysis of Variance

The analysis of variance revealed that there were no significant differencesamong the replications for all the studiedeight traits. This suggests that the experiment was conducted under consistent conditions so that the performance of entry was similar in each of the two replications. Whereas, all the genotypeshad shown significant differences for all the traits(Table 1), indicating sufficient amount of variability among the genotypes. The analysis of variance for parents and crosses were also significant indicating that parents were diverse and transmitted their valuable potential to their crosses for all the traits. Significant differences were also found between parents *vs.* crosses for all traits suggesting expression ofheterosis for all the traits. These results agreed with those obtained by El-Shamarka*et al*. (2020) and Ismail *et al*. (2020).

The analysis of variance of crosses was further divided into three components *i.e.,* lines, testers, and line × tester interactions. Significant differences for lines were observed for four traits *viz.,*days to 50% tasseling,days to 50% silking, starch content, popping expansion and for testers significant differences were found for plant height, grain yield and popping expansion. Whereas for line x tester, significant differences were found for all the traits except days to 50% tasseling, days to 50% silking and starch content indicating the importance of *SCA* of parents in getting good hybrid combinations and the influence of dominant or non-additive gene action in the inheritance of these traits.

Table 1. ANOVA for L x T analysis for yield, its components and quality traits in pop corn

Source of Variation	d.f.	Days to 50% tasseling	Days to 50% silking	Plant height	Number of kernel rows per ear	Number of kernels per row	Grain yield	Starch content	Popping expansion
Replications	1	2.7	1.9	4.06	0.6	0.5	302395	0.898	0.2
Genotypes	67	6.6**	6.3**	555.8**	9.3**	51.**	6450971**	18.6**	22.2**
Parents	23	7.5**	9.5**	146.4**	5.7**	45.2**	1476618**	18.2**	33.2**
P. vs. C.	1	1.8	111.3**	26258.7**	16.4**	1646.2**	243290219**	105.9**	13.9**
Crosses	43	1.9**	2.1**	177.1**	11.0**	17.9**	3603783**	16.7**	16.5**
Lines	21	2.7*	3.2*	180.4	14.1	21.4	2368046	32.4**	29.7**
Testers	1	1.7	0.1	1722.2**	4.7	11.1	41327514**	0.3	14.7*
Line x tester	21	1.214	1.245	100.22**	8.3**	14.7**	3043151**	1.9	3.4**
Error	67	0.810	0.871	12.550	1.300	3.509	186229	1.7	0.5

*Note: *, **: significant at 0.05 and 0.01 levels of probability, respectively*

Mean performance

Mean performance of 44 crosses and two checks BPCH 6 and Amber popcorn were mentioned in the Table 2. For the trait days to 50 % tasseling and days to 50% silking, none of the crosses were found significantly earlier over the checks but, two crosses PC1 x CML 286 (DT-54 days; DS-56 days) and PC10 x CML 451 (DT-54.5 days;DS-56.5 days) were found on par to the checks BPCH 6 (DT-54.5 days; DS- 56.5 days) and Amber popcorn (DT-54.0 days; DS- 56.5 days).For plant height,crosses PC 24-1x CML 286 (131 cm), PC 116 x CML 286 (139 cm) PC 12-2x CML 286 (140.5 cm),PC 22x CML 286(140.5 cm) had significant dwarf stature against checks BPCH 6 (147.0 cm) and Amber popcorn (148.0 cm).

