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Studies on heterosis in slicing cucumber

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ABSTRACT

Fifteen F_1 hybrids obtained by crossing 6 diverse parental lines of slicing cucumber through half-diallel method was studied to investigate the extent of heterosis for yield and its attributing characters. Pusa Uday (P_5), DC-1 (P_6) and CH-20 (P_4) were observed to be the top performing parents for total yield per plant and produced yields of 1.51, 1.26 and 1.12 kg per plant, respectively. Appreciable heterosis was observed over better parents, top parents and standard parents for all the characters studied. In order of merit, $P_1 \times P_5$ (CRC-8 × Pusa Uday), $P_2 \times P_5$ (CHC-2 × Pusa Uday) and $P_3 \times P_5$ (G-338 × Pusa Uday) were observed to be the three best performing F_1 hybrids for yield per plant. The higher yield recorded by these hybrids could be due to earliness, increased number of fruits and fruit weight. The best performing F_1 hybrid $P_1 \times P_5$ which recorded 44.81% heterosis for yield over standard check (P_5, Pusa Uday) may be exploited for commercial cultivation.

Key words: Heterosis, yield components, cucumber.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is grown commercially all over India in areas extending from higher altitude to plains including river beds. Tender fruits of slicing cucumber are in great demand for salad round the year in almost every part of the world. The fruits and seeds possess cooling, astringent and antipyretic properties and the fruits are good for people suffering from constipation, jaundice and indigestion. India, being a native place of cucumber, possesses wide range of genetic variability for qualitative and quantitative characters (Munshi *et al.*, 10). Inspite of this, very little effort has been made for genetic improvement of this crop through exploitation of hybrid vigour. Among the cucurbits, cucumber is distinct where sex mechanism is unique and can be easily manipulated for production of F_1 hybrids. Further, favourable genetic system, low inbreeding depression, high heterosis percentage, large number of seeds per fruit (per pollination) and low seed rate requirement per unit area has distinct advantage in commercial exploitation of heterosis in this crop. Keeping in view the above facts, the present investigation was carried out to study heterosis through 6 x 6 half diallel for yield and its contributing characters in cucumber.

MATERIALS AND METHODS

The present investigation was carried out during 2006-07 at Research Farm of Division of Vegetable Science, IARI, New Delhi. Six promising and diverse inbreds (Table 1) with respect to yield, earliness and other desirable characters, *viz.*, CRC-8 (P_1), CHC-2 (P_2), G-338 (P_3), CH-20 (P_4), Pusa Uday (P_5) and DC-1 (P_6), were crossed in 6 × 6 half diallel fashion to obtain 15 F_1 hybrids combinations (excluding reciprocals).

Table 1. Parental lines and their source of collection.

Parent	Source
CRC-8	Saharanpur (Uttar Pradesh)
CHC-2	HARP, Ranchi (Jharkhand)
G-338	Delhi
CH-20	HARP, Ranchi (Jharkhand)
Pusa Uday	Rae Bareli (Uttar Pradesh)
DC-1	Muzaffarpur (Bihar)

Fifteen F_1 hybrids along with 6 parents were evaluated in field for heterosis under randomized block design with three replications. The crops were sown in rows of 1.5 m with 50 cm spacing between the plants. All the recommended package of practices was followed to grow a successful crop. Out of 10 plants, 8 were marked for observations excluding the border plants. Observations on individual plant basis were recorded on seven quantitative characters, *viz.* days to first pistillate flower opening, days to first fruit harvest, fruit weight (g), number of fruits per plant, fruit length (cm), fruit diameter (cm) and total yield per plant (kg). Heterosis was calculated in the favourable direction over better parents (BP), top parents (TP) and standard parents (SP, Pusa Uday) for each character.

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RESULTS AND DISCUSSION

The mean performance of the 6 parental lines together with their 15 F_1 hybrids along with their CD values is given in Table 2 and range of mean values of parents, F_1 hybrids and heterosis percentage are given in Table 3. There was significant difference among the parental lines with respect to different characters studied including total yield per plant.

