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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN EARLY MATURING CAULIFLOWER

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ABSTRACT

A field experiment was conducted at Pantnagar (Uttarakhand) during 2013-14 to study the genetic variability in thirty five diverse genotypes of early maturing cauliflower for various quantitative and qualitative characters. Analysis of variance revealed significant differences among the genotypes for all the characters except for number of leaves per plant, days to curd initiation and days to curd maturity. The genotypes, viz. Inb-21-2, PES-2, PG-6, and PG-3 were found promising in terms of desirable quantitative and qualitative traits. Inb-21-2 had maximum curd yield (308.53 q ha^{-1}) while PG-3 exhibited earliest harvestable curd maturity (114.6 days). Moderate ranges of phenotypic and genotypic coefficients of variation (PCV and GCV) were observed for characters net curd weight, marketable curd weight, curd yield per hectare, harvest index, curd index and gross plant weight. High heritability along with moderate genetic advance were observed for gross plant weight, net curd weight, marketable curd weight and curd yield. From the study it could be concluded that net curd weight, marketable curd weight, curd yield and gross plant weight are the most important traits for applying selection in early cauliflower for crop improvement.

Keywords: Early cauliflower, genetic variability, heritability and genetic advance

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most widely grown vegetable crops in many parts of the world. India is the second largest producer of cauliflower in the world after China (Anonymous, 2014). It is one of the important winter vegetables grown under varying agro-climatic conditions in India. The word cauliflower comes from Latin term caulis and floris, meaning stem or stalk and flower, respectively. It is grown for its white tender curd which has been described as a pre-floral structure. Replacement of open-pollinated cultivars with narrow genetic based F_1 hybrids has resulted in the genetic erosion of cauliflower and other cole crops. So, sincere efforts are needed to preserve the germplasm (Singh *et al.,* 2013). The development of an effective improvement programme depends upon the existence of genetic variability in the crop. The nature and magnitude of variability present in the gene pool for different characters and relationship with each other determine the success of genetic improvement of a character. Most of the important characters including marketable yield are highly influenced by environment, since they are polygenically controlled. This makes the selection process difficult. Therefore, knowledge of heritability for different component traits were essential for any crop improvement programme, because the heritable component is the consequence of genotype and is inherited from generation to generation (Wright, 1921). Genetic coefficient of variation together with heritability and genetic advance estimates give reliable indication of the amounts of the extent of improvement accepted from selection and further remarked that accepted genetic gain under particular system, which provides true practical information needed by a breeder (Atter *et al.,* 2011). Hence, an investigation was carried out for estimating genetic variability, heritability and genetic advance among various economic traits in thirty five lines of early maturing cauliflower.

MATERIALS AND METHODS

The present investigation was conducted at the Vegetable Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) during summer season of 2013-2014. Pantnagar is geographically

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situated at an altitude of 243.84 m above mean sea level and at 29^0N latitude and 79.3^0 E longitudes. This falls in the humid subtropical zone and situated in the Tarai belt in the foothills of Shivalik range of the great Himalayas. The experimental material comprised of 35 diverse genotypes of early cauliflower. The seeds of all diverse lines were sown on 15 cm raised seedbeds in nursery and the seedlings were transplanted in the main field after one month at the spacing of 50 cm × 50 cm. The experiment was laid out in randomized block design with three replications. Uniform cultural operations were followed as per the recommended package of practices. Observations were recorded on five randomly selected competitive plants per replication for each entry on quantitative *viz*., plant height, plant diameter, number of leaves per plant, leaf length, days to curd initiation, days to curd maturity, gross plant weight, marketable curd weight, net curd weight, curd diameter, curd depth, harvest index, curd index and curd yield and five qualitative characters *viz.*, curd colour, curd compactness, tolerance to diseases, tolerance to insect pests and tolerance to disorders. The data regarding above mentioned quantitative characters were averaged and subjected to analysis of variance (Panse and Sukhatme, 1984). Phenotypic and genotypic coefficients of variations were estimated according to Burton and DeVane (1953). Heritability in broad sense was calculated as per formula given by Burton and DeVane (1953) and Allard (1960). Genetic advance expressed as per cent of population mean was calculated by the method given by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The study revealed that twenty one genotypes had white coloured curd, ten genotypes creamy white curd and four yellowish curd. Seventeen genotypes had compact curd while remaining eighteen genotypes possessed loose curd. Eighteen genotypes were reported to be tolerant to major diseases; twelve moderately tolerant and remaining five genotypes were susceptible to diseases (Table 1). According to tolerance to major insect pests, eighteen genotypes were classified as tolerant, thirteen as moderately tolerant and remaining four genotypes as susceptible. Twenty one genotypes were observed with none physiological disorder, eight with more occurrence of riceyness, two with more leafyness, three others with more buttoning and one was found with both Riceyness and leafiness.

