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Gynoecious inbred improves yield and earliness in cucumber (*Cucumis sativus*)

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ABSTRACT

Heterosis for yield and yield related traits were studied in 28 F_1 hybrids of cucumber (*Cucumis sativus* L.) obtained by 8 × 8 diallel (excluding reciprocal) crosses involving eight parents including one gynoecious line (GBS-1). The F_1 hybrids developed using gynoecious line as one parent were found to be superior in performance over top parents for various characters are GBS-1 × Pusa Uday for node number of first female flower (-2.61%), days to first female flower anthesis (-3.45 %), number of fruits/ plant (57.49 %) and yield / plant (66.40%) ,whereas GS-4 × Pusa Uday showed better heterosis for fruit length (20.34%), average fruit diameter (17.04 %) and average fruit weight (12.24%). The best three heterotic hybrids identified over the top parent for yield/plant GBS-1 × Pusa Uday (66.40%), GBS-1 × Punjab Naveen (54.44 %) and GS-4 × Pusa Uday (41.29%) and these may be exploited for commercial cultivation.

Key words: Cucumber, Heterosis, Yield components

Cucumber (*Cucumis sativus* L.) is one of the most important quickly maturing vegetable grown all over the world. It is mostly characterized by monoecious and gynoecious sex expression. Heterosis breeding using best combiners is one of the best methods to improve upon the existing varieties. The phenomenon of hybrid vigour or heterosis resulting from the crosses between genetically dissimilar parents form an important means of crop improvement, particularly in cross pollinated crops. India being the native place of cucumber possesses a vast range of genetic diversity, but the same has not been fully exploited. Heterosis breeding is one of the most efficient tools to exploit the genetic diversity in cucumber (Mohanty and Mishra 1999). Being monoecious, cross pollinated and having large number of seeds/ fruit, it provides ample scope for the utilization of hybrid vigour. Hayes and Jones (1916) were the first to report heterosis in cucumber. Since then a large number of hybrids have been developed and almost ninety per cent of the total area under cucumber is covered by hybrids in Western countries. This was achieved mainly due to the exploitation of gynoecious sex form in the development of hybrid varieties. Moderate to highly significant positive correlations (r) between per cent pistillate nodes and yield were also identified in cucumber suggesting sex expression has potential for increasing yield through indirect selection (Cramer and Wehner 1998). A positive correlation (r = 0.24 to 0.40) was observed with the number of female nodes on lateral branches and total fruits/ plant (Fazio 2001, Fan *et al*. 2006). The gynoecious parent holds immense potentiality for exploitation of hybrid vigour with respect to yield and earliness in bitter gourd (Behera *et al*. 2006, Dey *et al*. 2010). Though India is said to be the home of cucumber, the hybrid breeding programme utilising gynoecious line is not commercialized so far because of the unavailability of gynoecious inbreds with better combining ability. The present study was the first information for assessing heterosis in cucumber for yield and yield attributing traits utilizing gynoecious inbred.

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MATERIALS AND METHODS

Eight genetically diverse parental lines were used to develop twenty eight F_1 hybrids following a half diallel mating system at the main experimental farm of the Division of Vegetable Science, IARI, New Delhi. The experimental materials comprised of eight parental lines (inbreds) Gynoecious line GBS-1, DC-319B, GS-4, DC-1-1, Pusa Uday, Punjab Naveen, LOM-404 and 7026B-76. The 28 F_1 hybrids along with eight parents were evaluated in randomised block design with three replications. The crops 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 node number of first female flower, days to first female flower anthesis, days to first fruit harvest, number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), and yield per plant (g). Heterosis was calculated in the favourable direction over mid parents (MP), better parents (BP) and top parents (TP) for each character.

RESULTS AND DISCUSSION

The mean performance of the 8 parental lines together with their 28 F_1 hybrids along with their CD values (P = 0.05) is given in Table 1 and range of mean values of parents, F_1 hybrids and heterosis (%) are given in Table 2. There was significant difference among the parental lines with respect to different characters studied including total yield per plant. Earliness in cucumber is attributed to node number to first female flower and time required for first female flower appearance. Among eight parents used in the study, the gynoecious parent GBS-1 took lowest node number of first female flower, days to first female flower anthesis, days to first fruit harvest and highest number of fruits per plant. Whereas, parent Pusa Uday showed, maximum fruit length, fruit diameter, average fruit weight and yield per plant (Table 1). The range of mean values of

