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CHARACTER ASSOCIATION OF DIFFERENT GENOTYPES IN CAULIFLOWER (*BRASSICA OLERACEA* VAR. BOTRYTIS)

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Abstract

The present investigation was conducted during November-January, 2017 at Lovely Professional University, Phagwara, Punjab with fifteen diverse genotypes of Cauliflower (*Brassica oleracea* var. botrytis L.)". The experiment was laid out in Randomized Complete Block Design with three replications. Genetic variability was studied for different quantitative characters namely plant height, number of leaves (at 45DAT), number of leaves at harvest, curd diameter, curd depth, leaf stalk length, leaf lamina length, leaf length, leaf width, plant stalk length, days to curd maturity, days to curd initiation, marketable curd weight, gross curd weight, marketable curd weight, net curd weight, harvest index, curd index and curd yield. Data were analyzed statistically for their mean, range, genetic variability, coefficient of variation, heritability, genetic advance as percentage of mean.

Key words: Mean, heritability, genetic advance, correlation, genotypic, phenotypic

Introduction

In the world, India ranks 2nd in total production of vegetables after China, achieved good degree of sustainability in food production. But there is an urgent need of food security to fulfill the requirement of undernourished population through balanced diet. Vegetables play a vital role in balanced diet of human being as they are rich sources of nutrient and minerals like proteins, vitamins, carbohydrates, iron, potassium, calcium (micronutrients) etc.

Cauliflower (*Brassica oleracea var. botrytis*) also known as 'Phoolgobhi' belongs to family Brassicaceae, the most popular vegetable among the Cole crops. The leading cauliflower producing state are Bihar, West Bengal, Uttar Pradesh, Orissa, Assam, Haryana, Maharashtra etc. It is also commonly grown in the Nilgiri hills in the south and in the northern Himalayas. China, India, Italy, Europe and America are the major growing countries of cauliflower on large scale.

In 1822, Dr. Jemson was introduced cauliflower in India, a botanist from Royal Kew, who was the incharge of Company Bagh, Saharanpur, Uttar Pradesh (Nath *et al.,* 1994). The original introduction were Cornish cauliflower (Tropical or Indian Cauliflower) originated in England, followed by temperate types, originated in Germany and Netherland in 18th century. The tropical Indian cauliflower originated from the Cornish type of Central Kingdom, developed by natural crossing between Cornish type and other European type followed by selection by the farmers. An average temperature ranging from 5-8ºC to 25-28ºC is required throughout its lifecycle. This Crop may withstand temperature as low as -10ºC and as high as 40ºC during its vegetative growth period. These Tropical cauliflower are resistant to high temperature and high rainfall and are well adapted to early sowing and early harvest. Throughout the country it is grown from 11° N to 35° N latitude (Swarup and Chatterjee, 1972).

According to (Ameta *et al.,* 2016) genetic variability play an important role in plant improvement programmes. Exploitation of genetic potential for yield attributes delivers varieties for enhancing the productivity of a crop. In cauliflower high genetic variation exists for yield and yield contributing traits. Yield is a complex character governed by several other yield attributing characters, therefore an observation with respect to the magnitude of variability for the major quantitative traits reflects the status of variation available in hand for its effective utilization to breed improved varieties. An estimation of variability

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parameters *viz.,* GCV (genotypic coefficient of variation), PCV (phenotypic coefficient of variation), h^2 (heritability) and GA (genetic advance as per cent of mean) of the important yield contributing traits suggest the strategy to be selected for in genetic improvement of the crop.

Variability in genetic resources plays an important role in the development of improved lines and ultimately the yield improvement. Genetic variability is a variation in the performance of each individual in a population. Variability differs from genetic diversity, variability is the sum of variation occurs in a population. The variability defines that how much a particular trait response to genetic and environmental influences. In a population, genetic variability is very important to maintain the biodiversity, because in the absence of variability, it is very difficult to adapt the environmental changes by a particular population.

Vast spectrum of variability is shown by gene pool of *Brassica oleracea* var. botrytis L. because it includes different maturity groups. The gene flow within these horticultural forms is unrestricted but due to lack of knowledge of variability within different groups of cauliflower causes the breeders to face the dilemma of crop improvement with reduced variability. The first task by the breeder is to build up as large collection of germplasm as possible. The problem of narrow genetic base of this crop could be circumvented to certain degree by employing derivatives from crosses with wild species.

In order to achieve these, the present investigation was, therefore, planned with fifteen germplasm of *Brassica oleracea* var. botrytis with objective estimate the extent of genetic variability for various characters in Cauliflower.

Materials and Methods

The present investigation composed of 15 genotypes of cauliflower was carried out at Lovely Professional University, Phagwara, (Punjab) during winter season in 2017-18. The experiment comprised RCBD design with 15 treatments and 3 replications.