The mean values of parents for days to first pistillate flower opening ranged from 52.10 (P_1) to 57.33 (P_5) and among crosses mean ranged from 47.10 ($P_1 \times P_5$) to 55.87 ($P_4 \times P_5$). Out of 15 F_1 hybrids, a total of 7, 15 and 4 crosses showed negative heterosis over better parent, standard parent and top parent (P_1), respectively. The hybrid CRC-8 × Pusa Uday exhibited maximum heterosis -9.51, -17.84 and -9.59% over better parent, standard parent and top parent, respectively. With respect to days to first fruit harvest, parental mean ranged from 60.20 (P_1) to 64.57 days (P_5). Among the crosses it ranged from 56.63 ($P_1 \times P_6$) to 63.60 days ($P_4 \times P_6$). The extent of heterosis varied from -1.92 to 7.06 over better parent, -1.50 to 12.54 over standard parent and -3.60 to 6.20 over top parent (P_1). Five F_1 hybrids showed heterosis over top parent, out of which $P_1 \times P_5$ exhibited highest significant heterosis over better parent (-7.60%), standard parent (-12.54%) and also over top parent (-6.20%). Earliness (indicated by negative estimates of heterosis) is a well recognized and prime objective of any breeding programme as it helps the grower to reap a high market price earlier. The best crosses $P_1 \times P_6$, $P_1 \times P_5$, $P_2 \times P_5$, $P_2 \times P_6$, $P_5 \times P_6$ and $P_3 \times P_5$ were found to be the most promising for earliness. In accordance with the present findings, Hormuzdi and More (5), Li and Zhu (7), Singh *et al.* (12, 13), Bairagi *et al.* (1), Prasad *et al.* (11), Munshi *et al.* (9), and Kumbhar *et al.* (6) also observed earliness in the heterotic combinations in cucumber.

The estimates of parental mean value for fruit weight ranged from 116.30 (P_2) to 159.80 g (P_6) while for F_1 hybrids it varied from 123.03 ($P_1 \times P_2$) to 187.07 g ($P_1 \times P_5$). The range of heterosis varied from 7.29 to 22.96%, 7.07 to 22.96% and 10.93 to 20.25% over better parent, standard parent and top parent, respectively. Five hybrids showed highly significant heterosis over top parent (P_6). The F_1 hybrid $P_1 \times P_5$ exhibited maximum heterosis (22.96%) over better

Table 2. Performance of parental lines and F_1 hybrids in cucumber.

Parent/ Cross	Days to first pistillate flower opening	Days to first fruit harvest	Fruit weight (g)	No. of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Total yield per plant (kg)
CRC-8 (P_1)	52.10	60.20	120.83	8.20	14.60	4.74	0.944
CHC-2 (P_2)	54.43	62.33	116.30	7.80	12.70	4.71	0.860
G-338 (P_3)	55.27	63.57	129.60	7.60	13.23	4.64	0.873
CH-20 (P_4)	56.17	63.57	142.80	7.07	14.33	4.77	1.129
Pusa Uday (P_5)	57.33	64.57	152.13	6.62	14.60	5.23	1.514
DC-1 (P_6)	56.57	62.43	159.80	5.64	16.43	4.45	1.260
$P_1 \times P_2$	52.18	63.42	123.03	8.53	13.60	4.80	1.104
$P_1 \times P_3$	52.20	59.50	139.00	9.00	16.40	5.53	0.974
$P_1 \times P_4$	50.93	57.57	159.17	7.57	14.50	5.37	1.230
$P_1 \times P_5$	47.10	56.47	187.07	10.27	19.27	6.13	2.192
$P_1 \times P_6$	47.76	56.53	192.17	9.30	18.50	5.90	1.767
$P_2 \times P_3$	54.20	62.81	142.50	7.37	15.80	4.87	1.157
$P_2 \times P_4$	52.23	60.50	157.20	8.27	14.88	5.17	1.474
$P_2 \times P_5$	50.00	57.93	185.53	9.77	19.43	6.17	2.068
$P_2 \times P_6$	50.09	58.03	187.00	9.67	21.13	5.90	1.692
$P_3 \times P_4$	54.23	63.47	144.37	8.27	16.80	5.77	1.214
$P_3 \times P_5$	51.40	59.27	177.87	8.60	16.80	6.07	1.947
$P_3 \times P_6$	53.83	61.07	164.50	7.50	15.20	5.00	1.272
$P_4 \times P_5$	55.87	63.60	162.90	7.67	16.80	5.60	1.557
$P_4 \times P_6$	57.33	63.63	169.83	7.13	17.03	5.47	1.310
$P_5 \times P_6$	55.67	61.23	185.67	7.77	18.37	5.77	1.841
CD at 5%	1.33	0.53	10.79	0.75	1.82	0.59	0.070

Table 3. Range of mean values of parents, F_1 hybrids and heterosis percentage.