Table 1 Performance of parental lines and F1 hybrids in cucumber

Parents/Crosses	Node number of first female flower	Days to first female flower anthesis	Days to first fruit harvest	Number of fruits/ plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield (g)
GBS-1	3.44	40.09	48.77	8.94	11.81	3.80	120.50	1078.02
DC-319-B	4.94	45.47	55.06	5.55	16.33	4.63	175.19	975.79
GS-4	5.03	46.69	55.22	5.25	16.25	4.87	170.83	900.00
DC-1-1	5.24	47.42	56.73	5.93	16.69	5.04	183.50	1086.71
Pusa Uday	5.41	50.72	58.45	6.72	18.53	5.28	201.33	1368.44
Punjab Naveen	5.36	49.86	59.98	6.38	17.74	5.13	193.78	1229.65
LOM-404	5.21	44.04	54.44	5.25	15.15	5.00	182.86	853.83
7206-B-76	5.28	44.98	56.96	6.41	15.18	4.03	159.41	966.60
GBS-1 × DC-319-B	3.88	41.63	50.67	10.31	14.16	4.29	153.26	1580.40
GBS-1 × GS-4	3.97	41.66	51.36	10.37	14.34	4.49	150.79	1561.12
GBS-1 × DC-1-1	3.77	42.73	52.14	10.98	14.36	4.45	153.07	1680.11
GBS-1× Pusa Uday	3.35	38.71	48.75	14.08	15.34	4.80	161.74	2277.11
GBS-1 × Punjab Naveen	3.38	39.41	48.07	13.41	14.99	4.71	157.56	2113.37
GBS-1× LOM-404	3.87	40.70	51.96	9.19	13.94	4.57	152.47	1401.05
GBS-1 × 7206-B-76	4.05	40.85	52.51	10.50	13.98	4.03	143.45	1506.74
DC-319-B × GS-4	4.20	42.86	52.22	7.67	18.37	5.15	189.86	1456.17
DC-319-B × DC-1-1	4.26	43.36	53.71	7.41	18.19	5.13	194.26	1436.25
DC-319-B × Pusa Uday	4.40	44.10	55.63	7.33	20.44	5.16	211.15	1547.48
DC-319-B × Punjab Naveen	4.35	47.60	57.88	7.74	20.31	5.49	205.71	1591.23
DC-319-B × LOM-404	4.25	42.47	52.77	6.85	18.33	5.26	201.27	1378.06
DC-319-B × 7206-B-76	4.25	41.82	52.51	7.63	17.93	5.14	174.08	1328.25
GS-4× DC-1-1	4.53	43.73	55.58	7.32	20.63	5.22	212.09	1552.11
GS-4× Pusa Uday	4.64	45.15	56.45	8.56	22.30	6.18	225.97	1933.45
GS-4× Punjab Naveen	4.44	46.37	54.71	7.62	20.51	5.58	210.09	1601.44
GS-4× LOM-404	4.82	42.81	52.37	6.64	19.59	5.37	202.97	1347.03
GS-4 × 7206-B-76	4.56	43.78	53.04	7.71	18.49	5.17	175.85	1355.24
DC-1-1 × Pusa Uday	4.27	45.57	56.66	7.26	20.56	5.64	217.79	1580.30
DC-1-1× Punjab Naveen	4.36	45.96	55.49	7.49	19.56	5.68	216.33	1619.56
DC-1-1× LOM-404	4.53	43.36	53.89	7.18	18.57	5.44	206.85	1485.10
DC-1-1 × 7206-B-76	4.35	43.00	53.49	7.56	18.30	5.41	182.82	1382.12
Pusa Uday × Punjab Naveen	3.96	45.83	53.81	7.34	20.62	5.59	215.11	1578.13
Pusa Uday × LOM-404	4.18	45.78	54.01	7.06	18.53	5.83	215.34	1521.78
Pusa Uday × 7206-B-76	4.55	44.33	53.89	7.67	18.26	5.32	180.52	1385.24
Punjab Naveen × LOM-404	4.49	45.04	55.82	7.47	18.60	5.91	211.40	1579.26
Punjab Naveen × 7206-B-76	4.70	44.10	56.71	7.62	18.34	5.43	180.01	1372.11
LOM-404 × 7206-B-76	4.08	41.17	53.26	7.50	18.22	5.31	181.07	1358.03
CD (P = 0.05)	0.22	2.39	2.36	1.10	0.86	0.38	7.67	202.38

