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Performance of F_4 progenies developed through bud and mixed pollination in late cauliflower (B*rassica oleracea* var. *botrytis* L.): Variability study

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Abstract

The five plants in each progeny of F_3 from a cross PSB-1 x KT-9 were selected. These plants were bud and mix pollinated (BP & MP) to produce bud and mix pollinated seeds of F_3 i.e. F_4. The materials thus, developed were evaluated in compact family block design with three replications for eight horticultural and three quality traits. F_4 11-119-BP, F_4 11-111-BP, F_4 11-113-BP, F_4 5-109-BP and F_4 2-77-BP and F_4 4-92-MP, F_4 4-94-MP, F_4 11-120-MP, F_4 3-84-MP and F_4 11-112-MP possessed good yield and quality traits. PCV & GCV was high for the gross curd weight, net curd weight and harvest index. These three characters also exhibited high heritability and genetic advance as percentage of mean indicating the additive gene effects for these traits. The high heritability with low to moderate genetic advance was found for stalk length and days to harvesting.

Key words: Cauliflower, F_4, bud pollination, mixed pollination

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) has got an important place among cole crops due to its taste, flavour and nutritive value. It has been rightly described as the "Aristocrat of Cole crops" (Boswell, 1949). The crop is native of Southern Europe (Chatterjee and Swarup, 1972). Cauliflower was introduced in India from England by Britishers in 1822 (Chatterjee, 1986) and in such a short period of its introduction, it has gained a lot of importance among the breeders, farmers and consumers. It is grown for its white tender curds which are used as vegetable, soups and pickles. Cauliflower is good source of proteins, carbohydrates, minerals and vitamins (Choudhury, 1996).

The leading cauliflower growing states in the country are West Bengal, Bihar, Uttar Pradesh, Punjab, Rajasthan and Karnataka. In Himachal Pradesh, Snowball group of cauliflower contributes both in terms of off-season crop as well as seed crop. The seed production of late cauliflower is also highly remunerative and is being done on commercial scale in mid hills of Himachal Pradesh. In mid and high hills of the state, it is grown as off- season crop during summer months, which fetches a premium in the plains and brings lucrative returns to the farmers. A large number of cultivars are available in early and mid season group due to the presence of greater variability in both the groups. However, there are limited cultivars in Snowball/ late group as much variability is not available in this type.

Though snowball group provides ideal genotypes both to the farmers and consumers, yet these cultivars are very sensitive to fluctuating environmental conditions resulting sometimes in the development of undesirable traits which make the curds unfit for marketing. Thus an attempt was made in a heterotic cross PSB-1 × KT-9 of

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cauliflower and the identified/ selected F_3 were bud and mixed pollinated and the progenies developed (F_4) were evaluated for the performance of different horticultural and quality traits.

Materials and methods

The present studies were conducted at experimental farm of Department of Vegetable Crops, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. The experimental materials comprised different F_3 progenies selected from heterotic cross (PSB-1 x KT-9) of cauliflower. These F_3 progenies were identified on the basis of their performance and five plants from each progeny of F_3 were selected. These plants were bud and mix pollinated (BP and MP) to produce bud and mix pollinated seeds of F_3's i.e., F_4. The materials thus, developed were evaluated in compact family block design, whereby whole populations generated in F_4 under bud pollination and mix pollination were treated as main plot or family and randomized. The progenies developed from the selected plants were also randomly planted along with the checks in each family / main plot and considered as sub plots. These entries were replicated thrice and spaced at 60 x 45 cm. The plot size per entry comprised three rows per replication and each row had four plants. All the recommended package of practices was followed during growth period of the crop. The observations were recorded for plant frame (cm), No. of leaves per plant, No. of leaves per whorl, stalk length (cm), days to harvesting, gross curd weight (g), net curd weight (g) and harvest index (%) and quality traits viz. color, compactness and riceyness. Statistical analysis was done for all the traits except quality parameters. Coefficients of variability (phenotypic and genotypic) were calculated as per Burton and DeVane (1953), Heritability and Genetic advance as per Allard (1960) and Genetic gain was calculated as per the method suggested by Johnson et al. (1955b).

