

Original Research Article

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Assessment of Genetic Variability and Character Association for Yield and Its Contributing Components in Mid Maturing Indian Cauliflower

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ABSTRACT

Keywords

Mid maturing cauliflower, Genetic variability, Correlation, Path coefficient analysis.

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Quantifying the nature and magnitude of variation exist in Indian cauliflower lines for traits of economic importance are vital to plan effective breeding programmed. Replicated field trial was carried on a random selection of 15 genotypes of cauliflower belonging to mid group. Observations recorded on fifteen characters revealed the existence of considerable genetic variability to be exploited in breeding programmed and was reflected in broad range observed for each trait. Plant height, number of leaves per plant, leaf length, leaf width, curd angle, curd diameter, marketable curd weight, net curd weight and yield exhibited high heritability (> 60%) with high genetic advance as % of mean (> 20%) indicating the prevalence additive variance and hence direct selection may be followed for particular traits improvement. Emphasis should be given for genotypes that possessed high net curd weight which had maximum positive contribution on curd yield as per path coefficient analysis.

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most important brassica vegetable grown during winter season in India. It is a monogenomic species belonging to 'C' genome and possessed the chromosome number $n=9$ (Thamburaj and Singh, 2001). This crop has specific climatic requirement for the economic part *i.e.*, curd development in comparison with other brassicaceous vegetables. Often cauliflower gave severe negative response to unfavorable environmental conditions *viz.*, extreme temperatures and droughts that lead to economic reduction as results of pre mature curd formation (Singh *et al.*, 2014).

Exploration of the existence of genetic variability is pivotal for cauliflower crop improvement. Estimation of the existing genetic parameters serves as a basic tool for selection and hybridization since the degree of variability for a given character is pre requisite for its improvement.

Hence, considering the complexity of quantitative inheritance pattern of various characters, the present investigation was formulated with an objective of assessing and quantifying the genetic variability, heritability coupled with genetic advance over percent of mean, correlation coefficient and path

coefficient analysis for curd yield and its contributing traits.

Materials and Methods

The experimental materials for the present study consisted of 15 diverse accessions of cauliflower belonging to mid group collected from various parts of India and maintained at the Division of Vegetable Science, Indian Agricultural Research Institute (IARI), New Delhi. All these 15 genotypes were transplanted in the field during autumn-winter season of 2015-16 for comparative evaluation on various quantitative attributes. Experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were 20 plants in each plot of 6 m² area with a spacing of 50 cm distance between and 45 cm within row and standard package of practices were followed to raise a good crop.

At fully developed vegetative stage, five samples were randomly selected for each genotype except for days to maturity which was recorded on replication basis. Leaf characteristics were recorded from the second whorl from the inner side. An observation was recorded for yield and other contributing characters. Phenotypic data were recorded as per the guidelines for the conduct of test for Distinctiveness, Uniformity and Stability of cauliflower (*Brassica oleracea* var. *botrytis* L.) namely, plant height (cm), number of leaf per plant, leaf length (cm), leaf width (cm), days to 50% curd initiation, days to 50% curd maturity, curd angle (°), curd polar diameter (cm), curd equatorial diameter (cm), marketable curd weight (kg), net curd weight (kg) and curd yield (q/ha) (PPV & FRA, 2001).

The average values were used for analysis of variance on the basis of Panse and Sukhatme (1954). Components of variance were computed and classified as per Burton and De Vane (1953) and Sivasubramaniam and

Madhava (1973), respectively. Broad sense heritability was computed as per Allard (1960) and genetic advance as percent of mean were calculated by following and Johnson *et al.*, (1955). Correlation and path coefficient analysis were computed as per the formulation of Al-jibouri *et al.*, (1958) Miller *et al.*, (1958) and Dewey and Lu (1959), respectively.

Results and Discussion

The quantum of variability existing in the germplasm determined the success of breeding programmed (Kumar *et al.*, 2011). The characters studied showed significant genotypic difference indicating the existence of ample genetic variability to be exploited in breeding programmed and was reflected in broad range observed for each trait (Table 1). The variation existing between phenotype and genotype coefficient depicted higher PCV over GCV indicating the influence of environment in the manifestation of these character and hence, direct selection for the improvement of this trait is not efficient.

