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Hybrid vigour in cabbage (*Brassica oleracea* var. *capitata*) under mid hill conditions of central Himalaya

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Abstract

The study involved a diallel mating design with eight parents in cabbage (*Brassica oleracea* var. *capitata)* to evaluate heterosis for desired horticultural traits under mid hill conditions of central Himalaya. The hybrid Sel-1 x Sel-36 sector (P_4 x P_5) was identified the best among all combinations having significant heterosis for biological yield, head weight, net head weight and head size index.

Key words: Cabbage, *Brassica oleracea,* hybrid vigour, heterosis, inbred, hybrid

Introduction

Cabbage is a typical cool season cole crop grown for its tender heads. In India, the yield obtained is very low as compared to other countries. Its average production is around 6.03 tonnes/ hactare. The reasons for low yields include lack of suitable cultivars and poor quality of seeds. Traditional cultivars perform poorly both in head formation and yield per unit area (Sheshadri and Chatterjii, 1983). Development of cultivars and F_1 hybrid would help to increase the production. Hybrid production is one of the commonly known methods of increasing productivity in this crop. Hybrids in cabbage are quite common in agriculturally advanced counties. However, in India no hybrid from the government research institutions is recommended for commercial cultivation. Swarup *et al.* (1963) reported hybrid vigour in cabbage but it could not get impetus in India as seed production in this crop is restricted to temperate regions due to chilling requirement. Cabbage is a temperate zone crop and hills provide conducive environment for that. It grows best in relatively cool and moist weather. Optimum temperature for growth is 18-24^{0}C during day time and 7-13^{0}C during night. It can be grown in a wide range of sandy to loamy soil. Before entering into reproductive phase, plant has to pass at 4-10^0 C temperature for 7-9 weeks. The chilling treatment is not possible in plains, so seed production can be done only in hills. There are several microclimatic patches in hill zones, so there is need to develop hybrids that are geographically adaptable. The present study was planned to develop hybrids in this crop to enhance the production potential per unit area.

Materials and methods

Eight inbred lines of cabbage namely Sel-2 (P_1), Sel-3 (P_2), Sel-4 (P_3), Sel- 1(P_4), Sel-36 Sector (P_5), Sel-6 (P_6), Sel-5 (P_7) and Sel-7 (P_8) were selected. These are the inbreds of elite lines. All possible crosses (excluding reciprocals) among inbreds were made and twenty eight F_1s alongwith their parents were planted in randomized block design with three replications on September, 2001 at Defence Agricultural Research Laboratory, Pithoragarh. Observations were recorded on five randomly selected plants for biological yield (kg), head weight (kg), net head weight (kg), head length (cm) and head width (cm). Head size index (cm^2) was calculated by multiplying head length and head width. Size of net plot was 1.80m^2. Harvesting was done when the heads were firm. To record the biological yield, whole plant was uprooted and total yield of root and shoot was recorded. For recording head weight, root portion was cut down and head with all leaves was weighed. To record net head weight, heads were trimmed and non wrapper leaves were removed. A uniform produce was obtained by proper grading for marketable or economic yield. Heterosis was calculated as the percentage of F_1 performance over mid parent value (MP) and better parent value (BP) by the formula given by Allard (1960).

Results and discussion

The range for mean performance, heterosis and the best hybrid identified on the basis of above parameters is presented in Table 1. The highest range was noticed for head size index in parents and hybrids, the range of MP and BP heterosis was high for net weight of head followed by head weight, head size index and biological yield. Best hybrid based on BP heterosis was P_4 x P_5 for all the characters.

The mean values and the percentage of heterosis manifested by the hybrids over mid parent value (MP) and better parent value

Table 1. Range, heterosis, best parents and hybrids for horticultural traits

Characters	Range		Heterosis(%)		Best parent	Best hybrids based on	
	Parents	Hybrids	BP	MP		Performance	BP heterosis
Biological yield	1.440-1.580	1.600-2.750	1.26-82.11	5.84-82.99	P_2 & P_6	P_4 x P_5	P_4 x P_5
Head weight	1.175-2.710	1.190-2.725	13.80-84.12	12.34-89.23	P_2	P_4 x p_5	P_4 x p_5
Net weight of head	0.980-1.250	1.270-2.240	1.60-85.12	2.90-101.52	P_1	P_4 x P_5	P_4 x P_5
Head size index	116.13-206.54	211.65-321.27	0.82-83.32	14.05-90.04	P_6	P_4 x P_5	P_4 x P_5