Results and Discussion

Perusal of data in Table 1 indicated that twelve progenies showed less plant frame than the mean value, of which F_4 2-71-BP, F_4 4-93-BP, F_4 1-63-BP, F_4 3-81-BP and F_4 1-67-BP were promising. Thirteen F_4's (BP) had less number of leaves per plant as well as number of leaves per whorl of which F_4 1-63-BP, F_4 2-71-BP, F_4 4-93-BP, F_4 3-81-BP, F_4 4-91-BP and F_4 4-99-BP were promising. Significantly minimum stalk length was found in F_4 11-111-BP followed by F_4 3-81-BP, F_4 1-69-BP, F_4 4-99-BP, F_4 3-87-BP and F_4 5-105-BP. Twenty F_4's (BP) gave the stalk shorter than the mean. Minimum and maximum days to harvesting were exhibited by $F_4$1-67-BP and $F_4$11-115-BP, respectively. F_4 1-67-BP, F_4 1-63-BP, F_4 1-61-BP, F_4 1-69-BP, $F_4$2-71-BP, F_4 2-79-BP and F_4 3-83-BP showed significantly early maturity whereas F_4 11-115-BP, F_4 11-117-BP, F_4 11-113-BP. F_4 11-119-BP, F_4 2-77-BP, F_4 5-103-BP and $F_4$11-111-BP were found significantly late in maturity. F_4 11-119-BP recorded highest gross curd weight followed by F_4 5-109-BP, F_4 11-113-BP, F_4 11-111-BP and F_4 1-65-BP. F_4 11-119-BP recorded highest net curd weight followed by F_4 5-107-BP, F_4 11-113-BP, F_4 2-77-BP and F_4 11-111-BP. Harvest index was maximum in F_4 2-71-BP and F_4 4-91-BP, F_4 2-79-BP, F_4 2-77-BP and F_4 3-85-BP were also promising. White colour of the curd was exhibited by majority of the characters except F_4 11-115-BP, F_4 1-67-BP. $F_4$3-83-BP, $F_4$4-95-BP and $F_4$5-103-BP. Compact curds were found in F_4 11-111-BP while the progenies viz., F_4 2-79-BP, F_4 1-65-BP, $F_4$5-101-BP, $F_4$5-107-BP and F_4 2-77-BP gave compact to semi-compact curds. Majority of the F_4's showed non ricey curds however $F_4$1-69-BP, $F_4$1-65-BP, $F_4$1-67-BP and F_4 3-87-BP gave considerable percentage of ricey curds. From the above results it may be concluded that F_4 11-119-BP, F_4 11-111-BP, F_4 11-113-BP, F_4 5-109-BP and F_4 2-77-BP which possessed good yield and quality traits were found best.

Mean performance of F_4's (MP) with respect to different traits has been given in Table 2. It is evident from the table that sixteen progenies showed less plant frame than the mean value of which F_4 1-62-MP, F_4 3-90-MP, F_4 4-100-MP, F_4 2-72-MP and F_4 5-104-MP were promising. Eighteen F_4's (MP) had less number of leaves per plant and fifteen had less number of leaves per whorl of which F_4 2-72-MP , F_4 1-62-MP, F_4 2-74-MP, and F_4 3-82-MP were promising. Minimum stalk length was found in F_4-1-62-MP and nine F_4's (MP) gave the stalk shorter than the mean. Minimum and maximum days to harvesting were exhibited by F_4 1-62-MP and F_4 11-118-MP, respectively. F_4 1-62-MP, F_4 2-80-MP, F_4 2-76-MP, F_4 5-102-MP and F_4 5-106-MP were early while F_4 11-118-MP, F_4 4-96-MP, F_4 11-116-MP, F_4 11-120-MP and F_4 4-92-MP were significantly late in maturity. F_4 4-92-MP recorded highest gross curd weight followed by F_4 11-120-MP, F_4 4-94-MP, F_4 4-96-MP and F_4 3-84-MP. F_4 4-92-MP recorded highest net curd weight followed by $F_4$11-120-MP, F_4 3-90-MP, F_4 4-94-MP and F_4 3-84-MP. Harvest index was maximum in F_4 1-70-MP followed by F_4 5-110-MP, $F_4$2-78-MP, F_4 11-112-MP and $F_4$11-120-MP, F_4 3-90-MP and F_4 1-68-MP were also promising. Nine progenies gave more than 80.00 per cent white curds where F_4 1-66-MP, F_4 3-86-MP and F_4 3-84-MP gave some per cent of creamish yellow curds. None of the progeny had completely compact curds. F_4 11-120-MP showed more number of compact curds (80.00%) followed by $F_4$4-100-MP (73.33%) and $F_4$11-116-MP (73.33%), Majority of the progenies gave semi-compact curds. Majority of the progenies showed non-ricey curds and ranged from 66.67-100.00 per cent. The curds were completely non-ricey in 10 progenies viz., F_4 2-72-MP, F_4 2-74-MP, F_4 2-76-MP, F_4 2-78-MP, F_4 2-80-MP, F_4 3-82-MP, F_4 3-86-MP, $F_4$4 - 94-MP, F_4 4-96-MP, $F_4$5-110-MP. From the above results it may be concluded that F_4 4-92-MP, F_4 4-94-MP, F_4 11-

