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Short communication

Estimates of heterosis for yield and its contributing traits in cucumber

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ABSTRACT

Heterosis was studied for yield and its component traits in eight parental lines and 28 F_1 hybrids obtained from 8 × 8 half diallel cross excluding reciprocals in randomized block design (RBD) with three replication. P_4 (Pusa Uday), P_6 (DC-1) and P_5 (Punjab Naveen) were observed to be three best performing parents for total yield per plant. Appreciable heterosis was recorded over standard check (Pusa Uday) for all the traits studied except for fruit width. Three best performing hybrids were Pusa Uday × DC-1 followed by Pusa Uday × Kalyanpur Green and Pusa Uday × Punjab Naveen which showed significant heterosis of 86, 62.9 and 56.11%, respectively over standard parent for yield and other desirable traits and these hybrid combinations may be exploited for commercial cultivation.

Key words: *Cucumis sativus*, earliness, hybrid.

Cucumber (*Cucumis sativus* L.) is an important fruit vegetable crop of the tropical and subtropical regions of the world, grown in plains and river beds. It is grown throughout the country for its high nutritive value and medicinal properties. Among the cucurbits, cucumber has a unique sex mechanism and this feature can be easily manipulated for the production of F_1 hybrid (Airina *et al.*, 1). Heterosis breeding is one of the most efficient tools to exploit the genetic diversity in cucumber (Singh *et al.*, 6). It has been utilized in cucurbits to exploit dominance variance through the production of hybrids. The extent of heterosis over economic parent is a prerequisite for commercial exploitation of hybrid vigour in cucumber (Singh *et al.*, 7). F_1 hybrids in cucumber have several well known advantages over open pollinated varieties as in many vegetable crops and hence, provide a scope for the breeder to find out more appropriate combination to develop superior hybrids. Keeping in view the above facts, the present investigation was carried out to obtain information for assessment of heterosis for yield and yield attributing traits.

The experiment was carried out at the main experimental farm of the Division of Vegetable Science, ICAR-IARI, New Delhi. Eight genetically diverse parental lines P_1 (DC-77), P_2 (DC-70), P_3 (DC-83), P_4 (Pusa Uday), P_5 (Punjab Naveen), P_6 (DC-1), P_7 (Swarna Ageti) and P_8 (Kalyanpur Green) were used to develop twenty eight F_1 hybrids following 8 × 8 half diallel mating system. The 28 F_1 hybrids along with eight parents were evaluated in a randomized block design with three replications. Five to six seeds were sown on the side of the channel in a well prepared hill, with a spacing of 1.5 m between channels and 60 cm between hills. Standard and uniform agronomic practices recommended under irrigated conditions were followed throughout the growing season to raise a healthy crop. Five plants were randomly selected for taking observations after discarding the border plants at both the ends. Data were recorded on days to first female flower anthesis, days to first fruit set, days to first fruit harvest, number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g) and total yield per plant (g). Heterosis for each cross was calculated as percentage deviation of F_1 mean over the better parent and standard check for all the traits and their significance was tested by *t*-test. Pusa Uday was used as standard check.

The analysis of variance showed highly significant differences among the genotypes studied. The percent heterosis over better and standard check and the range of mean values for different traits of parents, F_1 hybrids and heterosis (over better and standard parent) are presented in Table 1 and Table 2, respectively. The result indicated that there was wide variation in magnitude and direction of heterosis for all the characters. Similar findings were reported by Kumar *et al.* (3). Among all the parents, parent P_6 (DC-1) took minimum days to first female flower opening (49.05), days to first fruit set (52.05), days to fruit harvest (57.05) and had maximum fruit diameter (3.83 cm). P_8 (Kalyanpur Green) recorded maximum fruit length (16.88 cm) and average fruit weight (251.98 cm). Highest number of fruits per plant (7.10)

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and total yield per plant (1473.33 g) was recorded in P_4 (Pusa Uday).

The F_1 hybrids had higher range of mean values than that of parents for all the characters studied except days to first female flower opening and days to first fruit set and days to first fruit harvest. Our results are in conformity with Shailaja *et al.* (5). The present study revealed appreciable amount of heterosis in positive and negative directions for all the characters except for fruit diameter which did not show any heterosis over better parent and standard check. Heterosis in negative direction is desirable for characters like days to first female flower opening, days to first fruit set and days to first fruit harvest. Earliness (indicated by negative estimates of heterosis) is an important objective of any breeding programme as it helps the grower to fetch higher market price earlier. The crosses Pusa Uday × DC-1 ($P_4 \times P_6$), were found to be the most promising for earliness (-6.22 and -19.35% over better parent and standard check, respectively). Similar findings were reported by Singh *et al.* (7) in cucumber. Out of 28 F_1 hybrids, the heterotic effects over their respective better and standard parent were observed in 13 and 9 hybrids for fruit length. Maximum fruit length was observed in the

Table 1. Heterosis percentage over better parent and standard check for eight quantitative characters.

