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Genetics of yield and its component traits in early cauliflower

Devaraju*, B. Varalakshmi and D.L. Savithramma*****
Division of Vegetable Crops, Indian Institute of Horticultural Research, Bangalore 560 089

ABSTRACT

Six genetical populations of early cauliflower (P_1, P_2, F_1, F_2, BC_1 and BC_2) developed by crossing different advanced breeding lines and varieties (IIHR-223, IIHR-302, IIHR-217-1-4-6-12, IIHR-73-24, IIHR-Sel-5 and First Early) were studied for estimation of gene effects for ten quantitative parameters, namely days taken for 50% curd initiation, days taken for 50% curd maturity, total plant weight, leaf number, leaf weight, stalk length, stalk weight, curd diameter, curd size, curd yield per plant. The results indicated that all the parameters studied were governed by dominant gene action and thus heterosis breeding can be employed for the improvement of these parameters in early cauliflower.

Key words: Early cauliflower, inheritance, gene action, six-generation mean analysis.

INTRODUCTION

Yield is a complex character influenced by various component characters inherited polygenically and highly subjected to environmental variations. The information regarding the nature and magnitude of gene action for quantitative characters is essential for the breeder to formulate an effective breeding programme. The present study was, therefore, conducted to generate information about genetics of yield and its component traits in early cauliflower using six generation mean analysis.

MATERIALS AND METHODS

Four early cauliflower hybrids, namely IIHR-223 × IIHR-302, IIHR-223 × IIHR-217-1-4-6-12, IIHR-217-1-4-6-12 × IIHR-73-24 and IIHR-Sel-5 × First Early were produced during *rabi* 2001. These F_1s were selfed to produce respective F_2 generations and crossed with their first and second parent to generate BC_1 and BC_2 generations respectively, during *rabi* 2002. All these six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) were tested in randomized block design with three replications at the Vegetable Farm, Indian Institute of Horticultural Research, Hessaraghatta during *kharif* 2003. In the main field a spacing of 60 cm between the rows and 45 cm between the plants was maintained, good crop was raised by following the recommended package of cultivation practices (Anon, 1). Observations were recorded on ten quantitative characters such as days taken for 50% curd initiation, days taken for 50% curd maturity, total plant weight, leaf number, leaf weight, stalk length, stalk weight, curd diameter, curd size, curd yield per plant from ten randomly selected plants in all generations, except F_2 and back crosses where 100 and 25 plants, respectively were selected. The means of each of the six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) for each cross-averaged over the replication were taken as generation means which were used for calculation of various genetic parameters. The estimates of six genetic parameters, namely m (mean), d (additive), h (dominance), i (additive × additive), j (additive × dominance), l (dominance × dominance) were calculated using the formula given by Hayman (6). The significance of these parameters was tested by t-test.

*Corresponding author
**Department of Horticulture, GKVK, University of Agricultural Sciences, Bangalore 560 065
***Department of Genetics & Plant Breeding, GKVK, University of Agricultural Sciences, Bangalore 560 065

RESULTS AND DISCUSSION

All the four crosses revealed the duplicate type of epistasis (Table 1). Significant negative dominance (h) effects were exhibited by three crosses, while one cross exhibited significant positive additive (d) effect. Negative estimates of dominant effects reveal the importance of dominant gene in expression of early curd initiation indicating the possibility of heterosis breeding for the improvement of this parameter in early cauliflower. This is in confirmation with the results of Deepa Singh and Varalakshmi (2), Deepa Singh *et al*. (3), and Varalakshmi (12). The interaction effects revealed significantly negative additive × additive (i) effects and significantly positive dominant × dominant (l) effects in all the crosses except IIHR-223 × IIHR-217-1-4-6-12.

Two crosses expressed the complementary epistasis, whereas other two revealed the duplicate type of epistasis. The additive and dominance effects were negative but non-significant in all the crosses except in

IIHR-223 × IIHR-302. However, the dominance effects were higher in magnitude than additive gene effects indicating the role of dominant genes in the expression of this parameter. The additive × dominant interaction effect (j) was significantly negative and dominant × dominant interaction (l) effect was significantly positive in the cross, IIHR-217-1-4-6-12 × IIHR-73-24. This is in confirmation with the reports of Swarup and Pal (10), Lal *et al.* (8), Dhiman *et al.* (4), and Varalakshmi (12).