Table 1. Mean performance of F_4 (BP) Progenies with respect to different traits

BIP (BP)	Plant frame (cm)	No. of leaves per plant	No. of leaves per whorl	Stalk length (cm)	Days to harvesting	Gross curd weight (g)	Net curd weight (g)	Harvest index (%)	Curd colour			Compactness?			Riceyness	
									Snow White	White	Creamish Yellow	Compact	Semi compact	Loose	Ricey	Non-Ricey
F_4 1-61-BP	54.94	20.64	5.16	2.95	124.45	1854.18	834.93	44.85	13.33	86.67	-	13.33	40.00	46.67	66.67	33.33
F_4 1-63-BP	52.30	18.25	4.56	2.94	123.50	1813.33	824.33	45.23	6.67	80.00	13.33	26.67	53.33	20.00	73.33	26.67
F_4 1-65-BP	54.63	20.75	5.19	3.03	128.67	2193.00	1028.67	46.71	26.67	73.33	-	6.67	66.66	26.67	53.33	46.67
F_4 1-67-BP	53.17	20.58	5.15	3.07	121.17	1695.28	847.67	49.69	6.67	46.66	46.67	-	33.33	66.67	60.00	40.00
F_4 1-69-BP	56.00	20.42	5.10	2.89	124.67	1809.33	765.67	42.36	6.67	53.33	40.00	6.67	20.00	73.33	46.67	53.33
F_4 2-71-BP	51.44	18.83	4.71	3.50	124.67	1592.22	825.00	52.74	13.33	66.67	20.00	40.00	26.67	33.33	100.00	-
F_4 2-73-BP	54.22	21.66	5.42	2.94	125.83	1969.44	902.33	45.67	-	100.00	-	26.67	33.33	40.00	93.33	6.67
F_4 2-75-BP	55.07	21.16	5.29	3.17	126.42	1920.94	871.67	45.50	20.00	53.33	26.67	46.66	26.67	26.67	100.00	-
F_4 2-77-BP	55.07	20.33	5.08	3.00	130.50	2089.47	1056.33	51.13	-	93.33	6.67	26.67	60.00	13.33	93.33	6.67
F_4 2-79-BP	54.26	20.33	5.08	3.03	124.67	1923.61	970.33	51.57	6.67	80.00	13.33	-	80.00	20.00	100.00	-
F_4 3-81-BP	52.82	19.78	4.96	2.87	125.66	1708.11	845.64	49.97	-	66.67	33.33	13.33	40.00	46.67	80.00	20.00
F_4 3-83-BP	54.37	20.56	5.17	3.00	124.67	1858.11	862.33	46.68	-	53.33	46.67	13.33	33.33	53.34	86.67	13.33
F_4 3-85-BP	56.54	20.91	5.23	2.97	125.83	1891.89	958.33	50.28	-	73.33	26.67	13.33	53.34	33.33	66.67	33.33
F_4 3-87-BP	55.72	21.08	5.27	2.97	128.08	1844.78	858.333	46.40	-	86.67	13.33	46.66	26.67	26.67	60.00	40.00
F_4 3-89-BP	54.47	20.75	5.19	2.93	126.83	2042.00	875.00	43.00	-	46.67	53.33	20.00	40.00	40.00	100.00	-
F_4 4-91-BP	55.26	20.17	5.04	3.04	127.33	1749.33	902.33	51.85	-	60.00	40.00	46.67	53.33	-	80.00	20.00
F_4 4-93-BP	51.84	19.67	4.92	3.03	129.78	1975.85	855.00	44.95	-	80.00	20.00	53.34	33.33	13.33	86.67	13.33
F_4 4-95-BP	56.17	21.35	5.34	2.97	129.18	2159.00	927.32	42.99	-	53.33	46.67	66.67	20.00	13.33	93.33	6.67
F_4 4-97-BP	55.32	20.75	5.19	3.00	127.67	1808.83	858.33	47.15	-	66.67	33.33	40.00	33.33	26.67	93.33	6.67
F_4 4-99-BP	57.70	20.08	5.52	2.90	129.83	2104.06	979.33	46.12	-	86.67	13.33	53.33	26.67	20.00	93.33	6.67
F_4 5-101-BP	54.34	20.33	5.08	3.02	130.17	2112.17	959.00	45.68	-	66.67	33.33	20.00	66.67	13.33	80.00	20.00
F_4 5-103-BP	56.32	21.08	5.27	3.09	130.50	2107.67	983.33	46.67	-	53.33	46.67	26.67	46.66	26.67	86.67	13.33
F_4 5-105-BP	54.31	20.17	5.04	2.93	129.83	2021.33	995.33	48.80	-	93.33	6.67	40.00	20.00	40.00	73.33	26.67
F_4 5-107-BP	56.53	21.39	5.38	2.98	126.77	2023.78	1093.33	46.92	-	80.00	20.00	33.33	60.00	6.67	100.00	-
F_4 5-109-BP	57.22	21.50	5.38	3.10	129.25	2329.17	990.67	42.73	-	80.00	20.00	26.67	73.33	-	100.00	-
F_4 11-111-BP	55.62	21.00	5.25	2.85	130.50	2208.11	1031.33	46.51	13.33	66.67	20.00	80.00	6.67	13.33	66.67	33.33
F_4 11-113-BP	55.57	20.68	5.17	3.29	133.42	2269.44	1066.67	47.31	13.33	53.34	33.33	60.00	20.00	20.00	80.00	20.00
F_4 11-115-BP	54.98	20.25	5.06	3.21	137.50	2073.11	918.33	44.02	-	46.67	53.33	53.34	13.33	33.33	93.33	6.67
F_4 11-117-BP	56.16	20.25	5.06	3.32	137.00	1945.33	877.33	45.45	-	60.00	40.00	66.67	33.33	-	100.00	-
F_4 11-119-BP	55.05	21.27	5.32	3.27	131.73	2440.67	1209.33	49.59	6.67	93.33	-	53.33	20.00	26.67	73.33	26.67
Mean	54.74	20.53	5.15	3.04	128.28	1695.28	925.34	46.87								
CD 0.05	NS	NS	0.15	0.095	1.38	144.96	80.24	2.07								