Cross	Days to first female flower opening		Days to first fruit set		Days to first fruit harvest		Fruit length (cm)	
	BPH	SPH	BPH	SPH	BPH	SPH	BPH	SPH
1 × 2	-1.75*	-0.07	-2.88**	-1.38	-3.09**	-1.51	-3.33	-0.85
1 × 3	3.50**	1.68*	2.47**	0.87	2.68**	0.93	-4.47	-7.91
1 × 4	-1.82*	-1.82*	-2.61**	-2.61**	-2.84**	-2.84**	-1.99	-1.96
1 × 5	-1.96*	-8.84**	-3.13**	-9.04**	-3.31**	-9.75**	-7.27	-7.41
1 × 6	1.94	-12.34**	0.47	-11.86**	0.55	-12.84**	-2.31	3.60
1 × 7	-2.55**	-10.59**	-2.84**	-9.89**	-3.14**	-10.73**	-17.56**	-3.22
1 × 8	1.66	-1.82*	1.25	-1.81*	1.31	-1.99*	-12.04**	11.99*
2 × 3	-1.85*	-3.58**	-2.11**	-3.63**	-2.32**	-3.98**	11.27*	14.13**
2 × 4	-1.82*	-1.82*	-2.48**	-2.48**	-2.74**	-2.75**	-5.31	-2.88
2 × 5	1.81*	-5.33**	0.44	-5.69**	0.53	-6.17**	4.82	7.51
2 × 6	1.94	-12.34**	1.36	-11.08**	1.58	-11.95**	-14.67**	-9.50
2 × 7	-0.62	-8.82**	-0.51	-7.73**	-0.61	-8.39**	6.13	24.60**
2 × 8	-1.97*	-5.33**	-1.68*	-4.66**	-1.87*	-5.06**	-1.50	25.41**
3 × 4	-3.63**	-5.33**	-3.79**	-5.28**	-4.10**	-5.73**	7.76	7.79
3 × 5	-0.08	-7.08**	-0.92	-6.97**	-0.96	-7.56**	-5.48	-5.62
3 × 6	2.14*	-12.17**	1.97*	-10.54**	2.18*	-11.42**	-19.41**	-14.53**
3 × 7	-2.55**	-10.59**	-2.17**	-9.27**	-2.42**	-10.06**	-23.99**	-10.76*
3 × 8	-3.78**	-7.08**	-3.24**	-6.17**	-3.56**	-6.70**	-24.95**	-4.45
4 × 5	-2.90**	-9.71**	-3.26**	-9.17**	-3.52**	-9.95**	-6.86	-6.83
4 × 6	-6.22**	-19.35**	-5.35**	-16.96**	-5.85**	-18.39**	1.45	7.59
4 × 7	-2.55**	-10.59**	-2.17**	-9.27**	-2.42**	-10.06**	-13.66**	1.37
4 × 8	-1.97*	-5.33**	-1.68*	-4.66**	-1.87*	-5.06**	-4.23	21.95**
5 × 6	-4.18**	-17.60**	-3.56**	-15.40**	-3.92**	-16.71**	-13.49**	-8.25
5 × 7	-4.46**	-12.34**	-2.17**	-9.27**	-2.42**	-10.06**	-1.76	15.33**
5 × 8	-1.96*	-8.84**	0.09	-6.02**	-1.64	-8.20**	-26.24**	-6.08
6 × 7	-2.14*	-15.85**	-1.84*	-13.89**	-2.01*	-15.06**	-9.29*	6.50
6 × 8	1.94	-12.34**	1.67*	-10.81**	1.83*	-11.73**	-11.67**	12.47*
7 × 8	1.27	-7.08**	1.14	-6.20**	1.20	-6.73**	-14.12**	9.35

*&**Significance at 1 and 5%, respectively; BPH = Better parent heterosis; SPH = Standard parent heterosis