Table 2. Mean performance of 44 crosses and two checks for eight traits

	Days to 50% tasseling	Days to 50% silking	Plant height	Number of kernel rows per ear	Number of kernels per row	Grain yield	Starch content	Popping expansion
PC1xCML286	54.0	56.0	162.0	16.4	40.9	5546.5	64.50	13.7
PC1xCML451	57.5	58.5	159.5	18.2	38.1	8413.5	65.25	12.2
PC5xCML286	56.5	58.5	154.0	12.3	40.7	6686.5	62.40	14.8
PC5xCML451	57.0	59.0	165.0	14.4	36.0	4460.0	62.65	9.6
PC6-1xCML286	57.0	59.0	150.5	18.3	36.4	5840.0	69.95	12.8
PC6-1xCML451	57.2	59.0	173.5	16.4	37.3	8013.5	65.30	10.2
PC10xCML286	57.1	59.0	158.0	12.4	39.1	5253.5	66.15	12.0
PC 10x CML 451	54.5	56.5	163.5	14.0	39.6	7293.5	64.35	8.85
PC12-2xCML286	56.5	57.5	140.5	16.3	37.0	6360.0	68.80	18.15
PC12-2xCML451	57.0	59.0	163.5	12.3	41.3	8113.5	69.70	15.3
PC22xCML286	57.0	59.0	140.5	12.2	33.8	5080.0	66.10	18.55
PC22xCML451	57.0	59.0	170.5	18.0	31.9	5610.0	66.30	19.9
PC24xCML286	57.0	59.0	143.5	16.4	34.3	5253.5	65.10	10.70
PC24xCML451	57.5	59.5	154.0	14.2	37.2	5200.0	64.30	10.1
PC24-1xCML286	57.0	59.0	131.0	18.1	38.7	3353.5	69.35	12.7
PC24-1xCML451	58.0	60.0	152.5	18.4	37.2	6360.0	69.75	13.2
PC25xCML286	58.0	60.5	151.5	12.4	38.0	5747.0	61.80	19.7
PC25xCML451	57.5	59.5	154.5	12.0	40.0	7243.5	63.60	19.7
PC25-1xCML286	57.5	59.0	143.5	18.0	37.3	4646.5	69.85	14.8
PC25-1xCML451	56.5	58.5	162.0	14.0	40.3	7266.5	70.00	13.25
PC26xCML286	58.0	59.5	164.5	18.0	42.0	4966.5	68.75	16.3
PC26xCML451	57.5	59.5	172.5	16.0	37.3	6593.5	69.55	14.5
PC28xCML286	58.0	60.5	158.0	16.5	41.3	4760.0	64.60	10.0
PC28xCML451	57.5	60.0	159.5	16.0	38.0	4747.0	63.25	12.35
PC38xCML286	56.5	58.5	149.5	16.4	38.0	6627.0	61.95	13.1
PC38xCML451	56.0	58.0	151.0	12.4	35.0	2773.0	61.00	12.1
PC 71-1xCML 286	58.5	59.5	152.5	14.0	39.1	4740.0	67.85	17.3
PC 71-1xCML 451	58.0	61.0	154.0	18.2	41.8	7793.5	66.80	15.75
PC72-2xCML286	58.0	61.0	151.5	12.0	34.0	4800.0	65.15	12.85
PC72-2xCML451	57.5	59.5	152.5	14.1	37.6	6893.5	65.45	14.6
PC116xCML286	57.5	59.5	139.0	14.0	42.2	6073.5	68.65	15.7
PC116xCML451	57.0	59.0	159.0	18.4	38.7	7560.0	68.40	13.2
PC117AxCML286	56.5	58.5	161.5	16.4	33.3	5213.5	63.55	11.9
PC117AxCML451	55.5	57.5	161.0	18.4	38.3	6853.0	62.20	12.7
PC200xCML286	58.0	59.5	162.0	12.2	38.7	4300.0	70.05	12.25
PC200xCML451	58.5	60.5	174.0	16.6	38.3	6840.0	70.65	11.45

PC201-1xCML286	58.5	60.5	158.0	12.4	37.3	5880.0	64.65	12.6
PC201-1xCML451	58.0	60.0	162.5	12.5	39.6	6800.0	65.80	13.8
PC209xCML286	57.5	59.5	157.0	16.3	35.4	5380.0	68.70	12.1
PC209xCML451	58.0	60.0	153.5	14.5	36.9	6446.5	69.65	12.4
PC213xCML286	57.5	59.5	157.0	12.1	32.1	4526.5	68.95	15.3
PC213xCML451	58.5	60.5	151.5	14.5	33.2	6073.5	69.95	15.6
PC506xCML286	56.5	58.5	142.0	12.0	28.3	2720.0	69.75	9.5
PC506xCML451	56.5	58.5	149.5	12.0	40.0	6560.0	70.15	8.5
Checks								
BPCH 6	54.5	56.5	147	14.2	36.8	5019.5	65.5	23.2
Amber popcorn	54.0	56.5	148.0	14.0	34.9	4894.0	66.5	24.6
C.D. 5%	1.8863	1.9046	7.1362	2.2629	3.7628	937.89	2.6431	1.6086

