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Combining ability studies in early and mid-maturity CMS based cauliflower lines

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ABSTRACT

The general and specific combining ability was studied in early and mid maturity CMS based lines through line x tester analysis involving two CMS lines in each maturity group along with 6 and 9 testers for early and mid maturity group, respectively. The combining ability analysis revealed highly significant differences among genotypes for all the characters studied. The tester 23000 in early and line 8410-22 and tester 754 of mid group showed significantly negative GCA effect for earliness to curd initiation, whereas lines 8498-2 and 8410-22 were best combiners for marketable curd weight in early and mid group, respectively. Cross combinations 8498-2 x SI-71 and 8409-309 × SL-1-2 were identified as best specific combinations for earliness amongst early and midseason CMS based lines.

Key words: Indian cauliflower, line x tester analysis, GCA, SCA, cytoplasmic male sterility.

INTRODUCTION

Cauliflower is one of the most important vegetable crops of Cole group grown extensively all over India. Despite tremendous diversity in this crop, little effort has been made to develop heat tolerant early genotypes for higher profit by the cauliflower growers. Since poor yield continue to be the major bottleneck in Indian cauliflower, therefore it is necessary that genetic resources are judiciously exploited for combining ability analysis to select desirable genotypes for hybrid breeding.

The line x tester mating design can be employed to gather information on general and specific combining ability about parents and cross combinations, respectively and also about breeding methodology to be employed. In view of this, the present investigation was carried out to study the combining ability of economic traits in early and mid maturity CMS-based lines using line x tester mating design.

MATERIALS AND METHODS

The experimental material consists of F_1 population of 12 and 18 crosses in early and mid maturity groups, respectively. In early maturity group, 8441-5 and 8498-2 as lines and Pusa Meghna, SI-7, 23000, SL-71, Pusa Deepali and 18-19 were used testers. Similarly, in mid maturity 8410-22 and 8409-309 were used as lines and Pusa Paushja, Pusa Himjyoti, 754, SL-7, HR-12-4, HR-6-5-1, Sarju Maghi, Pusa Sharad and Pusa Shukti as testers. Thirty hybrids along with their parental lines were evaluated in Randomized Block Design with three replications at the Division of Vegetable Science, IARI, New Delhi during 2007-2008. The spacing between and within rows was 60 and 45 cm, respectively. The observations were recorded for six major traits, namely days to 50% curd initiation, days to 50% curd maturity, marketable curd weight, net curd weight and curd compactness. The covariance of half sibs and full sibs were used for obtaining the estimates of general and specific combining ability effects and variances as per the procedure outlined by Kempthorne (2).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among the treatments for all the parameters studied. Further, the parents also differed significantly for most of the characters. The mean sum of square due to lines and testers were significant for all the traits. Similarly, the variance due to line × tester were significant for most of the traits. Pandey and Naik (3) also observed for the traits like leaf number, plant height, curd weight and curd size and Gangopadhyay *et al*. (1) for curd size and curd weight, and Singh *et al.* (4) for leaf number, leaf weight and leaf area in cauliflower. The GCA and SCA effects has been presented in Table 1 and 2 for early and mid groups.

For days to 50% curd initiation in CMS based early maturity group, none of the lines were significant, while in the tester genotype 23000 (-2.30) maximum negative GCA effect was observed. In mid-maturity CMS based cauliflower genotypes, line 8410-22 recorded (-0.43) negative GCA effect and the tester 754 (-4.22) recorded the maximum negative GCA

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effect followed by Pusa Himjyoti (-2.39). For days to 50% curd maturity in early maturity CMS based line, maximum negative GCA (gi) was recorded in 8441-5 (-0.89) and maximum negative GCA among testers was observed in 23000 (-2.39) followed by Pusa Deepali (-2.22). Similarly, in mid maturity CMS based line, there was no any lines for positive as well as negative GCA effect, while the maximum negative GCA (gj) of tester was recorded in genotypes 754 (-6.59) followed by HR-6-5-1 (-2.26) and maximum positive GCA effect was observed in Pusa Shukti (7.41).The negative GCA value for days to 50% curd initiation and curd maturity are desirable as this means less days taken which amounts to earliness. Early maturity is economic trait as it helps farmers getting high price for their produce in the market.