Table 2 Range of mean values for different characters of parents, F_1 hybrids and heterosis(over better, mid and top parents)

	Node number of first female flower	Days to first female flower anthesis	Days to first fruit harvest	Number of fruits/plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield / plant (g)
Range of mean values								
Parents	3.44 to 5.41	40.09 to 50.72	48.77 to 59.98	5.25 to 8.94	11.81 to 18.53	3.80 to 5.28	120.50 to 201.33	900 to 1368.44
F_1	3.35 to 4.82	38.71 to 47.60	48.07 to 57.88	6.64 to 14.08	13.94 to 22.30	4.03 to 6.18	143.45 to 225.97	1328.25 to 2277.11
Range of heterosis % over								
BP	-26.11 to 17.73	-8.78 to 6.59	-7.93 to 7.68	2.79 to 57.49	-17.22 to 23.60	-11.70 to 17.04	-19.66 to 15.58	1.23 to 71.87
MP	-5.85 to -26.53	-0.14 to -14.75	-11.59 to 0.68	12.07 to 79.82	0.63 to 28.23	0.68 to 21.65	0.08 to 21.43	18.65 to 86.16
TP	-40.11 to 17.73	-3.45 to 18.72	-1.44 to 18.69	25.72 to 57.49	-24.77 to 20.34	-23.67 to 17.04	-28.75 to 12.24	-2.94 to 66.40
Number of heterotic crosses over								
BP	28	20	14	28	27	27	14	22
MP	28	27	19	28	26	28	15	27
TP	28	25	26	28	23	28	14	4
Three top parents with their mean values	P_1 (3.44) P_2 (4.94) P_3 (5.03)	P_1 (40.09) P_7 (44.04) P_8 (44.98)	P_1 (48.77) P_7 (54.44) P_2 (55.06)	P_1 (8.94) P_5 (6.72) P_8 (6.41)	P_5 (18.53) P_6(17.74) P_4 (16.69)	P_5 (5.28) P_6 (5.13) P_4 (5.04)	P_5 (201.33) P_6 (193.78) P_4 (183.50)	P_5 (1368.44) P_6 (1229.65) P_4 (1086.71)
Three top F_1 hybrids with heterosis % over BP	$P_5 \times P_6$(-26.11) $P_7 \times P_8$ (-21.69) $P_5 \times P_7$(-19.76)	$P_5 \times P_6$(-8.78) $P_2 \times P_8$(-7.02) $P_7 \times P_8$(-6.51)	$P_5 \times P_6$(-7.93) $P_4 \times P_8$(-5.72) $P_5 \times P_8$(-5.39)	$P_1 \times P_5$(57.49) $P_1 \times P_6$(50.00) $P_2 \times P_3$(38.19)	$P_3 \times P_4$(23.60) $P_3 \times P_7$ (20.55) $P_3 \times P_5$(20.34)	$P_3 \times P_5$(17.04) $P_6 \times P_7$(15.20) $P_2 \times P_8$(11.01)	$P_3 \times P_4$(15.58) $P_4 \times P_7$(12.73) $P_3 \times P_5$(12.24)	$P_1 \times P_6$(71.87) $P_1 \times P_5$(66.40) $P_1 \times P_4$(54.60)
Three top F_1 hybrids with heterosis % over M P	$P_5 \times P_6$(-26.53) $P_1 \times P_5$(-24.37) $P_1 \times P_6$(-23.18)	$P_1 \times P_5$(-14.75) $P_1 \times P_6$(-12.38) $P_5 \times P_{6\text{-}}$(-8.78)	$P_1 \times P_6$(-11.59) $P_5 \times P_6$(-9.12) $P_1 \times P_5$(-9.05)	$P_1 \times P_5$(79.82) $P_1 \times P_6$(75.06) $P_1 \times P_4$(47.58)	$P_3 \times P_5$(28.23) $P_3 \times P_4$(25.25) $P_3 \times P_7$(24.78)	$P_3 \times P_5$(21.65) $P_4 \times P_8$(19.16) $P_2 \times P_{8\text{-}}$(18.70)	$P_3 \times P_5$(21.43) $P_3 \times P_4$(19.71) $P_3 \times P_6$(15.24)	$P_1 \times P_5$(86.16) $P_1 \times P_6$(83.16) $P_3 \times P_5$(70.46)
Three top F_1 hybrids with heterosis % over TP	$P_3 \times P_7$(-40.11) $P_3 \times P_5$(-34.88) $P_3 \times P_8$(-32.56)	$P_1 \times P_5$(-3.45) $P_1 \times P_6$(-1.7)	$P_1 \times P_6$(-1.44) $P_1 \times P_5$(-0.04)	$P_1 \times P_5$(57.49) $P_1 \times P_6$(50.00) $P_1 \times P_4$(22.81)	$P_3 \times P_5$(20.34) $P_3 \times P_4$(11.33) $P_5 \times P_6$(11.28)	$P_3 \times P_5$(17.04) $P_6 \times P_7$(11.93) $P_5 \times P_7$	$P_3 \times P_5$(12.24) $P_4 \times P_5$(8.18) (10.42)$P_4 \times P_6$(7.45)	$P_1 \times P_5$(66.40) $P_1 \times P_6$(54.44) $P_3 \times P_5$(41.29)