Analysis of variance showed that the differences due to genotypes were significant for all the characters studied except for number of leaves /plant, days to curd initiation and days to curd maturity, indicating adequate scope for selection of superior and diverse genotypes (data not shown). The line Inb-21-2 was found to excel others in overall performance with respect to marketable curd weight, net curd weight, curd index, harvest index and curd yield. The highest curd yield was recorded in Inb-21-2 (308.53 q ha^{-1}) followed by PES-2 (290.80 q ha^{-1}). Curd maturity in terms of days after sowing was found earliest in PG-3 (114.6) followed by DC-98-4-2 (116.6), PG-6 (117), Inb-PCF-79 (117.3) and PES-2 (117.6). On the basis of different quantitative and qualitative characters observed, the genotypes *viz.* Inb-21-2, PES-2, PG-3 and PG-6 were found promising.

The genotypes showed considerable range for most of the characters under study. The phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV) for all the traits indicating the predominant role of environment in the expression of the traits. Moderate ranges of PCV and GCV were found in net curd weight (PCV= 26.55 %, GCV= 24.99 %), marketable curd weight (PCV=22.70 %, GCV=21.34 %), curd yield (PCV=22.70 %, GCV=21.34 %), harvest index (PCV=20.59 %, GCV=20.17 %), curd index (PCV=20.17, GCV=15.04 %) and gross plant weight (PCV=16.47, GCV=15.56 %). Rest of the parameters exhibited low coefficients of variation. Moderate PCV and GCV for net curd weight and marketable curd weight have also been reported by Kanwar *et al.* (2010). Dubey *et al.* (2003) reported moderate PCV and GCV for curd index and harvest index while Sharma *et al.* (2006) observed moderate PCV and GCV for gross plant weight.