This finding is in concordance with Singh *et al.*, (2010), Kumar *et al.*, (2011) and Dipti and Singh (2013) in cauliflower. However, a close proximity between the PCV and GCV indicates minor environmental interference. The traits such as leaf width (cm), curd angle (°), curd polar diameter (cm), marketable curd weight (kg), net curd weight (kg), and yield (q/ha) showed high PCV and GCV (Table 2). This result is in line with the conclusion of Santhosha *et al.*, (2015) and in close harmony with Manaware *et al.*, (2017). The advancement of such characters can be brought about by subjecting the progenies to vigorous environmental condition. Characters like days to 50% of curd initiation and days to 50% of curd maturity exhibited low phenotypic and genotypic variation which is in consonance with results reported by Akshay and Singh (2015) and Sahu (2017).

Heritability estimates in broad sense alone does not give clear indication for selection of traits since significant environment interaction is noted (Johnson *et al.*, 1955). Hence, heritability values considered along with the predicted genetic gain increase the effectiveness of this parameter as a tool in selection program. In the present study, heritability was recorded high for most of the characters. Compartmenting the heritability into additive and non-additive gene action gave direction for execution of breeding programmed. High heritability coupled with high genetic advance as percent of mean (> 20%) were observed in plant height, number of leaves per plant, leaf length, curd angle and marketable curd weight which is in agreement with Sahu (2017). The finding of Santhosha *et al.*, (2015) is similar with respect to leaf

width, curd diameter, net curd weight and yield. Kumar *et al.*, (2011) and Nimkar and Korla (2011) also observed high heritability coupled with high genetic advance as percent of mean for net curd weight. High heritability with high genetic advance showed that the genotypic variance for those characters were probably due to high additive gene effect (Panse, 1957) indicating the exploitation of direct phenotypic selection. Similar to the findings of Santhosha *et al.*, (2015), traits such 50% of curd initiation and 50% of curd maturity exhibit high heritability with low genetic advance as % of mean (< 10%) which revealed the predominance of non-additive gene action in the expression of these characters; hence, heterosis breeding could be exploited.

Table.1 Range and mean value for different characters of 15 genotypes of mid maturing Indian cauliflower

Components	Plant Height (cm)	Number of Leaves per Plant	Leaf Length (cm)	Leaf Width (cm)	Curd Angle (°)	Days to 50% Curd Initiation	Days to 50% Curd Maturity	Curd Polar Diameter (cm)	Curd Equatorial Diameter (cm)	Marketable Curd Wt. (kg)	Net Curd Wt. (kg)	Yield (q/ ha)
Range	30.20 to 54.23	14.20 to 21.53	22.06 to 43.17	10.06 to 24.33	15.08 to 37.89	91.33 to 105.33	104.67 to 121.33	4.84 to 9.76	8.43 to 15.22	0.170 to 0.357	0.150 to 0.310	49.33 to 103.33
MSS	112.10**	10.66**	109.72**	37.35**	90.76**	60.81**	72.70**	5.39**	7.39**	0.007**	0.006**	624.53**
Mean	43.65	17.44	33.32	15.96	25.50	97.51	111.44	6.37	10.25	0.235	0.204	67.74
CD _{0.05}	3.45	1.40	2.70	1.28	1.93	7.86	9.00	0.48	0.79	0.021	0.019	5.10

MSS: Mean sum of squares; *, ** Significant at 5 and 1% level, respectively.

Table.2 Estimates of different genetic parameters with reference to yield and yield contributing characters in 15 mid maturing Indian cauliflower genotypes

Characters	PCV (%)	GCV (%)	Broad-sense heritability (%)	Genetic advance	Genetic Advance as% of mean
Plant Height (cm)	14.13	13.95	97.45	12.38	29.36
Number of Leaves /Plant	10.96	10.73	95.77	03.77	21.63
Leaf Length(cm)	18.25	18.10	98.36	12.32	36.99
Leaf Width (cm)	22.19	22.07	98.91	07.22	45.21
Curd Angle (°)	21.64	21.53	98.99	11.26	44.13
Days to 50% of Curd Initiation	04.99	04.42	78.66	07.88	08.08
Days to 50% of Curd Maturity	04.80	04.21	76.93	08.48	07.61
Curd Polar Diameter (cm)	21.12	21.01	99.00	02.74	43.07
Curd Equatorial Diameter (cm)	15.42	15.26	97.99	03.19	31.12
Marketable Curd Weight (kg)	20.09	19.96	98.76	00.10	40.86
Net Curd Weight (kg)	21.38	21.27	98.93	00.09	43.57
Yield (q/ ha)	21.39	21.25	98.73	29.47	43.50