parents, range of heterosis, number of heterotic crosses and three superior crosses with their heterosis over better, mid and top parent in all characters studied were presented in Table 2.

High yield in once-over mechanical harvesting operations have been obtained by cultivation of gynoecious hybrids in cucumber at high plant densities. Time of harvest is also critical consideration for maximizing financial gain in commercial crops. Early picking is desirable to catch the early market for better remuneration and provides ample scope for crop rotation with other crops in the same field. The mean values of parent for node number of first female flower ranged from 3.44 (GBS-1) to 5.41 (Pusa Uday) and among crosses mean ranged from 3.35 (GBS-1 × Pusa Uday) to 4.82 (GS-4 × LOM-404). The F_1 hybrid Pusa Uday × Punjab Naveen exhibited maximum heterosis over better and mid parent (-26.11%), whereas F_1 hybrid GS-4 × LOM-404 showed maximum heterosis over top parent (-40.11%). In days to first female flower anthesis, the parental mean ranged from 40.09 (GBS-1) to 50.72 days (Pusa Uday). Among the crosses it ranged from 38.71 (GBS-1 × Pusa Uday) to 47.60 days (DC-319-B × Punjab Naveen). The extent of heterosis varied from -8.78 to 6.59% over better parent, -0.14 to -14.75% over mid parent and -3.45 to 18.72% over top parent (GBS-1). Two F_1 hybrids namely, GBS-1 × Pusa Uday and GBS-1 × Punjab Naveen showed significant heterosis over top parent and out of these two cross combination, GBS-1 × Pusa Uday (-3.45%) showed highest significant heterosis in days to first female flower anthesis over top parent. Dijkhuizen and Staub (2002) also reported that gynoecious cucumber hybrids are typically early flowering and possess a concentrated fruit set. The estimates of parental mean value for days to first fruit harvest ranged from 48.77 (GBS-1) to 59.98 days (Punjab Naveen), white for F_1 hybrids it ranged from 48.07 (Pusa Uday × Punjab Naveen) to 57.88days (DC-319-B × Punjab Naveen). The range of heterosis varied from -7.93 to 7.68%, -11.59 to 0.68% and -1.44 to 18.69% over better parent, mid parent and top parent respectively. Two F_1 hybrids, which showed negative heterosis over top parent are GBS-1 × Punjab Naveen (-1.44%) and GBS-1 × Pusa Uday (-0.04%). Earliness (indicated by negative estimates of heterosis) is a prime objective of any breeding programme. In accordance with the present findings, Singh *et al*. (1999), Munshi *et al*. (2005) and Kumbhar *et al*. (2005) also observed earliness in the heterotic combinations in cucumber. For number of fruits per plant, parental mean varied from 5.24 (LOM-404) to 8.94 (GBS-1). On the other hand, in crosses it ranged from 6.64 (GS-4 × LOM-404) to 14.08 (GBS-1 × Pusa Uday). The extent of heterosis varied from 2.79 to 57.49% over better parent, 12.07 to 79.82% over mid parent and while top parent heterosis varies from 25.72 to 57. 49%. The F_1 hybrids GBS-1 × Pusa Uday showed maximum heterosis over better parent (57.49%), mid parent (79.82%) and top parent (59.79%). The mean value of fruit length of parental genotypes ranged from 11.81 (GBS-1) to 18.53cm (Pusa Uday) and for F_1 hybrids it ranged from 13.94 (GBS-1 × LOM-404) to 22.30cm (GS-4 × Pusa Uday). Heterosis ranged from -17.22 to 23.60% over better parent, 0.63 to 28.23% over mid parent and -23.67 to 17.04% over top parent. The F_1 hybrids GS-4 × DC-1-1 showed maximum heterosis over better parent (23.60%) whereas, GS-4 × Pusa Uday showed