Table 1**:** Qualitative characters of different genotypes of early cauliflower

S. No.	Genotypes	Curd Colour	Curd Compactness	Tolerance to diseases	Tolerance to insect pests	Occurrence of disorders
1.	Inb-21-2	White	Compact	Tolerant	Tolerant	No
2.	Inb-23-2	White	Compact	Tolerant	Susceptible	No
3.	Inb-PCF-27	Creamy white	Loose	Susceptible	Susceptible	Riceyness
4.	Inb-PCF-65	Creamy white	Loose	Susceptible	Moderately tolerant	No
5.	Inb-PCF-79	White	Loose	Tolerant	Tolerant	Riceyness
6.	Inb-PCF-92	White	Compact	Tolerant	Tolerant	No
7.	Inb-PCF-104	White	Compact	Tolerant	Tolerant	No
8.	Inb-PCF-105	Yellowish	Loose	Tolerant	Moderately tolerant	No
9.	Inb-PCF-108	White	Compact	Tolerant	Tolerant	Riceyness and leafyness
10.	Inb-PCF-114	Creamy white	Compact	Tolerant	Tolerant	No
11.	Inb-PCF-117-1	White	Loose	Tolerant	Tolerant	Riceyness
12.	Inb-PCF-118	Creamy white	Compact	Moderately tolerant	Moderately tolerant	No
13.	Inb-PCF-120	Creamy white	Loose	Moderately tolerant	Moderately tolerant	No
14.	Inb-PCPGR-1614	White	Loose	Tolerant	Tolerant	No
15.	PCPGR-1614	Yellowish	Loose	Moderately tolerant	Moderately tolerant	No
16.	Inb-DC-94-4-3	White	Compact	Moderately tolerant	Tolerant	Buttoning
17.	Inb-DC-98-4-2	White	Loose	Moderately tolerant	Tolerant	Buttoning
18.	PCPGR-2004	Creamy white	Compact	Moderately tolerant	Tolerant	No
19.	PG-3	White	Compact	Tolerant	Tolerant	No
20.	PG-5	White	Loose	Tolerant	Tolerant	Riceyness
21.	PG-6	White	Compact	Tolerant	Tolerant	No
22.	Composite-2	White	Loose	Susceptible	Moderately tolerant	Leafyness
23.	Composite-3	White	Compact	Tolerant	Tolerant	No
24.	Composite-4	Yellowish	Loose	Moderately tolerant	Moderately tolerant	Riceyness
25.	DC-5-3	White	Compact	Moderately tolerant	Moderately tolerant	Buttoning
26.	DC-98-4-2	Creamy white	Loose	Moderately tolerant	Susceptible	No
27.	DC-98-4-3	Creamy white	Loose	Tolerant	Moderately tolerant	Riceyness
28.	DC-541-5	White	Compact	Moderately tolerant	Tolerant	No
29.	CFH-131	White	Loose	Susceptible	Moderately tolerant	Leafyness
30.	PS-1	White	Loose	Tolerant	Moderately tolerant	Riceyness
31.	PES-1	White	Compact	Tolerant	Tolerant	No
32.	PES-2	White	Loose	Moderately tolerant	Moderately tolerant	No
33.	PES-3	Yellowish	Compact	Susceptible	Susceptible	No
34.	C-1	Creamy white	Compact	Tolerant	Tolerant	No
35.	PF-2	Creamy white	Loose	Moderately tolerant	Moderately tolerant	Riceyness

A broad sense heritability estimate provides information on relative magnitude of genetic and environmental variation in germplasm pool. Estimates of broad sense heritability were high (more than 80 %) for characters *viz.,* gross plant weight (89.33 %), net curd weight (88.62 %), marketable curd weight (88.41 %) and curd yield (88.41 %). High heritability for net curd weight and marketable curd weight have also been reported by Singh *et al.* (2006) and Singh *et al.* (2013) while high heritability for gross plant weight and harvest index was noted by Dubey *et al.* (2003) and Sharma *et al.* (2006). However, moderate range of heritability was exhibited by harvest index, plant height, curd diameter, curd index, and leaf length. Highest genetic advance as per cent of mean was observed for net curd weight (48.47 %) followed by marketable curd weight (41.35 %) and curd yield (41.35 %), harvest index (32.71 %) and gross plant weight (30.31 %). Kanwar *et al.* (2010) also earlier recorded moderate range of genetic advance as per cent of mean for net curd weight and marketable curd weight while Sharma *et al.* (2006) noted moderate genetic advance as per cent of mean for harvest index and gross plant weight. However, in contrast to present findings, high

Table 2: Mean performance of various genotypes of early cauliflower for quantitative characters