Table 1 contd…

Cross	Fruit width (cm)		Av. fruit wt. (g)		No. of fruits/ plant		Total yield/plant (g)	
	BPH	SPH	BPH	SPH	BPH	SPH	BPH	SPH
1 × 2	4.31	-5.14	19.83**	-20.51**	6.17	-4.65	30.00**	-28.73**
1 × 3	7.99	-0.25	22.25**	-18.90**	42.00**	10.33**	47.06**	-18.55**
1 × 4	-8.49	-8.40	-18.68**	-18.68**	0.28	0.23	18.78**	18.70**
1 × 5	6.21	-1.03	-11.42*	-31.65**	10.73**	2.21	54.99**	8.60**
1 × 6	-11.56	-4.89	-20.35**	-24.83**	-13.57**	-20.14**	50.00**	22.17**
1 × 7	-1.17	-5.23	-1.83	-29.57**	5.08	-12.68**	36.19**	-25.34**
1 × 8	-8.41	-14.57	-6.01	-7.33	21.24**	9.86**	38.65**	-8.37**
2 × 3	4.15	-3.86	44.96**	-12.48**	26.19**	13.33**	69.12**	-6.33*
2 × 4	-4.76	-4.70	-11.48*	-11.48*	23.77**	23.71**	28.28**	28.28**
2 × 5	-8.32	-14.66	-0.94	-23.57**	25.33**	15.68**	43.98**	0.88
2 × 6	4.43	12.23	-11.55*	-16.53**	21.44**	12.21**	49.17**	21.49**
2 × 7	0.78	-3.39	12.27*	-19.46**	25.48**	4.27	59.97**	-14.48**
2 × 8	-7.21	-13.52	-13.95**	-15.16**	8.81*	-1.41	43.79**	-4.98
3 × 4	6.34	6.44	-29.31**	-29.31**	19.77**	19.72**	28.96**	28.96**
3 × 5	11.62	3.98	7.89	-16.75**	4.12	-3.90	59.35**	11.65**
3 × 6	-9.21	-2.43	-26.80**	-30.91**	21.44**	12.21**	28.33**	4.53
3 × 7	10.03	5.51	0.03	-28.24**	14.97**	-4.46	50.74**	-16.52**
3 × 8	1.00	-5.79	-28.51**	-29.51**	33.63**	21.08**	11.95**	-26.02**
4 × 5	-4.01	-3.92	-14.68**	-14.68**	53.05**	41.27**	56.11**	56.11**
4 × 6	0.52	8.03	12.37**	12.37**	65.60**	53.00**	86.65**	86.65**
4 × 7	-9.24	-9.15	-19.38**	-19.38**	45.54**	20.94**	42.53**	42.53**
4 × 8	-6.34	-6.22	1.12	1.12	28.86**	16.76**	62.90**	62.90**
5 × 6	-7.04	-0.09	-6.09	-11.38*	28.00**	18.26**	113.11**	49.32**
5 × 7	-6.43	-10.27	2.52*	-20.90**	19.28**	10.09**	74.36**	22.17**
5 × 8	0.00	-6.72	-9.68*	-10.95*	29.81**	19.81**	64.68**	15.38**
6 × 7	-0.35	7.07	-11.20*	-16.20**	19.41**	10.33**	58.33**	28.96**
6 × 8	-14.68	-8.28	3.03	1.58	17.99**	9.01**	36.81**	11.43**
7 × 8	8.96	4.51	-6.10	-7.42	34.97**	22.30**	33.52**	-11.76**

*&**Significance at 1% and 5%, respectively; BPH = Better parent heterosis; SPH = Standard parent heterosis

hybrid DC-70 × DC-83 over better parent (11.27%) and hybrid DC-70 × Kalyanpur Green over standard parent (25.41%). Lima *et al.* (4) reported that heterosis for fruit yield was positive and high, while heterosis for fruit characteristics (length, diameter, relation of L/D and average fruit weight) was of smaller values. Maximum average fruit weight was recorded by the hybrid combination DC-70 × DC-83 over better (44.96%), while hybrid combination Pusa Uday × DC-1 showed maximum fruit weight over standard parent (12.37%). Hybrid Pusa Uday × DC-1 showed maximum heterosis of 12.37 and 12.37% and 113 and 86.65% over better parent and standard parent for number of fruits and total yield per plant, respectively. The results also indicated that maximum yield per plant in the above mentioned hybrids was attributed by maximum number of fruits per plant. Yield in cucumber can be estimated more accurately by the no of fruits per plant rather than by its fruit size because fruit size of all the genotypes is almost similar but may vary in their thickness or shape. Therefore, a breeder always concentrates on increasing this particular trait to increase the yield of cucumber. Heterosis for number of fruits per plant and yield per plant has also been reported by Jat *et al*. (2) and Singh *et al.* (7).

Table 2. Range of mean values for different traits of parents, F_1 hybrids and heterosis (over better and standard parent).