The field trial was conducted at Lovely Professional University, Phagwara, (Punjab) in November, 2017 to estimate genetic variability. Nursery is raised in portrays, each portrays had 99 holes, in each hole 2-3 seeds had sown. The growing media used for raising seedlings in portrays is a mixture of coco peat and perlite in a ratio of 2:1. Before sowing, the seed were treated with Captan @2g/kg of seed to protect the seed from fungal diseases. Four week old seedlings were transplanted on 7th November 2017 in a well prepared field on 15cm high ridges from ground level which are 60cm apart. Before transplanting, light irrigation was given to the field because moist soil favour the transplanting to withstand in the field. Transplanting should be done in evening hours with the spacing of 60cm × 45cm (row × plant spacing). The observations were recorded on 18 quantitative characters. Five plants of each genotype were selected randomly from each replication and tagged for recording the data/ observations of following characters; Plant height at 30 days after sowing (cm), Number of leaves at harvesting, Leaf length (cm), Leaf width (cm), lamina length (cm), plant stalk length(cm), leaf stalk length(cm), curd diameter (cm), curd depth (cm), gross plant weight(kg), net curd weight (kg), curd index, harvest index (%), days to curd maturity and curd yield (q/ha) The characters, which showed significant differences among genotypes, were further subjected to analysis of the following parameters; Variability, Heritability, Genetic advance, Genetic advance as percent of population mean.

Variability Parameters of variability were estimated as per formulae given by Burton and De Vane (1953). Phenotypic coefficient of variation (PCV)

a. Phenotypic coefficient of variation (PCV)

$$PCV\ E\%F = ü\frac{Phenotypic\ Variation\ E_V P_F}{General\ Mean\ of\ population\ EGM_F} \times 100$$

b. Genotypic Coefficient of variation (GCV)

$$GCV\ E\%F = ü\frac{Genotypic\ Variation\ E_V g_F}{General\ Mean\ of\ population\ EGM_F} \times 100$$

c. Environmental Coefficient of variation (ECV)

$$ECV\ E\%F = ü\frac{Environmental\ Variation\ E_V e_F}{General\ Mean\ of\ population\ EGM_F} \times 100$$

Where,

Ve = Me

$V_g = M\bar{r}M$

$V_p = V_g + V_e$

$GM = \frac{Grand\ Total}{r \times t}$

Estimation of Heritability Heritability in broad sense was calculated for each character as described by Johnson *et al.* (1955) as follows.

$$h_2(b) = \frac{\sigma 2gi}{\sigma 2pi}$$

$\underline{h}^2_{(b)}$ = Heritability in broad sense

σ^2_{gi} = Genotypic variance for character 'i'

σ^2_{pi} =Phenotypic variance for character 'i'

The genotypic and phenotypic variance was obtained from the expectation of mean squares of analysis of variance of RBD.

3.7.2.2 Genetic advance

The expected genetic advance under selection was calculated by the formula as given below (**Johnson *et al.*, 1955).**

$G.A._{(S)} = h^2_{(b)} \times ó_{pi} \times K$

Where,

$G.A._{(s)}$ = expected genetic advance

$h^2_{(b)}$ = heritability in broad sense

σ_{pi} = Phenotypic standard deviation of character 'i'

K = constant for which the value is given as 2.06 which is the expectation in case of 5 per cent selection intensity as given by Lush (1940).

Genetic advance as percentage of population mean

$$= \frac{Expected\,Genetic\,Adance}{General\,mean} \times 100$$

The magnitude of different parameters is categorized as follows:

PCV and GCV	> 30%	High
	15-30%	Moderate
	< 15%	Low
Heritability	> 80%	High
	50-80%	Moderate
	<50 %	Low
Genetic advance as per cent of population mean		
	>20%	High
	10-20%	Moderate
	0-10%	Low