Genotypes	Plant height (cm)	Leaves per plant	Leaf length (cm)	Days to curd initiation	Days to curd maturity	Gross plant weight (g)	Marketable curd weight (g)	Net curd weight (g)	Curd diameter (cm)	Curd depth (cm)	Harvest index (%)	Curd index (cm^2)	Yield (q/ha)
1.	69.80	29.7	50.4	109.3	119.3	2004.33	771.33	638.00	17.8	11.6	31.94	208.59	308.53
2.	71.20	26.6	47.9	120.3	129.3	1577.00	386.67	296.00	12.4	9.47	18.79	118.52	154.67
3.	69.00	28.7	46.7	119.6	128.6	1604.67	476.00	359.00	15.6	10.3	22.36	162.31	190.40
4.	65.67	28.6	45.6	113.3	122.6	1636.33	476.33	353.00	14.1	11.3	21.60	159.17	190.53
5.	62.53	25.4	46.1	108.6	117.3	1553.00	412.00	318.67	13.5	9.03	20.47	122.80	164.80
6.	60.07	23.6	41.9	111.3	120.6	1176.67	382.67	269.67	13.7	10.8	23.07	148.63	153.07
7.	63.80	26.4	48.8	112.0	121.3	1755.67	456.33	351.67	14.3	9.87	20.03	141.47	182.53
8.	59.93	24.8	46.5	112.3	122.0	1474.67	375.67	278.67	13.9	8.97	18.85	124.85	150.27
9.	66.20	25.8	46.8	112.3	121.3	1561.00	533.67	428.33	14.7	10.3	27.45	152.34	213.47
10.	72.73	27.6	55.9	120.0	129.6	2108.33	436.67	325.33	13.5	10.3	15.61	140.46	174.67
11.	69.80	27.0	48.0	119.3	128.6	1581.00	339.00	244.67	11.7	9.13	15.49	107.82	135.60
12.	60.47	24.8	49.8	116.6	125.3	1858.00	456.33	342.00	13.4	9.30	18.40	124.81	182.53
13.	64.20	24.4	47.8	111.6	120.3	1728.33	431.33	332.67	13.2	10.7	19.23	141.28	172.53
14.	62.87	23.7	47.3	111.3	120.0	1500.00	324.67	240.33	12.3	8.97	16.02	111.05	129.87
15.	66.27	25.5	48.5	113.0	122.3	1669.33	473.33	361.67	14.0	10.7	21.67	149.28	189.33
16.	62.60	23.9	47.8	110.0	119.0	1702.00	411.67	310.33	12.7	8.90	18.21	112.77	164.67
17.	68.40	29.0	51.1	116.0	125.3	2170.00	716.67	595.00	16.9	11.2	27.55	190.10	286.67
18.	61.07	23.4	44.4	117.0	127.0	1505.67	536.00	431.00	14.4	9.83	28.65	142.13	214.40
19.	75.20	28.6	50.4	109.0	114.6	2267.00	608.67	486.67	15.2	10.9	21.58	166.24	243.47
20.	60.80	25.4	47.6	110.6	119.3	1527.67	429.00	327.67	13.1	9.03	21.46	118.37	171.60
21.	64.00	29.9	50.4	108.6	117.0	2112.67	628.00	517.00	16.6	11.7	24.47	196.42	251.20
22.	62.60	27.6	46.9	111.3	119.3	1676.00	497.67	388.67	14.7	10.1	23.17	148.95	199.07
23.	63.67	27.2	48.8	110.3	119.0	1904.67	526.33	416.00	14.1	10.2	21.85	144.21	210.53
24.	66.87	27.5	48.2	109.6	118.0	1579.33	399.33	297.33	12.6	9.97	18.79	125.82	159.73
25.	80.27	31.4	54.3	112.0	121.3	2479.67	505.33	390.67	15.6	10.3	15.89	160.94	202.13
26.	67.53	25.8	48.3	110.6	116.6	1685.67	516.67	412.00	15.4	10.8	24.44	167.83	206.67
27.	73.87	29.5	49.6	116.0	125.0	2060.33	470.33	359.67	14.5	9.93	17.48	145.29	188.13
28.	63.13	26.0	45.6	117.0	125.3	1549.00	400.00	304.67	13.3	9.93	19.66	131.21	160.00
29.	74.27	29.6	55.8	110.0	119.6	2215.67	648.00	508.00	15.2	11.0	23.02	167.81	259.20
30.	72.80	29.1	51.6	109.6	119.0	2002.67	495.33	381.33	14.1	9.97	19.24	141.01	198.13
31.	62.67	26.9	48.7	109.3	118.0	1821.00	482.67	379.67	14.2	8.97	20.85	127.91	193.07
32.	70.40	28.0	51.4	108.6	117.6	2083.00	727.00	598.00	15.8	12.0	28.72	190.41	290.80
33.	67.93	26.0	47.8	109.6	118.3	1703.33	422.67	325.33	13.5	9.57	19.09	128.84	169.07
34.	66.87	30.6	53.0	110.6	119.3	2101.67	523.00	403.33	14.0	9.93	19.18	139.36	209.20
35.	69.87	28.4	49.9	111.3	120.0	2004.67	439.33	337.00	13.4	10.2	16.83	138.16	175.73
SEm±	1.80	1.73	1.47	2.92	3.17	55.86	21.81	19.66	0.57	0.58	1.20	11.30	8.73
CV	4.66	11.0	5.19	4.50	4.53	5.38	7.73	8.95	6.92	9.91	9.84	13.44	7.73
CD (1%)	6.74	6.47	5.49	10.9	11.8	209.36	81.76	73.69	2.13	2.18	4.52	42.34	32.71
CD (5%)	5.08	4.87	4.14	8.25	8.95	157.64	61.56	55.48	1.61	1.64	3.40	31.88	24.63
GM	66.83	27.07	48.87	112.54	121.37	1798.29	489.019	380.257	14.24	10.16	21.174	145.633	195.608