Table.3 Phenotypic and genotypic correlation coefficients of different traits in mid maturing Indian cauliflower

		X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁
X ₂	P	-0.37*										
	G	-0.41**										
X ₃	P	0.90**	-0.41**									
	G	0.90**	-0.44**									
X ₄	P	0.51**	0.19 ^{NS}	0.44**								
	G	0.51**	0.17 ^{NS}	0.43*								
X ₅	P	0.21 ^{NS}	0.13 ^{NS}	0.25 ^{NS}	0.25 ^{NS}							
	G	0.20 ^{NS}	0.12 ^{NS}	0.24*	0.24 ^{NS}							
X ₆	P	0.45**	0.29 ^{NS}	0.56**	0.46**	0.48**						
	G	0.43**	0.23 ^{NS}	0.57*	0.46**	0.49*						
X ₇	P	0.37*	0.27 ^{NS}	0.52**	0.31*	0.38**	0.97**					
	G	0.34*	0.20 ^{NS}	0.53*	0.30*	0.38*	0.96**					
X ₈	P	0.45**	0.12 ^{NS}	0.44**	0.40**	0.29 ^{NS}	0.38**	0.35*				
	G	0.45**	0.11 ^{NS}	0.44**	0.39**	0.28 ^{NS}	0.38**	0.35*				
X ₉	P	0.19 ^{NS}	0.06 ^{NS}	0.18 ^{NS}	0.13 ^{NS}	-0.11 ^{NS}	0.15 ^{NS}	0.18 ^{NS}	0.79**			
	G	0.18 ^{NS}	0.03 ^{NS}	0.17 ^{NS}	0.12 ^{NS}	-0.13 ^{NS}	0.10 ^{NS}	0.13 ^{NS}	0.79*			
X ₁₀	P	0.29 ^{NS}	0.10 ^{NS}	0.27 ^{NS}	0.24 ^{NS}	-0.25 ^{NS}	0.12 ^{NS}	0.13 ^{NS}	0.71**	0.87**		
	G	0.28 ^{NS}	0.07 ^{NS}	0.26 ^{NS}	0.23 ^{NS}	-0.27 ^{NS}	0.07 ^{NS}	0.09 ^{NS}	0.71*	0.87**		
X ₁₁	P	0.33*	0.09 ^{NS}	0.29 ^{NS}	0.28 ^{NS}	-0.27 ^{NS}	0.12 ^{NS}	0.11 ^{NS}	0.68**	0.83**	0.98**	
	G	0.32*	0.07 ^{NS}	0.28 ^{NS}	0.28 ^{NS}	-0.28 ^{NS}	0.09 ^{NS}	0.07 ^{NS}	0.68*	0.83**	0.98**	
X ₁₂	P	0.32*	0.07 ^{NS}	0.28 ^{NS}	0.27 ^{NS}	-0.28 ^{NS}	0.08 ^{NS}	0.06 ^{NS}	0.67**	0.82**	0.97**	0.99**
	G	0.33*	0.07 ^{NS}	0.28 ^{NS}	0.28 ^{NS}	-0.28 ^{NS}	0.11 ^{NS}	0.09 ^{NS}	0.68*	0.83**	0.99**	0.01**

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

X₁ = Plant height (cm);

X₂ = Number of leaves per plant;

X₃ = Leaf length (cm);

X₄ = Leaf width (cm);

X₅ = Curd angle (°);

X₆ = Days to 50% of curd initiation;

X₇ = Days to 50% of curd maturity;

X₈ = Curd polar diameter (cm);

X₉ = Curd equatorial diameter (cm);

X₁₀ = Marketable curd weight (kg);

X₁₁ = Net curd weight (kg);

X₁₂ = Yield (q/ ha).