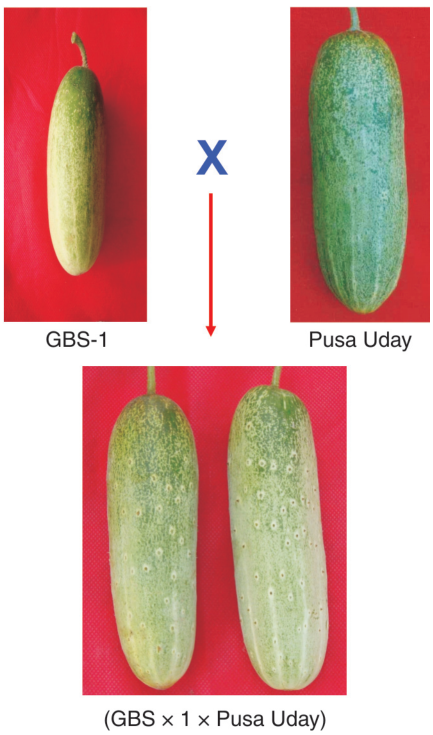

Fig 1 Best performing F1 hybrid over top parent for yield per plant

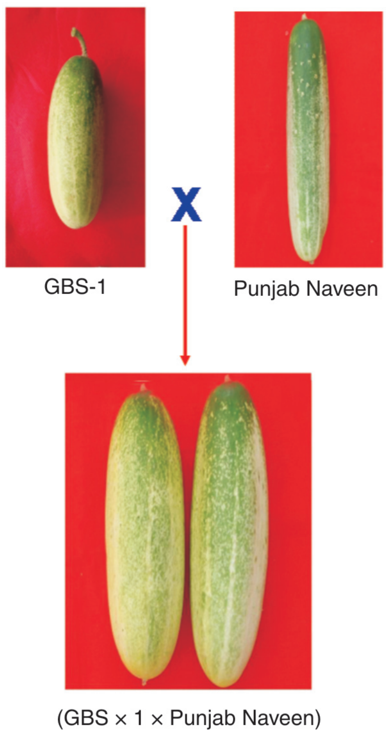

Fig 2 Second best performing F1 hybrid over top parent for yield per plant

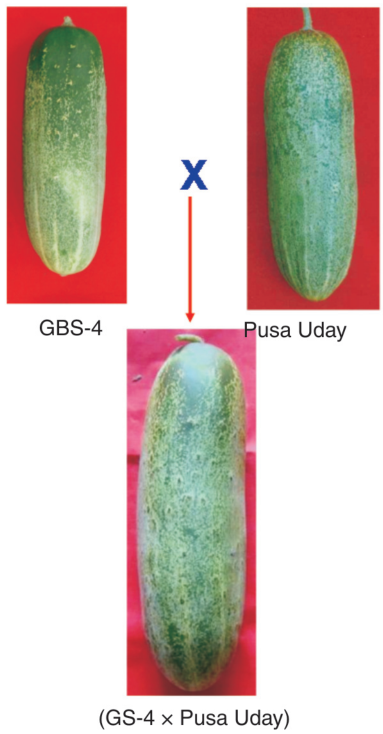

Fig 3 Third best performing F1 hybrid over top parent for yield per plant

maximum heterosis over mid parent (28.23%) and top parent (20.34%). The result of fruit diameter of parental mean ranged from 3.80 (GBS-1) to 5.28cm (Pusa Uday) and mean of crosses varied from 4.03 (GBS-1 × 7026B-76) to 6.18cm (GS-4× Pusa Uday). Range of heterosis was estimated from -11.70 to 17.04% over better parent, 0.68 to 21.65% over mid parent and -23.67 to 17.04% over top parent. The F_1 hybrid (GS-4 × Pusa Uday) showed maximum heterosis over better parent (17.05%), mid parent (21.65%) and top parent (17.04%). Hayes and Jones (1916) reported that first generation crosses in cucumber frequently exhibit high parent heterosis due to increased fruit size and fruit number per plant. The mean value for average fruit weight of parents ranged from 120.50 (GBS-1) to 201.33g (Pusa Uday), whereas for crosses it ranged from 143.45 (GBS-1 × 7026B-76) to 225.97g (GS-4 × Pusa Uday). The extent of heterosis ranged from -19.66 to 15.58% over better parent, 0.08 to 21.43% over mid parent and -28.75 to 12.24% over top parent. The F_1 hybrids GS-4 × DC-1-1 showed maximum heterosis over better parent (15.58%), whereas GS-4 × Pusa Uday showed maximum heterosis over mid (21.43%) and top parent (12.24%). The mean value for total yield per plant of parents ranged from 900 (GS-4) to 1368.44g (Pusa Uday), whereas in crosses it ranged from 1328.25 (DC-319-B × 7026B-76) to 2277.11g (GBS-1 × Pusa Uday). The extent of heterosis ranged from 1.23 to 71.87% over better parent, 18.65 to 86.16 over mid parent and -2.94 to 66.40% over top parent. The F_1 hybrids GBS-1 × Punjab Naveen showed maximum heterosis over better parent (71.87%), whereas GBS-1 × Pusa Uday showed maximum heterosis over mid (86.16%) and Top Parent (66.40%). Three best performing F_1 hybrids, GBS-1 × Pusa Uday, (Fig 1), GBS-1 × Punjab Naveen (Fig 2) and GS-4 × Pusa Uday (Fig 3) recorded 66.40%, 54.44% and 41.29% higher yield, respectively over top parent Pusa Uday.