Particulars	Days to first female flower opening	Days to first fruit set	Days to first fruit harvest	Fruit length (cm)	Fruit dia. (cm)	Av. fruit wt. (g)	No. of fruits per plant	Total yield per plant (g)
Range of mean values								
Parent	49.56 to 59.02	52.04 to 62.03	57.05 to 67.03	11.32 to16.88	2.98 to 3.83	153.28 to 255.58	5.24 to 7.10	775.63 to 1473.33
F_1	46.00 to 57.00	49.00 to 60.60	54.00 to 65.60	11.33 to 16.63	3.05 to 4.01	174.68 to 287.19	5.67 to 10.86	1050.00 to 2750
Range of heterosis % over								
BP	-6.22 to 3.50	-5.85 to 2.68	-5.35 to 2.47	-26.24 to 11.27	-14.68 to 11.62	-29.31 to 44.96	0.28 to 65.60	11.95 to 113.11
SP	-19.35 to 1.68	-18.39 to 0.93	-16.96 to 0.87	-14.53 to 25.41	-14.66 to 12.23	-31.65 to 12.37	-4.65 to 53.00	-28.73 to 86.65
No. of heterotic crosses over								
BP	21	20	20	13	-	19	24	28
SP	27	26	26	09	-	24	21	25
Three top parents with their mean values	P_6 (49.05)	P_6 (52.05)	P_6 (57.05)	P_8 (16.88)	P_6 (3.83)	P_8 (251.98)	P_4 (7.10)	P_4 (1473.33)
	P_7 (52.33)	P_7 (55.34)	P_7 (60.31)	P_7 (15.57)	P_4 (3.57)	P_4 (255.58)	P_6 (6.56)	P_6 (1200.00)
	P_5 (53.04)	P_5 (56.04)	P_5 (61.06)	P_6 (14.06)	P_7 (3.42)	P_6 (241.20)	P_5 (6.55)	P_5 (1032.33)
Three top F_1 hybrids with heterosis% over BP	$P_4 \times P_6$ (-6.22)	$P_4 \times P_6$ (-5.85)	$P_4 \times P_6$ (-5.35)	$P_2 \times P_3$ (11.27)	-	$P_2 \times P_3$ (44.96)	$P_4 \times P_6$ (53.08)	$P_5 \times P_6$ (113.11)
	$P_5 \times P_7$ (-4.46)	$P_3 \times P_4$ (-4.10)	$P_3 \times P_4$ (-3.79)	$P_3 \times P_4$ (7.76)	-	$P_1 \times P_3$ (22.25)	$P_1 \times P_3$ (41.57)	$P_4 \times P_6$ (86.65)
	$P_5 \times P_6$ (-4.18)	$P_5 \times P_6$ (-3.92)	$P_5 \times P_6$ (-3.56)	$P_2 \times P_7$ (6.13)	-	$P_1 \times P_2$ (19.83)	$P_4 \times P_5$ (41.33)	$P_5 \times P_7$ (74.36)
Three top F_1 hybrids with heterosis% over SP	$P_4 \times P_6$ (-19.35)	$P_4 \times P_6$ (-18.39)	$P_4 \times P_6$ (-16.96)	$P_2 \times P_8$ (25.41)	-	$P_4 \times P_6$ (12.37)	$P_4 \times P_6$ (53.00)	$P_4 \times P_6$ (86.65)
	$P_5 \times P_6$ (-17.60)	$P_5 \times P_6$ (-16.71)	$P_5 \times P_6$ (-15.40)	$P_2 \times P_7$ (24.60)	-	$P_6 \times P_8$ (1.58)	$P_4 \times P_5$ (41.27)	$P_4 \times P_8$ (62.9)
	$P_6 \times P_7$ (-15.85)	$P_6 \times P_7$ (-15.06)	$P_6 \times P_7$ (-13.89)	$P_4 \times P_8$ (21.95)	-	$P_4 \times P_8$ (1.12)	$P_2 \times P_4$ (23.71)	$P_4 \times P_5$ (56.11)

BP = Better parent; SP = Standard parent (Pusa uday)

It is apparent that atleast one good performer parent was involved in those hybrids showing best effect for the particular trait. A cross showing high and desirable heterosis and have at least one good performing parent, then the possibility of exploitation of such cross is very high. Three best performing hybrids Pusa Uday × DC-1 followed by Pusa Uday × Kalyanpur Green and Pusa Uday × Punjab Naveen which showed significant heterosis of 86, 62.9 and 56.11%, respectively over standard parent for yield and other desirable characters may be exploited for commercial cultivation.

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