Marketable curd weight in early maturity CMS based genotypes, line 8498-2 was identified as best line with 0.138 GCA (gi) effect, while tester 18-19 identified as best tester with maximum positive GCA (gj) effect (0.07), Similarly, in mid-maturity CMS based lines, the maximum positive GCA (gi) effect

Table 1. General combining ability (GCA) effect of early and mid CMS based line x tester parents.

Parent	Days to 50% curd initiation	Days to 50% curd maturity	Marketable curd weight (kg)	Net curd weight (kg)	Curd compactness	Gross plant weight (kg)
			Early maturity lines			
8441-5	-0.36	-0.89**	-0.138**	-0.003	3.35**	-0.104**
8498-2	0.36	0.89**	0.138**	-0.003	-3.35**	0.104**
Segi	0.17	0.21	0.019	0.011	0.830	0.019
$CD_{0.05}$	0.36	0.43	0.025	0.022	1.720	0.03
			Early maturity testers			
Pusa Meghna	-0.19	0.61	0.051 *	0.058 **	0.42	0.424 **
Sl-7	1.14**	1.61**	-0.040	-0.039	-2.77	-0.190 **
23000	-2.03**	-2.39**	-0.014	0.004	-0.53	-0.083 *
Sl-71	0.81*	1.28**	-0.010	-0.011	-10.10**	-0.141 **
Pusa Deepali	-0.36	-2.22**	-0.057 *	-0.042 *	3.78*	-0.071 *
18-19	0.64*	1.11**	0.070 **	0.029	9.21**	0.062
SEgj	0.30	0.36	0.0206	0.0191	1.44	0.0333
$CD_{0.05}$	0.63	0.38	0.0427	0.0397	2.99	0.0691
			Mid maturity lines			
8410-22	-0.43**	-0.26	0.082**	0.055**	3.37	0.27
8409-309	0.43**	0.26	-0.082**	-0.055**	-3.37	-0.27
Segi	0.13	0.18	0.017	0.0144	0.72	0.05
$CD_{0.05}$	0.26	0.37	0.035	0.0293	1.46	0.10
			Mid maturity testers			
Pusa Paushja	-0.72*	-1.26**	0.34**	0.252**	4.63**	0.43**
PHJ	-2.39**	-2.09**	-0.034	-0.032	-4.41**	-0.42**
754	-4.22**	-6.59**	-0.025	0.028	-1.85	0.18
Sl-1-2	1.28**	2.41**	-0.020	0.008	1.55	-0.27*
HRM-12-4	-0.89**	-0.09	-0.14**	-0.127**	8.55**	-0.21
HR-6-5-1	-0.06	-2.26**	-0.084*	-0.090**	5.35**	-0.01
SM	-0.06	0.41	-0.025	-0.018	-8.92**	0.09
PS	2.28**	2.07**	-0.025	0.035	-7.51**	0.08
Pusa Shukti	4.78**	7.41**	0.013	-0.057	2.61	0.13
$CD_{0.05}$	0.55	0.78	0.0732	0.0621	3.08	0.23

*,** significant at 5 and 1% levels, respectively.

Table 2. Specific combining ability (SCA) effect of early and mid maturity CMS based crosses.