Results and discussion

Analysis of variance indicated variability occurred for all traits (table 1). Data represented that the plant height at harvesting was ranged from 39cm (Snowball) to Jyoti (48.4cm) with an average of 42.32cm. Number of leaves at 45DAS was recorded between the ranges from 8.73 (Shipra) to 10.8 (Aghani) with an average of 9.74. Number of leaves at harvest was recorded between the ranges from 16.9 (Neha) to 18.6 (Pahuja) with an average of 17.64. Curd diameter was recorded between the ranges from 10.3cm (Sonali) to 13.4cm (Pahuja) with an average of 11.88cm. Curd depth was recorded between the ranges from 8.53cm (Poornima) to 10.03 (Pahuja) with an average of 9.40.Plant stalk length was recorded between the ranges from 1.97cm (Snowball) to 2.9cm (Infinity 77) with an average of 2.49cm. Leaf Lamina length was recorded between the ranges from 26.17cm (Omaxe) to 31.3cm (Pahuja) with an average of 28.93cm.Leaf Stalk length was recorded between the ranges from 6.67cm (Pahuja) to 8.76cm (Cauliflower F1 hybrid) with an average of 7.57cm. Leaf width was recorded between the ranges from 14.33cm (Sonali) to 17.53cm (Pahuja and Infinity 77) with an average of 16.06cm. Gross Plant weight was recorded between the ranges from 0.73 (Sonali) to 1.05 (Pahuja) with an average of 0.88kg. Marketable curd weight was recorded between the ranges from 0.36 (Sonali) to 0.63 (Pahuja) with an average of 0.48 kg. Net curd weight was recorded between the ranges from 0.28kg (Cauliflower F1 hybrid) to 0.57kg (Pahuja) with an average of 0.39kg. Leaf length was recorded between the ranges from 32.70cm (Snowball) to 39.50cm (Sonali) with an average of 36.38cm. Days to Curd Initiation was recorded between the ranges from 57.33 (Snowball) to 73.33 (Pahuja) with an average of 65.87. Days to curd maturity was recorded between the ranges from 77 (Snowball) to 99 (Pahuja) with an average of 88.18. Curd Index was recorded between the ranges from 89.29 (Poornima) to 34.45 (Pahuja) with an average of 111.9. Harvest Index was recorded the ranges from 0.34% (Tokyo) to 0.57% (infinity 77) with an average of 0.45%. Curd yield was recorded the ranges from 20.99 q/ha (Cauliflower F1 hybrid) to 41.96 q/ha (Pahuja) with an average of 29.42 q/ha. Moderate values of PCV were found in net curd weight, curd yield, marketable curd weight, harvest index, plant stalk length, curd index, gross plant weight, while the remaining parameters exhibit low PCV. Similar to the present investigation, high range of variability in cauliflower was observed in curd yield and curd Index (Jamwal1992).Moderate range of PCV for net curd weight was also reported by Sharma *et al.* (2006), Kanwar *et al.* (2010) and Kumar *et al.* (2011) and moderate range of PCV was reported by Gautam *et al.* (2005) and Kumar *et al.* (2011). Moderate PCV for marketable curd weight was also observed by Gautam *et al.* (2005), Sharma *et al.* (2006) and Kanwar *et al.* (2010). Moderate PCV for harvest index was also observed by Gautam *et al.* (2005), Sharma *et al.* (2006) and Kumar *et al.* (2011). Low genetic variability indicates narrow genetic variability. Sharma *et al.* (2006) and Kanwar *et al.* (2010) also reported moderate range of GCV for net curd weight and marketable curd weight. Moderate GCV for harvest index was earlier reported by Sharma *et al.* (2006) and Kumar *et al.* (2011). It could be therefore, suggested that for the improvement of these characters, there is a need to create variability.

Table 1: Mean, range, general mean (GM), standard error mean (SEM), phenotypic coefficient of variation (PCV %), genotypic coefficient of variation (GCV %), environmental coefficient of variation (ECV %), heritability, genetic advance and genetic advance as percent of mean

Characters	Range	GM	SEM	Coefficient of Variation (%)			Heritability h2(%)	Genetic Advance	Genetic advance as % of mean (%)
				PCV (%)	GCV (%)	ECV (%)			
Plant height at harvest (cm)	39-48.14	42.32	0.85	6.44	5.42	3.48	71	3.97	9.39
Leaves at 45DAS	8.73-10.8	9.74	0.094	6.37	6.15	1.67	93	1.19	12.23
Leaves at harvest	16.9-18.6	17.64	0.089	2.83	2.69	0.88	90	0.93	5.26
Curd Diameter (cm)	10.3-13.4	11.88	0.084	9.31	9.23	1.22	98	2.24	18.84
Curd Depth (cm)	8.53-10.03	9.41	0.095	4.48	4.12	1.75	85	0.74	7.81
Plant stalk length(cm)	1.97-2.9	2.49	0.092	13.09	11.43	6.39	76	0.51	20.55
Leaf Lamina length(cm)	26.17-31.3	28.93	0.61	6.12	4.91	3.66	64	2.35	8.12
Leaf stalk length (cm)	6.67-8.76	7.57	0.081	7.06	6.81	1.85	93	1.03	13.55
Leaf width (cm)	14.33-17.53	16.06	0.255	6.23	5.59	2.75	81	1.66	10.33
Gross Plant weight (kg)	0.73-1.05	0.88	0.011	11.13	10.91	2.19	96	0.19	22.03
Marketable Curd weight	0.36-0.63	0.48	0.0104	18.51	18.12	3.78	96	0.18	36.55
Net Curd weight	0.28-0.57	0.4	0.0108	23.27	22.79	4.73	96	0.18	45.96
Leaf length (cm)	32.70-39.50	36.38	0.477	5.63	5.15	2.27	84	3.54	9.72
Days to Curd Initiation	57.33-73.33	65.87	0.849	7.48	7.14	2.23	91	9.25	14.04
Days to Curd Maturity	77-99	88.18	0.864	7.19	6.99	1.7	94	12.33	13.98
Curd Index(cm^2)	89.29-134.45	111.9	0.766	12.68	12.63	1.19	99	28.98	25.9
Harvest Index (%)	0.34-0.57	0.45	0.008	15.44	15.14	3.06	96	0.14	30.57
Curd Yield (q/ha)	20.99-41.96	29.42	0.805	23.25	22.76	4.74	96	13.5	45.9