Parameter	Days to first pistillate flower opening	Days to first fruit harvest	Fruit weight (g)	No. of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Total yield per plant (kg)
1. Range of mean values							
Parents	52.10 to 57.33	60.20 to 64.57	116.30 to 159.80	5.64 to 8.20	12.70 to 16.43	4.45 to 5.23	0.860 to 1.514
F_1	47.10 to 55.87	56.53 to 63.63	123.03 to 187.07	7.13 to 10.27	13.60 to 21.13	4.80 to 6.17	0.974 to 2.192
2. Range of heterosis percentage							
BP	-0.53 to -9.51	-1.92 to 7.06	7.29 to 22.96	0.84 to 25.21	11.76 to 33.11	1.26 to 25.18	-0.53 to 44.82
SP	-2.89 to -17.84	-1.50 to 12.54	7.07 to 22.96	7.70 to 55.13	12.32 to 44.70	7.07 to 17.97	2.85 to 44.81
TP	-1.34 to -9.59	-3.60 to 6.20	10.93 to 20.25	0.85 to 25.20	12.59 to 28.60	2.67 to 17.20	2.85 to 44.81
3. Number of heterotic crosses over							
BP	7	9	10	7	10	10	9
SP	15	13	9	14	10	5	6
TP	4	5	6	5	5	5	6
4. Three top parents	P_1 (52.10)	P_1 (60.20)	P_6 (159.80)	P_1 (8.20)	P_6 (16.43)	P_5 (5.23)	P_5 (15.14)
	P_2 (54.43)	P_2 (62.33)	P_5 (152.13)	P_2 (7.80)	P_5 (14.60)	P_1 (4.74)	P_6 (12.60)
	P_3 (55.27)	P_6 (62.43)	P_4 (142.80)	P_3 (7.60)	P_3 (14.33)	P_2 (4.71)	P_4 (11.28)
5. Three top F_1s with heterosis percentage							
BP	$P_1 \times P_5$ (-9.51)	$P_2 \times P_5$ (-7.60)	$P_1 \times P_5$ (22.96)	$P_2 \times P_5$ (25.21)	$P_2 \times P_5$ (33.11)	$P_2 \times P_6$ (25.18)	$P_1 \times P_5$ (44.82)
	$P_1 \times P_6$ (-8.33)	$P_2 \times P_6$ (-6.90)	$P_2 \times P_5$ (21.96)	$P_2 \times P_5$ (25.20)	$P_1 \times P_5$ (31.96)	$P_1 \times P_6$ (24.47)	$P_1 \times P_5$ (40.20)
	$P_2 \times P_5$ (-8.14)	$P_3 \times P_5$ (-6.76)	$P_1 \times P_6$ (20.25)	$P_2 \times P_6$ (23.93)	$P_2 \times P_6$ (28.60)	$P_2 \times P_5$ (17.83)	$P_2 \times P_5$ (36.60)
SP	$P_1 \times P_5$ (-17.84)	$P_1 \times P_5$ (-12.54)	$P_1 \times P_6$ (26.31)	$P_2 \times P_5$ (55.13)	$P_2 \times P_6$ (44.70)	$P_2 \times P_5$ (17.97)	$P_1 \times P_5$ (44.81)
	$P_1 \times P_6$ (-16.69)	$P_1 \times P_6$ (-12.45)	$P_1 \times P_5$ (22.96)	$P_2 \times P_5$ (47.58)	$P_2 \times P_5$ (33.08)	$P_1 \times P_5$ (17.20)	$P_2 \times P_5$ (36.60)
	$P_2 \times P_5$ (-12.78)	$P_2 \times P_5$ (-10.28)	$P_2 \times P_6$ (22.92)	$P_2 \times P_6$ (46.07)	$P_1 \times P_5$ (31.9)	$P_2 \times P_6$ (12.82)	$P_3 \times P_5$ (28.61)
TP	$P_1 \times P_5$ (-9.59)	$P_1 \times P_5$ (-6.20)	$P_1 \times P_6$ (20.25)	$P_1 \times P_5$ (25.20)	$P_2 \times P_6$ (28.6)	$P_2 \times P_5$ (17.97)	$P_1 \times P_5$ (44.81)
	$P_1 \times P_6$ (-8.33)	$P_1 \times P_6$ (-6.09)	$P_2 \times P_5$ (17.06)	$P_2 \times P_5$ (19.14)	$P_2 \times P_5$ (18.25)	$P_1 \times P_5$ (17.20)	$P_2 \times P_5$ (36.60)
	$P_2 \times P_5$ (-4.03)	$P_2 \times P_5$ (-3.77)	$P_5 \times P_6$ (16.18)	$P_2 \times P_6$ (17.92)	$P_1 \times P_5$ (17.28)	$P_3 \times P_5$ (16.06)	$P_3 \times P_5$ (28.60)
6. Best F_1 hybrid	$P_1 \times P_5$	$P_1 \times P_5$	$P_1 \times P_5$	$P_1 \times P_5$	$P_2 \times P_6$	$P_2 \times P_5$	$P_1 \times P_5$