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Table 2. Mean performance of F_4 (MP) Progenies with respect to different traits

BIP (BP)	Plant frame (cm)	No. of leaves per plant	No. of leaves per whorl	Stalk length (cm)	Days to harvesting	Gross curd weight (g)	Net curd weight (g)	Harvest index (%)	Curd colour			Compactness?			Riceyness	
									Snow White	White	Creamish Yellow	Compact	Semi compact	Loose	Ricey	Non-Ricey
F_4 1-62-MP	51.30	20.00	5.00	2.74	127.67	1700.00	745.33	44.08	6.67	80.00	13.33	13.33	46.67	40.00	66.67	33.33
F_4 1-64-MP	53.91	21.53	5.35	3.00	130.92	2085.67	981.29	46.64	26.67	53.33	20.00	20.00	53.33	26.67	80.00	20.00
F_4 1-66-MP	54.63	21.43	5.45	3.01	136.40	1830.00	830.00	44.94	6.67	60.00	33.33	6.67	40.00	53.33	53.33	46.67
F_4 1-68-MP	55.49	21.13	5.35	3.24	133.81	2120.00	1050.00	48.78	6.67	86.66	6.67	13.33	26.67	60.00	60.00	40.00
F_4 1-70-MP	55.60	23.69	5.10	3.11	130.80	1930.00	1010.00	52.04	26.67	53.33	20.00	20.00	53.33	26.67	86.67	13.33
F_4 2-72-MP	53.25	19.91	5.02	3.09	131.72	2031.27	961.12	47.04	-	100.00	-	26.67	53.33	20.00	100.00	-
F_4 2-74-MP	54.03	20.42	5.10	3.42	133.00	2087.33	995.28	47.41	20.00	73.33	6.67	33.33	40.00	26.67	100.00	-
F_4 2-76-MP	54.78	20.59	5.23	3.18	128.42	2071.00	983.11	47.41	13.33	66.67	20.00	20.00	66.67	13.33	100.00	-
F_4 2-78-MP	55.57	20.50	5.13	3.31	134.83	2062.33	1033.11	50.07	6.67	86.66	6.67	40.00	46.67	13.33	100.00	-
F_4 2-80-MP	57.76	22.14	5.54	3.20	127.67	1867.00	891.22	48.53	13.33	73.34	13.33	13.33	46.67	40.00	100.00	-
F_4 3-82-MP	56.30	20.42	5.10	3.36	135.25	2175.00	1007.39	45.75	13.33	66.67	20.00	20.00	53.33	26.67	100.00	-
F_4 3-84-MP	54.26	21.25	5.31	3.26	132.33	2520.28	1200.00	47.51	-	73.33	26.67	26.67	40.00	33.33	93.33	6.67
F_4 3-86-MP	58.21	23.18	5.79	3.13	129.58	2110.14	987.33	47.02	6.67	60.00	33.33	20.00	60.00	20.00	100.00	-
F_4 3-88-MP	54.23	21.42	5.35	3.37	134.75	2200.00	1025.00	46.44	-	80.00	20.00	13.33	46.67	40.00	66.67	33.33
F_4 3-90-MP	53.05	20.64	5.16	3.47	132.18	2526.12	1223.76	48.44	-	93.33	6.67	53.33	13.33	33.34	80.00	20.00
F_4 4-92-MP	55.49	21.67	5.42	3.39	136.65	2633.22	1258.11	48.19	-	93.33	6.67	60.00	26.67	13.33	93.33	6.67