All the four crosses exhibited duplicate type of epistasis. The dominant (h) and additive × additive interaction effects (i) were significant and positive in all the crosses. The dominance effects were larger than the corresponding mean and additive components in all the crosses except in IIHR-Sel-5 × First Early. This revealed major contribution of dominance gene effects towards the inheritance of total plant weight in cauliflower. This is in confirmation with the reports of Kale *et al*. (7) in cauliflower. All the crosses revealed the duplicate type of epistasis except in IIHR-223 × IIHR-217-1-4-6-12 where complementary epistasis was exhibited. The estimate of gene effects revealed significantly positive dominance (h) effect, which exceeds the additive effects indicating that the character is under the influence of non-additive gene action. This is in accordance with the results of Pal and Swarup (9), Lal *et al.* (8), Dhiman *et al.* (4), and Varalakshmi (12). The interaction component (i) was significantly positive in two crosses, but negative in one cross, whereas (l) was significant in either direction.

Duplicate epistasis was exhibited by all the crosses except in IIHR-223 × IIHR-217-1-4-6-12, which revealed complementary type of epistasis. Additive (d) effect was significant and positive in two crosses, while dominance (h) component was positive and significant in all crosses except IIHR-Sel-5 × First Early. The dominance (h) effect exceeds the additive effect in two crosses, which indicates that the character is under the influence of dominance gene action. This is in confirmation with the findings of Singh and Varalakshmi (2), Singh *et al* . (3), Swarup and Pal (10), Lal *et al.* (8), Dhiman *et al.* (4), and Varalakshmi (12). The interaction effect (i) was significant and positive in two crosses and the dominant × dominant (l) effect was significant in all the crosses in either direction.

All the crosses revealed the duplicate type of epistasis for this trait; the dominance (h) effect was significant and negative in IIHR-223 × IIHR-217-1-4-6-12 indicating the role of non-additive gene action. The additive × additive interaction effect (i) was significantly negative in IIHR-223 × IIHR-302, while dominant × dominant (l) effect was significant in all the crosses except in IIHR-223 × IIHR-217-1-4-6-12.

All the crosses revealed significantly positive dominance (h) effect, which is larger in magnitude than its corresponding additive effect (d). This indicates that dominance effect had a major contribution towards the inheritance of stalk weight in cauliflower, which is in conformity with the results of Deepa Singh and Varalakshmi (2), Deepa Singh *et al*. (3), Thakur *et al*. (11), and Varalakshmi (12). All the crosses exhibited duplicate epistasis. The estimate of interaction component 'i' was significantly positive in all the four crosses, while additive × dominance (j) was significant and positive in IIHR-223 × IIHR-302. Dominant × dominant (l) interaction effect was significant and negative in all the crosses except IIHR-217-1-4-6-12 × IIHR-73-24.

All the crosses revealed duplicate type of epistasis, except IIHR-223 × IIHR- 217-1-4-6-12 where complementary epistasis was noticed. The additive (d) effect was significant and negative in two crosses, while dominance (h) effect was significant and positive in IIHR-Sel-5 × First Early, which exceeds the corresponding additive (d) effect. It reveals the importance of dominance effect in the expression of curd diameter. Deepa Singh and Varalakshmi (2) and Deepa Singh *et al.* (3) also reported non-additive gene effect for curd diameter. The interaction component 'h' and 'i' were significant and positive, while 'j' was significant and negative in IIHR-Sel-5 × First Early.

All the crosses exhibited duplicate type of epistasis for curd size. The additive (d) effect was significant and negative in IIHR-223 × IIHR-302, while (h) dominance was significant and positive in IIHR-Sel-5 × First Early, which is larger than the corresponding additive (d) effect. This reveals that dominance gene action plays a major role in inheritance of curd size. These results are in confirmation with the findings of Gangopadhyay *et al*. (5), and Varalakshmi (12). The estimate of interaction effect 'j' was significant and negative in IIHR-Sel-5 × First Early.

All four crosses exhibited duplicate epistasis for curd yield per plant. The estimation of gene effects in all the crosses revealed significantly positive dominance effect which exceeds the corresponding additive as well as mean effects. This indicates the major contribution of dominance gene action towards the inheritance of curd yield per plant. These results are in accordance with the finding of Gangopadhyay *et al*. (5), and Varalakshmi (12). The estimation of interaction effects reveals the additive × additive (i) was significant and positive in the cross, IIHR-223 × IIHR-217-1-4-6-12. The 'dominance × dominance (l) component was significant and negative in all the crosses except in IIHR-Sel-5 × First Early.

Table 1. Estimation of gene effects based on six generation means for different quantitative traits in early cauliflower.