Table 3: Range, General Mean (GM) and Variability parameters for 18 quantitative characters in early cauliflower

Character	Range	GM±SEm	PCV (%)	GCV (%)	ECV (%)	Heritability (h^2)	Genetic Advance (GA)	GA as % of mean
Plant height (cm)	59.93-80.27	66.838±1.80	8.331	6.904	4.663	68.669	7.877	11.785
No. of leaves per plant	23.47-31.4	27.074±1.73	11.984	4.664	11.04	15.145	1.012	3.739
Leaf length (cm)	41.93-55.93	48.878±1.47	7.398	5.267	5.19	50.676	3.775	7.723
Days to curd initiation	108.67-120.33	112.543±2.92	4.853	1.821	4.50	14.084	1.585	1.408
Days to curd maturity	114.67-129.67	121.371±3.17	4.91	1.904	4.52	15.034	1.846	1.521
Gross plant weight (g)	1176.67-2479.67	1798.29±55.85	16.469	15.565	5.38	89.328	544.982	30.306
Marketable curd weight (g)	324.67-771.33	489.019±21.81	22.701	21.345	7.72	88.414	202.19	41.346
Net curd weight (g)	240.33-638.00	380.257±19.66	26.549	24.994	8.95	88.623	184.308	48.469
Curd diameter (cm)	11.77-17.87	14.245±0.57	10.936	8.464	6.92	59.904	1.922	13.495
Curd depth (cm)	8.90-12.03	10.162±0.58	11.718	6.246	9.91	28.41	0.697	6.858
Harvest index (%)	15.49-31.94	21.174±1.20	20.586	18.08	9.84	77.129	6.926	32.709
Curd index(cm^2)	107.82-208.59	145.633±11.30	20.175	15.049	13.44	55.641	33.676	23.124
Yield(q/ha)	129.87-308.53	195.608±8.73	22.701	21.345	7.73	88.414	80.876	41.346

heritability for days to curd maturity and number of leaves per plant was reported by Kanwar *et al.* (2010).Johnson *et al.* (1955) suggested that the estimates of heritability coupled with genetic advance provide better information rather than heritability alone. High heritability along with moderate genetic advance were observed for gross plant weight, net curd weight, marketable curd weight and curd yield. The results are in conformity with Kumar *et al.* (2011). Early group of cauliflower has wide range of variability for different economic traits. From above study it can be concluded that net curd weight, marketable curd weight, curd yield gross plant weight and harvest index are the most important traits for applying the selection in cauliflower genotypes for crop improvement programme.

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