The studies indicated that wide range of variation was recorded in the germplasm for all the traits. For the success of plant breeder in improvement of crop plant, variability in the characters of any crop species is the raw material for a plant breeder and extent of variability present in the population with respect to various characters is the factor. There are better chances of producing desired crop variety due to presence of more variability. At phenotypic level variation is a combination of genetic as well as environmental variability, which does not help in effective selection. Hence, the decisive factors primarily rest on genotypic variability or more specifically, additive genetic variability in which a breeder is mostly interested. Statistics like range, mean, coefficient of variation, heritability and genetic advance provide basic information on the variation of a character at phenotypic and genotypic level. This also gives an indication of the influence of environment in bringing about the variation.

Heritability

Range of heritability estimates was high in curd index (99%) followed by curd diameter (98%), harvest index (96%), curd yield (96%), gross plant weight (96%), marketable curd weight (96%), net curd weight (96%), days to curd maturity (94%), number of leaves at 45 days(93%), leaf stalk length (93%), days to curd initiation (91%), number of leaves at harvest (90%), curd depth (85%), leaf length (84%), Leaf width (81%) while moderate range of heritability was observed in plant stalk length (76%), plant height (71%) followed by leaf lamina length (64%). However, in contrast to present findings, high heritability for days to curd maturity was reported by Mahajan and Gill (1997), Kanwar and Korla (2002), Gautam *et al.* (2005), Kanwar *et al.* (2010) and Kumar *et al.* (2011). Similar reports have also been put forward by Sharma *et al.* (2006), Atter *et al.* (2009), Kanwar *et al.* (2010) and Kumar *et al.* (2011) reported high heritability for net curd weight and marketable curd weight. Kumar *et al.* (2011) earlier reported high heritability for curd yield while high heritability for gross plant weight was earlier observed by Radhakrishna and Korla (1994), Khar *et al.* (1997), Dubey (2003) and Jindal and Thakur (2004). High heritability for number of leaves per plant were observed by Khar *et al.* (1997), Sharma *et al.* (2006) and Kanwar *et al.* (2010) which are in contrast to the present results.

Genetic advance as per cent of the mean

The genetic advance as per cent of mean was highest for net curd weight (45.96 %), followed by curd yield (45.9%), marketable curd weight (36.55%), harvest index (30.57%), curd index (25.9%), gross plant weight (22.03%), Plant stalk length(20.55%), curd diameter (18.84%), days to curd initiation (14.04), days to curd maturity (13.98), leaf stalk length (13.55%), number of leaves at 45days (12.23), leaf width (10.33), leaf length

(9.72%), plant height (9.39%), Leaf lamina length (8.12%), curd depth (7.81%), number of leaves at harvest (5.26%). However, in contrast to present findings, high heritability for days to curd maturity was reported to Kanwar *et al.* (2010) and Kumar *et al.* (2011) who also observed moderate genetic advance for net curd weight and marketable curd weight. Moderate genetic advance for curd yield per hectare was also earlier reported by Kumar *et al.* (2011) while moderate genetic advance for gross plant weight was observed by Gautam *et al.* (2005) and Sharma *et al.* (2006). Kanwar *et al.* (2010) reported high heritability coupled with moderate genetic advance for net curd weight while, high heritability with moderate genetic advance for marketable curd weight was reported by Singh *et al.* (2013).

The broad sense heritability (ratio of genetic variance to the phenotypic variance) is an important parameter in the breeding and genetics, because knowledge of numerical magnitude of heritability is of special importance for planning breeding programmes and for the examination of experimental result.

Conclusion

On the basis of findings, it was concluded that there was a wide range of variation among the germplasm lines for all the characters under study. The studies of variability present in different characters indicated that considerable scope existed for the improvement of Cauliflower cultivars. Out of fifteen genotypes, five genotyped viz; Pahuja (41.96), Infinity 77 (39.98), Neha (39.76), Jyoti (32.35) and IG-25(36.37) were found promising for curd yield per hectare than other genotypes.

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