For the trait number of kernel rows per ear, eleven crosses out of forty-four were significantly superior over both the checks and highest was observed in three crosses *viz.,* PC 24-1 x CML 451, PC 116 x CML 451 and PC 117A x CML-451 with a value of 18.4.Seventeen crosses were found significantly superior over both the checks for number of kernels per row and the cross PC 116 x CML 286 (42.2) followed by PC 71-1 x CML 451 (41) showed high number of kernels per row.For grain yield, among the 44 hybrids, twenty-three hybrids had significantly superior grain yield over both the checks and three hybrids *viz.,* PC1 x CML451, PC12-2 x CML451 and PC6-1 x CML451 gave high grain yields of 8414, 8114 and 8014 kg/ha, respectively. Similar results were reported by (Aslam *et al*.2017, El-Hosary*et al*.2018, Abdel-Moneam et al. 2020) Two hybrids *i.e.,* PC 200 x CML 451 and PC 506 x CML 451reported high starch content of 70%and the findings align with Zulkadir*et al.* (2020). Mean value for the trait Popping expansion (%) was 14 % within the range of 8.5 % to 19.9 % these results are consistent with Zulkadir*et al*. (2020). None of the hybrids had significantly superior popping expansion over both the checks.

Table 3. GCA effects of lines and testers for yield, its components and quality traits in popcorn.

	Days to 50% tasseling	Days to 50% silking	Plant height	Number of kernel rows per ear	Number of kernels per row	Grain yield	Starch content	Popping expansion
PC 1	-1.909**	-1.920**	5.094**	2.313**	1.944*	1124.057**	-1.736*	-0.538
PC 5	-0.409	-0.420	3.844*	-1.711**	0.837	-282.693	-4.099**	-1.362**
PC 6-1	-0.159	-0.170	6.469**	2.351**	-0.656	1070.807**	1.008	-2.051**
PC 10	-1.409**	-1.420**	5.219**	-1.779**	1.794	417.557	-1.344*	-3.113**
PC 12-2	-0.409	-0.920	-3.531*	-0.720	1.594	1380.807**	2.641**	3.187**
PC 22	-0.159	-0.170	-0.031	0.089	-4.681**	-510.943*	-0.424	5.662**
PC 24	0.091	0.080	-6.781**	0.325	-1.781	-629.193**	-1.914**	-3.163**
PC 24-1	0.341	0.330	-13.906**	3.258**	0.452	-999.193**	2.962**	-0.545
PC 25	0.591	0.830	-2.531	-2.797**	1.469	639.307**	-3.910**	6.137**
PC 25-1	-0.159	-0.420	-2.906	0.978	1.269	100.557	3.314**	0.483
PC 26	0.591	0.330	12.844**	1.960**	2.144*	-75.943	2.546**	1.649**
PC 28	0.591	1.080*	3.094	1.212*	2.094*	-1102.443**	-2.685**	-2.371**
PC 38	-0.909*	-0.920	-5.281**	-0.597	-1.031	-1155.943**	-5.135**	-0.945*
PC 71-1	0.841	1.080*	-2.406	1.101	2.944**	410.807	0.721	2.974**
PC 72-2	0.591	1.080*	-3.656*	-1.978**	-1.756	-9.193	-1.322	0.179
PC 116	0.091	0.080	-6.731**	1.153*	2.919**	960.807**	1.945**	0.949*