Parent	Days to 50% curd initiation	Days to 50% curd maturity	Marketable curd weight (kg)	Net curd weight (kg)	Curd compactness	Gross plant weight (kg)
(A) Specific combining ability of early maturity group						
8441-5 x PM	-0.47	-1.11*	-0.05	-0.06*	-5.42*	-0.23**
8441-5 x SL-7	-0.14	0.22	0.03	0.03	-2.89	0.08
8441-5 x 23000	0.69	1.89**	0.01	0.02	-6.34**	0.11 *
8441-5 x SL-71	2.19**	2.89**	0.04	0.04	3.81	0.12 *
8441-5 x PD	-0.64	-1.94**	0.11 **	0.07*	-3.16	0.20 **
8441-5 x 18-19	-1.64**	-1.94**	-0.14 **	-0.11**	13.99**	-0.28 **
8498-2 x PM	0.47	1.11 *	0.05	0.06*	5.42*	0.23 **
8498-2 x SL-7	0.14	-0.22	-0.03	-0.03	2.89	-0.08
8498-2 x 23000	-0.69	-1.89**	-0.01	-0.02	6.34**	-0.11 *
8498-2 x SL-71	-2.19**	-2.89**	-0.04	-0.04	-3.81	-0.12*
8498-2 x PD	0.64	1.94**	-0.11**	-0.07*	3.16	-0.20 **
8498-2 x 18-19	1.64**	1.94**	0.14**	0.11**	-13.99**	0.28**
SE±Sij-Sik	0.42	0.52	0.03	0.03	2.03	0.05
(B) Specific combining ability of mid maturity group						
8410-22x Pusa Paushja	0.09	-2.41**	0.134 *	0.028	6.55**	-0.06
8410-22x PHJ	-1.24**	-0.57	0.093	0.061	0.31	0.18
8410-22x 754	-1.74**	0.93	-0.066	-0.072	1.86	0.13
8410-22x Sl-1-2	3.43**	3.26**	-0.104 *	-0.059	3.91	0.57**
8410-22x HRM-12-4	0.59	2.09**	-0.082	-0.034	-3.29	-0.07
8410-22x HR-6-5-1	2.43**	3.26**	-0.041	0.020	-1.04	-0.40*
8410-22x SM	-1.57**	-3.07**	0.001	0.058	-3.69	-0.15
8410-22x PS	-1.57**	-2.07**	-0.132 *	-0.105 *	-4.09	-0.41*
8410-22x Pusa Shukti	-0.41	-1.41*	0.196 **	0.103 *	-0.53	0.21
8409-309 x Pusa Shukti	-0.09	2.41**	-0.134 *	-0.028	-6.55**	0.06
8409-309 x PHJ	1.24**	0.57	-0.093	-0.061	-0.31	-0.18
8409-309 x 754	1.74 **	-0.93	0.066	0.072	-1.86	-0.13
8409-309 x SL-1-2	-3.43**	-3.26**	0.10*	0.059	-3.90	-0.57**
8409-309 x HRM-12-4	-0.59	-2.09**	0.08	0.034	3.29	0.07
8409-309 x HR-6-5-1	-2.43**	-3.26**	0.04	-0.020	1.04	0.40*
8409-309 x SM	1.57**	3.07**	-0.001	-0.058	3.69	0.15
8409-309 x PS	1.57**	2.07**	0.13*	0.105 *	4.09	0.41*
8409-309 x Pusa Shukti	0.41	1.41*	-0.19**	-0.103 *	0.53	-0.21
SE ± Sij-Sik	0.31	0.44	0.04	0.04	1.75	0.13

*,**Significant at 5 and 1% levels, respectively.

was recorded in the line 8410-22 (0.08) and Pusa Paushja (0.34) among testers. Positive GCA values are indicative of desirability for high values of the trait. For net curd weight in early maturity CMS based lines none of the lines were significant for this trait while maximum GCA (gj) effect of tester was recorded in Pusa Meghna (0.058). Further, in mid-maturity CMS lines, the maximum GCA (gi) effect was recorded in genotypes 8410-22 (0.05). However, Pusa Paushja was noticed as best parent with maximum GCA (gj) (0.25) for this trait.

Curd compactness, line 8441-5 showed maximum positive GCA (gi) effect (3.35), while tester 18-19 was found best parental tester for curd compaction with

maximum GCA (gj) 9.21 followed by Pusa Deepali (3.78) in early maturity CMS group. In mid maturity CMS group, tester HR-12-4 was the best tester with maximum GCA (gj) effect. However, none of the lines were significant for this trait. Similarly, for gross plant weight in CMS based early maturity group, Palam Uphar was best parental line with maximum GCA (gi) (0.10) and Pusa Meghna was the best tester with highest GCA (gj) effect (0.42). Similarly, in mid group of CMS lines, 8409-309 was identified best parental line with maximum GCA (gi) effect (9.07), while SL-7 was best tester with maximum GCA (gj) effect (6.57).