F_4 4-94-MP	53.96	21.08	5.27	3.63	134.25	2559.67	1206.08	46.42	-	86.67	13.33	46.67	46.66	6.67	100.00	-
F_4 4-96-MP	55.16	21.00	5.25	3.56	137.33	2554.11	1164.19	45.13	13.33	73.34	13.33	53.33	40.00	6.67	100.00	-
F_4 4-98-MP	56.44	21.73	5.43	3.23	134.82	2150.00	1012.24	47.14	6.67	80.00	13.33	40.00	60.00	-	86.67	13.33
F_4 4-100-MP	53.14	20.92	5.23	3.29	132.25	2125.00	1008.69	47.09	20.00	66.67	13.33	73.34	13.33	13.33	86.67	13.33
F_4 5-102-MP	58.99	22.95	5.75	3.08	130.33	2475.00	1095.28	44.75	-	100.00	-	26.67	66.66	6.67	80.00	20.00
F_4 5-104-MP	53.26	20.92	5.23	3.32	133.00	2146.00	1016.22	47.64	13.33	66.67	20.00	26.67	60.00	13.33	86.67	13.33
F_4 5-106-MP	56.44	21.17	5.29	3.24	130.50	2348.00	1125.00	47.73	-	80.00	20.00	40.00	53.33	6.67	93.33	6.67
F_4 5-108-MP	54.12	20.50	5.13	3.41	135.08	2137.33	1002.03	47.30	20.00	73.33	6.67	46.67	46.66	6.67	93.33	6.67
F_4 5-110-MP	55.72	20.67	5.17	3.38	136.50	1975.00	1019.56	51.84	-	93.33	6.67	26.67	73.33	-	100.00	-
F_4 11-112-MP	54.07	20.67	5.17	3.38	136.08	2157.00	1080.06	49.44	20.00	66.67	13.33	60.00	33.33	6.67	86.67	13.33
F_4 11-114-MP	53.32	21.17	5.29	3.29	136.08	2333.33	1074.19	45.85	20.00	53.33	26.67	53.33	20.00	26.67	80.00	20.00
F_4 11-116-MP	57.25	21.08	5.27	3.42	137.50	2263.00	1025.00	45.70	20.00	60.00	20.00	73.33	26.67	-	86.67	13.33
F_4 11-118-MP	56.08	20.50	5.13	2.89	137.92	2333.11	1025.00	44.57	6.67	86.66	6.67	66.66	26.67	6.67	93.33	6.67
F_4 11-120-MP	54.73	21.42	5.35	3.36	136.58	2604.06	1241.22	47.69	-	80.00	20.00	80.00	13.33	6.67	93.33	6.67
Mean	54.84	21.14	5.27	3.22	133.22	2178.59	1028.60	47.22								
$CD_{0.05}$	1.25	NS	0.15	0.12	1.28	179.69	97.70	1.90								

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Table 3. Comparison of means of F_4 (BP) and F_4 (MP) progenies

Traits	Mean		
	F_4 (BP)	F_4 (MP)	t-ratio
Plant frame (cm)	54.74	54.84	-0.165
No of leaves/plant	20.53	21.14	-1.52
No of leaves/whorl	5.15	5.27	-1.93
Stalk length (cm)	3.04	3.25	-2.1*
Days to harvesting	128.28	133.22	-5.80*
Gross curd weight (g)	1973.08	2178.59	-3.61*
Net curd weight (g)	925.34	1028.60	-3.68*
Harvest index (%)	46.87	47.22	-0.595