parent while F_1 hybrid $P_1 \times P_6$ showed maximum heterosis over standard parent (26.31%) and top parent (20.25%). A perusal of average data for number of fruits per plant revealed that the parental mean varied from 5.64 (P_6) to 8.20 (P_1), whereas in crosses it ranged from 7.13 ($P_4 \times P_6$) to 10.27 ($P_1 \times P_5$). The extent of heterosis varied from 0.84 to 25.21% over better parent, 7.70 to 55.13% over standard parent and 0.85 to 25.20% over top parent. The highly significant heterosis was noted in 5, 9 and 3 hybrids over better parent, standard parent and top parent (P_1), respectively. The F_1 hybrid $P_1 \times P_5$ showed maximum heterosis over standard parent (55.13%) and over top parent (25.20%). The mean value for fruit length of parental genotypes varied from 12.70 cm (P_2) to 16.43 cm (P_6) and for F_1 hybrids it ranged from 13.60 cm ($P_1 \times P_2$) to 21.13 cm ($P_2 \times P_6$). Heterosis ranged from 11.76 to 33.11% over better parent, 12.32 to 44.70% over standard parent and 12.59 to 28.60% over top parent (P_6). Five crosses were possessing significant heterosis over top parent. Cross $P_2 \times P_5$ showed maximum heterosis over better parent (33.11%) and $P_2 \times P_6$ exhibited maximum heterosis over standard parent (44.70%) and over top parent (28.60%). The results for fruit diameter of parental mean ranged from 4.45 cm (P_6) to 5.23 cm (P_5) and mean of the crosses varied from 4.80 cm ($P_1 \times P_2$) to 6.17 cm ($P_2 \times P_5$). Range of heterosis was estimated from 1.26 to 25.18% over better parent, 7.07 to 17.97% over standard parent and 2.67 to 17.20% over top parent (P_5). Five crosses were significantly superior to the top parent. The F_1 hybrid $P_2 \times P_5$ showed maximum heterosis (17.97%) over standard as well as top parent. The mean value for total yield per plant of parents ranged from 0.860 kg (P_2) to 1.514 kg (P_5), whereas for crosses it ranged from 0.974 kg ($P_1 \times P_3$) to 2.192 kg ($P_1 \times P_5$). The extent of heterosis for this foremost trait ranged from 0.53 to 44.82 over better parent, 2.85 to 44.81% over standard as well as top parent (P_5). The six crosses performed better than standard or top parent. The maximum heterosis estimate over better parent was recorded in crosses like $P_1 \times P_5$ (44.82%), followed by $P_1 \times P_6$ (40.20%) and $P_2 \times P_5$ (36.60%). Based on the result on standard or top parent heterosis, it was evident that cross $P_1 \times P_5$ exhibited maximum heterosis (44.81%) followed by $P_2 \times P_5$ (36.60%) and $P_3 \times P_5$ (28.60%). In present investigation, characters like fruit weight, number, length and diameter were studied and the best F_1 crosses for these characters were $P_1 \times P_6$, $P_1 \times P_5$, $P_1 \times P_6$ and $P_2 \times P_5$, respectively. Hayes and Jones (4) reported the first generation crosses in cucumber frequently exhibit high parent heterosis due to increased fruit size and fruit number per plant. Heterotic effect for these fruit characters in cucumber were also reported by Bairagi *et al.* (2), Lower *et al.* (8), Frederick and Staub (3), Vijayakumari *et al.* (14, 15), Singh *et al.* (13), Prasad *et al.* (11), Munshi *et al.* (9), and Kumbhar *et al.* (6).

The crosses $P_1 \times P_5$, $P_1 \times P_6$, $P_2 \times P_5$ and $P_2 \times P_6$ were found to be best heterotic combinations as they exhibited significant heterosis percentage for yield per plant over the standard check parent. The high yielding F_1 hybrid P_1 x P_5 (CRC-8 x Pusa Uday) was earliest in maturity and showed 44.81% heterosis for yield over standard check Pusa Uday may be recommended for commercial exploitation.

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