Table 2. Mean performance of parents, F_1s and percent heterosis over mid parent (MP) and better parent (BP)

Parents/ Hybrids	Biological yield/ (kg)			Head weight (kg)			Net weight of head (kg)			Head size index (cm^2)			Marketable yield/plot
	Mean	MP	BP	Mean	MP	BP	Mean	MP	BP	Mean	MP	BP	(kg)
P_1	1.54	-	-	1.50	-	-	1.25	-	-	158.64	-	-	8.00
P_2	1.58	-	-	1.52	-	-	1.14	-	-	179.64	-	-	6.50
P_3	1.55	-	-	1.50	-	-	1.25	-	-	179.84	-	-	7.50
P_4	1.51	-	-	1.48	-	-	1.21	-	-	175.25	-	-	7.00
P_5	1.44	-	-	1.40	-	-	1.12	-	-	162.85	-	-	6.72
P_6	1.58	-	-	1.51	-	-	1.20	-	-	183.87	-	-	7.35
P_7	1.54	-	-	1.49	-	-	1.22	-	-	116.13	-	-	7.55
P_8	1.48	-	-	1.43	-	-	0.98	-	-	206.54	-	-	6.00
$P_1 \times P_2$	2.74	75.85**	73.41**	2.70	78.80**	77.63**	1.90	58.55**	52.00**	292.25	72.81**	62.68**	12.32
$P_1 \times P_3$	2.37	52.77*	52.00*	2.32	54.97*	48.66*	1.51	20.43	20.00	233.25	37.82	29.69	9.95
$P_1 \times P_4$	2.31	51.01*	50.00*	2.29	53.35*	52.33*	1.50	22.11	20.00	258.25	54.70*	47.36*	9.00
$P_1 \times P_5$	2.41	61.16*	56.49*	2.37	63.44**	58.00**	1.51	27.26*	21.65*	278.27	73.11**	70.87**	10.00
$P_1 \times P_6$	2.37	51.97*	50.00*	2.34	55.14*	54.63*	1.49	21.63	19.20	271.95	58.80*	47.90*	8.94
$P_1 \times P_7$	2.18	41.39	41.55	2.11	41.42*	40.66*	1.46	18.06	16.80	254.99	85.60**	60.73**	8.00
$P_1 \times P_8$	2.09	38.11	35.71	2.01	37.20	34.00	1.31	17.44	4.80	208.25	14.05	0.82	7.86
$P_2 \times P_3$	2.26	44.12*	43.03*	2.22	46.98*	45.72*	1.52	27.25*	21.60*	276.50	53.86*	53.74*	9.00
$P_2 \times P_4$	2.16	44.10*	36.70*	2.12	41.00	39.14	1.62	37.35*	33.05*	263.00	48.24*	46.45*	10.25
$P_2 \times P_5$	2.00	32.23	26.58	1.18	-	-	1.37	21.27	20.17	250.25	46.16	39.35	8.22
$P_2 \times P_6$	2.27	44.03*	43.67*	2.23	48.50*	47.03*	1.61	38.09*	34.16*	247.53	36.21	34.62	10.00
$P_2 \times P_7$	2.07	32.41	31.01	2.00	34.04	31.57	1.26	6.38	3.27	250.40	69.36**	39.53	7.56
$P_2 \times P_8$	2.15	40.74*	36.07*	2.12	50.85	45.39	1.47	38.15*	28.94*	280.47	45.28	35.79	8.80
$P_3 \times P_4$	2.44	58.91*	57.41*	2.42	62.51**	61.53**	1.45	17.89	17.60	220.02	23.92	22.34	8.00
$P_3 \times P_5$	2.74	82.99**	76.77**	2.71	87.28**	81.27**	2.06	73.31**	64.80**	311.65	81.88**	73.29**	13.18
$P_3 \times P_6$	2.67	70.12**	68.98**	2.62	73.98**	73.17**	2.22	81.60**	77.60**	320.84	76.42**	74.49**	12.00
$P_3 \times P_7$	1.90	22.58	22.58	1.92	28.85	28.42	1.27	2.90	1.60	239.67	61.96**	33.26	7.62
$P_3 \times P_8$	1.82	19.80	17.41	1.78	81.75	19.06	1.59	42.49	27.20	249.11	28.95	20.61	9.55
$P_4 \times P_5$	2.75	85.90**	82.11**	2.73	89.23**	84.12**	2.24	92.17**	85.12**	321.27	90.04**	83.32**	13.50
$P_4 \times P_6$	1.95	26.15	23.41	1.91	27.75	26.49	1.44	19.47	19.00	248.44	38.36	35.11	8.64
$P_4 \times P_7$	1.93	26.06	25.32	1.91	28.54	28.28	1.56	28.35	27.86	257.87	77.00**	47.14*	9.50
$P_4 \times P_8$	2.66	77.63**	76.15**	2.60	78.69**	75.67**	2.21	101.52**	82.64**	310.22	62.51**	50.19*	12.88
$P_5 \times P_6$	1.60	5.84	1.26	1.56	-	-	1.38	18.91	15.00	216.94	25.14	17.98	8.25
$P_5 \times P_7$	1.67	11.77	8.44	1.62	12.34	-	1.47	25.69	20.49	263.25	88.72**	61.65**	9.15
$P_5 \times P_8$	2.03	38.50	37.16	1.19	-	-	1.43	35.55	27.67	270.80	46.62	31.11	8.50
$P_6 \times P_7$	1.88	20.21	19.98	1.83	21.82	-	1.49	23.62	22.13	245.99	64.00**	33.78	10.00
$P_6 \times P_8$	2.27	48.42*	43.67*	2.24	52.04*	48.01*	1.69	55.13*	40.83*	251.03	28.60	21.54	10.35
$P_7 \times P_8$	1.72	13.59	11.68	1.69	15.99	13.80	1.51	37.73	23.77	280.40	73.80**	35.76	9.50
CD(p=0.05)	0.44	0.39	0.35	89.23	0.35	0.32	0.30	0.29	0.28	82.94	74.91	72.85	
(p=0.01)	0.48	0.45	0.44	84.18	0.38	0.36	0.33	0.33	0.32	91.86	84.99	82.15	