Table 4. Coefficients of variability (phenotypic and genotypic), heritability and genetic gain for different characters in different progenies of cauliflower

Characters		PCV (%)	GCV (%)	H (%)	Genetic advance	Genetic gain
Plant frame (cm)	1	-	-	-	-	-
	2	4.16	2.74	43.40	2.04	3.72
Number of leaves per whorl	1	4.92	2.97	36.50	0.19	3.69
	2	4.71	2.71	33.20	0.17	3.22
Stalk length (cm)	1	5.07	4.78	88.80	0.28	9.21
	2	6.31	6.13	94.50	0.40	12.34
Days to harvesting	1	3.02	2.77	83.60	6.68	5.21
	2	2.39	2.37	97.60	6.42	4.82
Gross curd weight (g)	1	10.12	9.95	96.70	397.54	20.15
	2	11.72	11.66	99.00	520.71	23.90
Net curd weight (g)	1	10.73	10.72	99.90	204.16	22.06
	2	12.18	11.99	96.80	249.88	24.29
Harvest index (%)	1	5.88	5.79	96.80	5.50	11.73
	2	4.05	3.90	93.00	3.66	7.75

1 = F_4's (BP) 2 = F_4's (MP)

120-MP, F_4 3-84-MP and F_4 11-112-MP which possessed good yield were found best.

The means of F_4 bud pollinated and F_4 mix pollinated progenies were compared with the help of t-ratio with respect to traits under study (Table 3). Significant differences in the means were noticed for days to harvesting, net curd weight, gross curd weight and stalk length. The differences were non significant for all other characters.

Estimates of the phenotypic and genotypic coefficients of variability (Table 4) were comparatively low for all the traits in (F_4) progenies. However, net curd weight (10.73, 12.18 and 10.72, 11.99%) and gross curd weight (10.12, 12.18 and 9.95, 11.99%) show maximum variability in both the progenies, respectively. The phenotypic coefficients of variability were larger in magnitude than genotypic coefficients of variability for all the traits in different families. The difference in the values of these estimates were also less in most of the characters indicating that genetic factors had played major role in the expression of these characters. Overall net curd weight followed by gross curd weight and harvest index had high coefficients of genotypic and phenotypic variability. Earlier workers like Jamwal et al. (1992) and Khar et al. (1997) had also reported high values for these characters.

Heritability and genetic advance are two complimentary parameters, the former may be used to estimate expected genetic advance through selection. The success of any selection programme depends upon the extent of heritability as well as genetic advance which usually changes for population to population and

environment to environment. Burton (1952) was of the opinion that the genetic coefficient of variation along with heritability give the best picture of the genetic advance to be expected from selection whereas, Johnson *et al.* (1955b) advocated that heritability together with genetic advance is more useful than the heritability alone in predicting the resultant effects in selecting best individuals in soyabean.

Heritability in broad sense (Table 4) was found to be high for net curd weight (99.90, 96.80%), harvest index (96.80, 93.00%), gross curd weight (96.70, 99.00%) and days to harvesting (83.60, 97.60%) in both the progenies i.e. F_4's (BP & MP), respectively. These were low for other characters indicating that these characters are controlled largely by genetic factors. Genetic advance as percentage of mean was found maximum in net curd weight (22.06, 24.29%) and gross curd weight (20.15, 23.90%) in both the progenies i.e. F_4 (BP) and F_4 (MP) respectively. It was found to be moderate for stalk length and harvest index in F_4 (BP) and low for remaining characters viz. plant frame number of leaves per whorl and days to harvesting. Similar results were also reported by Lal *et al.*, 1990, Jamwal *et al.*, 1992, Radhakrishna and Korla, 1994 and Sanjeev, 1998). In the present studies the characters like gross curd weight and net curd weight exhibited high genotypic coefficients of variability, heritability and genetic advance as percentage of mean indicating thereby that selection would be effective for the improvement of these characters as these are controlled by additive gene action (Panse, 1957, Lal *et al.*, 1990, and Radhakrishna and Korla, 1994). Whereas, high heritability with low to moderate genetic advance was found for stalk length and days to harvesting (Kanwar and Korla, 2002a & 2002b). The other characters exhibited low values of either of these estimates indicating that these are controlled by non-additive gene and selection would not be effective for bringing the improvement.

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