PC 117A	-1.159*	-1.170*	5.719**	2.418**	-1.756	177.307	-3.707**	-1.238**
PC 200	1.091*	0.830	12.344**	-0.625	0.969	-285.943	3.740**	-1.701**
PC 201-1	1.091*	1.080*	4.594*	-2.570**	0.894	484.057*	-1.387*	-0.326
PC 209	0.591	0.580	-0.281	0.377	-1.356	57.307	2.591**	-1.275**
PC 213	0.841	0.830	-1.406	-1.741**	-4.906**	-555.943*	2.847**	1.962**
PC 506	-0.659	-0.670	-9.781**	-3.015**	-3.406**	-1215.943**	3.349**	-4.551**
S.E.± (lines)	0.450	0.466	1.771	0.936	0.936	215.77	0.656	0.367
CML286	0.000	-0.034	-4.424**	-0.233	-0.356	-685.307**	0.06	0.409**
CML451	0.000	0.034	4.424**	0.233	0.356	685.307**	-0.06	-0.409**
S.E.±(testers)	0.135	0.140	0.534	0.282	0.282	65.05	0.198	0.110

**, ** significant at 0.05 and 0.01 levels of probability, respectively*

General combining ability effects:

Estimates of GCA effects of 22 inbred lines and two testers of eight traits are presented in Table 3. Inbred PC 1 was found to be good general combiner for days to 50% tasseling, days to 50% silking, number of kernel rows per ear, number of kernels per row, grain yield and PC 116 for dwarf plant height, number of kernel rows per ear, number of kernels per row, grain yield, starch content and popping expansion. Three inbreds *viz.,* PC 1, PC 10 and PC 117A had significant and negative *gca* effects for flowering traits indicating potential of these inbreds in developing early maturing hybrids. Seven lines and one tester CML 286 were found to be good general combiners for plant height in desirable direction. For grain yield, in addition to PC 1 and PC 116, lines PC 6-1, PC 12-2, PC 25, PC 201-1 and tester CML 451 were good general combiners with significant *gca* effects and these inbreds can be utilized in the development of high yielding hybrids.These findings were in concurrent with work done by Lima *et al*. (2019), Parsons *et al*. (2020),Kamphorst*et al*. (2021), Omy *et al*. (2023).For starch content and popping expansion, PC 12-2, PC 26, PC 116, PC 213 were the good general combiners and could be used in breeding of better popping quality hybrids.

Specific combining ability effects:

SCA effects of 44 test crosses for eight studied traits are presented in Table 4. The results revealed that none of the crosses had significant *sca* effects in desirable direction for all the traits. For grain yield, nine crosses had positive and significant *sca* effects and these crosses involved either high x high or high x low or low x low general combiners and the highest effect was found in PC 38 x CML 286 (2612.30**) followed by PC 5 x CML 286 (1798.55**) and PC 506 x CML 451 (1234.693**). Few crosses *viz.,* PC 1 x CML 451,PC 25-1 x CML 451 and PC 71-1 x CML 451 showing high desirable specific combining ability effects also shown high *per se* performance for grain yield and these crosses had good general combiner as one of the parents. Earlier studies of Parsons *et al*. (2020),Kamphorst*et al*. (2021), Omy *et al*. (2023) had the similar results. For days 50% tasseling, PC 1 x CML 286 had negative and significant effects and for days to silking, none of the crosses were found significant in desirable direction. Eight, seven and three crosses had significant *sca* effects in desirable direction for plant height, number of kernel rows per ear and number of kernels per row, respectively. For starch content, PC 6-1 x CML 286 and for popping expansion, PC 5 x CML 286, PC 10 x CML 286, PC 22 x CML 451, PC 28 x CML 451 and PC 72-2 x CML 451 were good specific combiners. It was observed that for majority of the traits, involvement of one good general combiner is desirable to get the better specific combination. In High x low general combiners, gene interaction between positive alleles of high combiners and negative alleles of low combiners could produce good segregants. Gene action is non fixable for such traits and hence could be exploited in heterosis breeding. Similar finding of non-additive gene action in governing in governing these traits were reported byAminu *et al.* (2014),Abdulazeez, S.D *et al.* (2021)