For days to curd initiation in early CMS based hybrids, 2 out of 12 crosses were recorded as having significantly negative SCA, with maximum in 8498-2 × SL-71 (-2.19) followed by 8441-5 × 18-19 (-1.64). In mid CMS group, 5 out of 18 crosses exhibited significantly negative SCA for this trait and maximum negative SCA effect was recorded in 8409-309 × SL-1-2 (-3.43) followed by 8409-309 × HR-6-5-1 (-2.43) and 9410-22 × PS (-1.57). The SCA for days to 50% curd maturity in early maturity CMS based hybrids, out of 12 hybrids, 5 hybrids exhibited significantly negative SCA effects in favourable direction. The hybrid 8498-2 × SL-71 showed the maximum negative SCA effect (-2.89) followed by 8441-5 × 18-19 (-1.94). The maximum positive SCA effect was noticed in crosses 8441-5 × SL-71 (2.89) followed by 8498-2 × 18-19 (1.94). Negative SCA values for 50% days to curd initiation and maturity suggest early maturity for the combinations, which can be early maturing hybrids earning high remunerations to farmers.

In mid maturity CMS based hybrids, the hybrid 8409-309 × SL-1-2 showed maximum negative SCA effect (-3.43, -3.26) for days to 50% curd initiation and maturity followed by 8409-309 × HR-6-5-1 (-2.43, -3.26), while maximum positive sinficant SCA effect was recorded in 8410-22 × SL-1-2 (3.43, 3.26), respectively. For marketable curd weight in early maturity CMS based hybrids, 2 out of 12 hybrids showed significantly positive SCA effect. The maximum SCA effect was recorded in 8498-2 × 18-19 (0.14) followed by 8441-5 × PD (0.11). Similarly, in mid maturity CMS based hybrids, 4 out of 18 had positively significant SCA effect. The maximum SCA effect was recorded in hybrid 8410-22 × Pusa Shukti (0.196) followed by 8410-22 × Pusa Paushja (0.134) and 8409-309 × Pusa Sharad (0.130) and maximum negative SCA effect was recorded in 8409-309 × Pusa Shukti (-0.19). Positive SCA values are indicative of desirability for high values of the trait.

The net curd weight in early maturity CMS based hybrids, maximum SCA effect was recorded in 8498-2 × 18-19 (0.11) followed by 8441-5 × Pusa Deepali (0.07). Similarly, in mid maturity, maximum SCA effect was observed in 8409-309 × Pusa Sharad (0.105) followed by 8410-22 × Pusa Shukti (0.103) and maximum negative value was noticed in 8410-22 × Pusa Sharad (-0.105). For curd compactness in early CMS based hybrid, maximum SCA effect was recorded in 8441-5 × 18-19 (13.99) followed by 8498-2 × 23000 (6.34). While in mid maturity 8410-22 × Pusa Paushja was identified with maximum positive value (6.55). For gross plant weight in CMS based early maturity, 4 hybrids showed positive and significant SCA effect. The maximum value was recorded in hybrid 8418-2 × 18-19 (0.28) followed by 8441-5 × SL-71 (0.12), while negative SCA with maximum value was recorded in 8441-5 × 18-19 (-0.28). Similarly, in mid maturity, maximum significantly positive SCA was recorded in hybrid 8410-309 × Pusa Sharad (0.41) and maximum negative SCA was, however, estimated in hybrid 8409-309 × SL-1-2 (-0.57).

The magnitude of SCA variance was higher than GCA variance for all the characters studied. Thus, it may be concluded that there was preponderance of dominant gene action for all the six characters suggesting thereby heterosis breeding for improvement in early and mid season Indian cauliflower.

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