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

(BP) for different characters is presented in Table 2. For biological yield, the percentage of heterosis ranged from 5.84-85.90 over mid parent value. Highest heterosis percentage was recorded in the hybrid P_4xP_5 (85.90) followed by P_3 x P_5 (82.99) and P_4 x P_8 (77.63). Over better parent value, the percentage of heterosis ranged from 1.26-82.11. The hybrid P_4 x P_5 exhibited the maximum heterosis percentage (82.11).

For head weight, the cross P_4 x P_5exhibited the maximum heterosis percentage (89.23) for mid parent value and 85.12% for better parent value. For net weight of head, the maximum heterosis over mid parent value was exhibited by the cross combination P_4 x P_8 (101.52%) followed by P_4x P_5 (92.17%) and P_3 x P_5 (73.31%). For better parent value hybrid P_4 x P_5 exhibited maximum heterosis (85.12%) followed by P_4 x P_8 (82.64%).

For head size index, the range of heterosis for mid parent value was from 14.05 - 90.04. Significant heterosis was exhibited by hybrid P_4 x P_5 (90.04%). For better parent value, the same hybrid exhibited the maximum heterosis (83.32%).

Heterosis in cabbage has been documented for yield, size of head, weight of head and uniformity. Heterosis for yield has been studied by Nieuwhof (1963). According to him, heterosis for yield was attributable to head weight. Similar finding was observed in present study also. Swarup *et al.* (1963) found over dominance in case of yield and in case of net weight of head complete dominance was observed. Net head weight involves further trimming by removing the non wrapper leaves. So marketable yield will be less than head weight yield. Similar results on hybrid vigour in cabbage were recorded by Verma *et al.* (1990).

The study revealed that cross combination P_4 x P_5, P_4 x P_8 and P_3 x P_5 may be tested for yield and other characteristics in different agroclimatic conditions for exploitation of hybrid vigour. Climate of the hills is suitable for the production of hybrid seed so farmers can easily take up the production of hybrid seed. This would help in meeting the increasing demand of F_1 hybrid seed. Further study is in progress for testing and recommendation of hybrid seed for commercial cultivation to boost the yield of cabbage in mid hill conditions.

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