Table.4 Estimates of direct (diagonal) and indirect effect at genotypic level for different characters on curd yield in 15 mid maturing Indian cauliflowers

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁
X ₁	0.047	-0.019	0.042	0.024	0.009	0.020	0.016	0.021	0.008	0.013	0.015
X ₂	0.002	-0.005	0.002	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	-0.00	-0.000
X ₃	-0.047	0.023	-0.052	-0.023	-0.013	-0.030	-0.028	-0.023	-0.009	-0.014	-0.015
X ₄	-0.006	-0.002	-0.005	-0.011	-0.003	-0.005	-0.003	-0.004	-0.001	-0.003	-0.003
X ₅	-0.001	-0.001	-0.001	-0.001	-0.005	-0.003	-0.002	-0.002	0.001	0.001	0.001
X ₆	0.025	0.013	0.033	0.027	0.028	0.058	0.055	0.022	0.006	0.004	0.005
X ₇	-0.004	-0.002	-0.006	-0.003	-0.004	-0.011	-0.011	-0.004	-0.001	-0.001	-0.001
X ₈	-0.009	-0.002	-0.009	-0.008	-0.006	-0.008	-0.007	-0.021	-0.017	-0.015	-0.014
X ₉	0.002	0.000	0.001	0.001	-0.001	0.001	0.001	0.007	0.009	0.007	0.007
X ₁₀	0.022	0.006	0.021	0.019	-0.022	0.006	0.007	0.057	0.070	0.081	0.080
X ₁₁	0.298	0.62	0.258	0.257	-0.260	0.082	0.063	0.631	0.768	0.914	0.930

Residual effect = 0.0108

X₁ = Plant height (cm);

X₂ = Number of leaves per plant;

X₃ = Leaf length (cm);

X₄ = Leaf width (cm);

X₅ = Curd angle (°);

X₆ = Days to 50% of curd initiation;

X₇ = Days to 50% of curd maturity;

X₈ = Curd polar diameter (cm);

X₉ = Curd equatorial diameter (cm);

X₁₀ = Marketable curd weight (kg);

X₁₁ = Net curd weight (kg);

X₁₂ = Yield (q/ ha).

Correlation studies (Table 3) revealed the influence of environment on phenotypic expression regardless of the strong inherent association among these traits. In, the present investigation, a positive and significant association was recorded for the entire ancillary characters *viz.*, plant height, curd polar diameter, curd equatorial diameter, marketable curd weight and net curd weight with curd yield. Similar observation was reported by Kumar *et al.*, (2011); Singh *et al.*, (2014b) and Santhosha *et al.*, (2015). Curd polar and equatorial diameter has positive significant association with marketable curd weight and net curd weight at phenotypic and genotypic level. The result for curd equatorial diameter was in conformity with Kumar *et al.*, (2017) but contrast with the current finding for curd polar diameter. Some characters do not produce significant correlation with yield which might be due to extreme negative effects. Correlation analysis depicts the association among the traits although it does not give direct effect on the magnitude and nature towards yield. Henceforth, path coefficient analysis at genotypic level (Table 4) was estimated to partition the direct and indirect effect of the twelve morphological traits on yield for efficient weightage and effective improvement of desirable traits.

Net curd weight had maximum direct positive contribution on curd yield which is in conformity with Kumar *et al.*, (2011); Sheemar *et al.*, (2012), Nimkar (2013), Singh *et al.*, (2013) and Santhosha *et al.*, (2015). The negative direct effects were recorded for number of leaves per plant, leaf length, leaf width, curd angle, curd maturity and curd polar diameter. Similar observations were recorded by Sahu (2017) for leaf length and leaf width, Singh *et al.*, (2014b) for curd diameter, Singh *et al.*, (2006) and Sheemar *et al.*, (2012) for number of leaves per plant and for 50% of curd maturity, Kumar *et al.*, (2011) reported similar finding. These results

suggested the selection of lower values for particular traits. The value of the residual effect is low *i.e.*, 0.0108, this indicates the competency of the analysed characters in maximizing the curd yield. The present findings highlighted the existence of adequate genetic variability in the germplasm and the need to evaluate for economic traits improvement. The traits that showed positive correlation with yield and also exhibit direct or indirect effect on yield could bring improvement in yield and yield components.

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