Table 4. SCA effects of superior crosses for all the traits studied

	Days to 50% tasseling	Days to 50% silking	Plant height	Number of kernel rows per ear	Number of kernels per row	Grain yield	Starch content	Popping expansion
PC1xCML286	-1.750**	-1.216	5.549*	-0.686	1.756	-748.193*	-0.438	0.341
PC 1xCML 451	1.750**	1.216	-5.549*	0.686	-1.756	748.193*	0.438	-0.341
PC 5xCML 286	-0.250	-0.216	-1.201	-0.812	2.713*	1798.55**	-0.174	2.189**
PC6-1x CML 286	0.00	0.034	-7.076**	1.213	-0.094	-401.443	2.248*	0.903
PC 10x CML 286	1.250	1.284	1.674	-0.571	0.106	-334.693	0.860	1.166*
PC 12-2x CML 286	-0.250	-0.716	-7.076**	2.243**	-1.794	-191.443	-0.503	1.016
PC 12-2x CML 451	0.250	0.716	7.076**	-2.243**	1.794	191.443	0.503	-1.016
PC 22x CML 286	0.00	0.034	-10.576**	-2.689**	1.281	420.307	-0.150	-1.084*
PC 22x CML 451	0.00	-0.034	10.576**	2.689**	-1.281	-420.307	0.150	1.084*
PC 24x CML 286	-0.250	-0.216	-0.826	1.333	-1.119	712.057*	0.352	-0.109
PC 24-1x CML 286	-0.500	-0.466	-6.451*	0.111	1.098	-817.943*	-0.235	-0.653
PC 24-1x CML 451	0.500	0.466	6.451*	-0.111	-1.098	817.943*	0.235	0.653
PC 25-1x CML 286	0.500	0.284	-4.951	2.250**	-1.119	-624.693*	-0.132	0.344
PC 25-1x CML 451	-0.500	-0.284	4.951	-2.250**	1.119	624.693*	0.132	-0.344
PC 26x CML 286	0.250	0.034	0.299	1.233	2.706*	-128.193	-0.464	0.753
PC 28x CML 286	0.250	0.284	3.549	0.464	2.006	691.807*	0.608	-1.602**
PC 28x CML 451	-0.250	-0.284	-3.549	-0.464	-2.006	-691.807*	-0.608	1.602**
PC 38x CML 286	0.250	0.284	3.674	2.225**	1.831	2612.30**	0.421	0.097
PC 71-1x CML 451	0.00	0.716	-3.549	1.881*	0.994	841.443**	-0.472	-0.378
PC 72-2x CML 451	-0.250	-0.784	-3.799	0.829	1.444	361.443	0.184	1.302*
PC 116x CML 286	0.250	0.284	-5.776*	-1.960*	2.131	-57.943	0.063	0.828
PC 116x CML 451	-0.250	-0.284	5.776*	1.960*	-2.131	57.943	-0.063	-0.828
PC 200x CML 286	-0.250	-0.466	-1.701	-1.952*	0.581	-584.693	-0.366	-0.003
PC 200x CML 451	0.250	0.466	1.701	1.952*	-0.581	584.693	0.366	0.003
PC 209x CML 451	0.250	0.216	-6.174*	-1.166	0.394	-152.057	0.537	0.548

PC 213x CML 451	0.500	0.466	-7.049**	0.968	0.194	88.193	0.552	0.559
PC 506x CML 451	0.00	-0.034	-0.674	-0.258	5.494**	1234.693**	0.274	-0.078
S.E.± (Crosses)	0.6367	0.660	2.505	1.324	1.324	305.14	0.782	0.520

**, ** significant at 0.05 and 0.01 levels of probability, respectively*

Conclusion:

Highly significant differences were observed among the parents and crosses for all the traits indicating the sufficient variation in the parents for improvement of yield and quality traits. For grain yield, lines PC 1, PC 116, PC 6-1, PC 12-2, PC 25, PC 201-1 and tester CML 451 were good general combiners with positive and significant *gca* effects and can be selected for the development of hybrids. Moreover crosses,PC 1 x CML 451,PC 25-1 x CML 451,PC 71-1 x CML 451 and PC 5 x CML 286 showed high desirable specific combining ability effects with high *per se* performance for grain yield and for popping expansion crosses PC 22 x CML 451, PC 5 x CML 286, PC 72-2 x CML 451 displayed desirable sca effects with high *per se*values. In addition to these hybrids PC 5 x CML 286 exhibited positive significant *sca*values along with high *per se* performance for both the traits, so these crosses can be exploited for future popcorn hybrid breeding programmes to achieve for the improvement for both grain yield and popping expansion.

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