Character	Cross	Gene effect						Type of epistasis
		m	d	h	i	j	l	
Days taken for 50% curd initiation	C1	73.34**	1.67	-31.33**	-23.33**	1.00	21.33**	D
	C2	66.67**	1.33	-4.16	2.67	2.16	4.33	D
	C3	66.67**	2.33**	-6.17**	-4.67**	-1.16	19.00**	D
	C4	73.34**	-2.00	-15.67*	-14.66*	6.00	23.33*	D
Days taken for 50% curd maturity	C1	77.00**	1.66	-13.51	-2.02	1.50*	-20.59	C
	C2	77.00**	-2.00	-9.83	-4.00	-0.833	-0.33	C
	C3	77.00**	-1.00	-12.16	-10.00	-2.83*	16.33*	D
	C4	79.66**	-0.33	-7.50	-4.66	4.50	5.66	D
Total plant weight (g)	C1	541.04**	80.00*	826.52**	667.83**	84.59	-1291.8**	D
	C2	414.05**	261.70**	902.31**	649.84**	300.67**	-422.86*	D
	C3	545.05**	152.43**	729.82**	695.57**	97.85**	-1539.21	D
	C4	596.18	53.16	514.77**	290.94*	-39.33	-699.61*	D
Leaf No.	C1	14.65**	0.89	11.21**	9.02**	0.21	-16.79**	D
	C2	12.86**	-0.63	1.52	0.62	-0.06**	9.64**	C
	C3	13.29**	1.06	3.94	6.03**	0.88	-7.33*	D
	C4	14.68**	0.89	-1.70	-4.65*	1.01	9.89*	D
Leaf weight (g)	C1	268.61**	88.67*	493.89**	434.89**	73.61	-895.56**	D
	C2	194.80**	60.50**	118.45*	118.45*	87.33**	182.22*	C
	C3	241.11**	37.66	212.89**	212.89**	-0.41	-469.38**	D
	C4	290.43**	-3.33	37.61	37.61	13.58	-264.31*	D
Stalk length (cm)	C1	5.14**	-0.083	-0.93	-1.61*	0.033	5.15**	D
	C2	5.55**	0.033	-2.88**	-2.68	-0.058	3.73*	D
	C3	5.09**	0.033	0.46	0.83	0.12	-1.82	D
	C4	4.90**	0.11	0.52	0.88	-0.16	-2.32**	D
Stalk weight (g)	C1	107.30**	18.83	143.71**	123.61**	44.05**	-235.93**	D
	C2	90.41	1.67	115.63**	79.00**	7.79	-124.27**	D
	C3	104.65	-12.16	90.10*	80.38**	15.91	-100.95	D
	C4	126.25	-24.00	113.91*	73.66*	-29.91	-147.50*	D
Curd dia.(cm)	C1	8.80**	-1.83	1.53	1.64	-2.29**	-1.29	D
	C2	9.60**	1.67	-0.90	-0.88	-1.60**	-0.34	C
	C3	9.43**	-12.16	-1.46	-2.18*	-0.57	2.27	D
	C4	8.60**	-24.00	3.69**	2.31*	-0.59	-5.13*	D
Curd size (cm^2)	C1	48.04**	-14.90**	19.08	10.40	-16.33**	-9.50	D
	C2	50.83**	-0.96	16.51	8.93	-2.71	-21.16	D
	C3	53.80**	-0.18	-5.45	-8.92	3.44	1.95	D
	C4	47.89	-1.15	21.77*	8.98	-6.29	-19.26	D
Curd yield per plant (g)	C1	217.91**	-25.83	434.91**	374.00**	-14.41	-608.83**	D
	C2	204.05**	47.83*	485.78**	387.45**	64.83**	-483.11**	D
	C3	285.90*	-25.33	184.58**	122.38*	-24.49	-281.32*	D
	C4	264.58**	18.33	296.68**	200.99**	-49.98	-261.03	D

*Significant at 5% **Significant at 1% D = Duplicate epistasis C = Complementary epistasis

C1 = IIHR-223 × IIHR-302, C2 = IIHR-223 × IIHR-217-1-4-6-12, C3 = IIHR-217-1-4-6-12 × IIHR-73-24, C4 = IIHR-Sel-5 × First Early.

It is concluded that, all the above parameters studied in early cauliflower like, days taken for 50% curd initiation, days to 50% curd maturity, total plant weight, leaf number, leaf weight, stalk length, stalk weight, curd diameter, curd size and curd yield per plant were under the influence of non-additive gene action. Hence heterosis breeding can be employed successfully to exploit the hybrid vigour for these parameters in early cauliflower.

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