Heterotic effect for these fruit characters in cucumber were also reported by Bairagi *et al*. (2005) and Munshi *et al*. (2005). Kumar *et al*. (2010) reported appreciable amount of heterosis was observed over better, top and standard parents for all the characters studied. The F_1 hybrid GBS-1 × Pusa Uday showed highest percentage (66.40%) heterosis in yield over top parent Pusa Uday and may be exploited for commercial cultivation. Hormuzdi and More (1989) and Dogra et *al*. (1997) also reported high heterosis in cucumber both over better parent and standard parent when gynoecious line used as female parent. Hormuzdi and More (1989) and More (2002) also demonstrated potentiality of gynoecious line in cucumber improvement programme in general and development of tropical gynoecious lines and F_1 hybrids in particular. Hence, the gynoecious line, GBS-1 holds immense potential for future breeding programme in cucumber improvement.

REFERENCES

Bairagi S K, Ram H H, Singh D K and Maurya S K. 2005. Exploitation of hybrid vigour for yield and attributing traits in cucumber. *Indian Journal of Horticulture* **62**:41–5.

Behera T K, Dey S S and Sirohi P S. 2006. 'DBGY-201' and 'DBGY-202' two gynoecious lines in bitter gourd (*Momordica charantia* L.) isolated from indigenous source. *Indian Journal of Genetics and Plant Breeding* **66**: 61–2.

Cramer C S and Wehner T C. 1998. Fruit yield and yield component means and correlations of four slicing cucumber populations improved through six to ten cycles of recurrent selection. *Journal of the American Society forHorticultural Science* **123**:388–95.

Dey S S, Behera T K, Munshi A D and Pal Anand. 2010. Gynoecious inbred with better comining ability improves yield and earliness in bitter gourd (*Momordica charantia* L.). *Euphytica* **173**:37–47.

Dijkhuizen A and Staub J E. 2002. QTL conditioning yield and fruit quality traits in cucumber (*Cucumis sativus* L.): effects of environment and genetic background. *Journal of New Seeds* **4**:1–30.

Dogra B S, Rastogi K B, Kala B N and Sharma H R. 1997. Heterosis and combining ability studies for yield and quality characters in cucumber (*Cucumis sativus* L.). *Journal of Hill Research* **10**(1):39–42.

Fan Z, Robbins M D and Staub J E. 2006. Population development by phenotypic selection with subsequent marker-assisted selection for line extraction in cucumber (Cucumis sativus L.). *Theoretical and Applied Genetics* **112**:843–5.

Fazio G. 2001. 'Comparative study of marker-assisted and phenotypic selection and genetic analysis of yield components in cucumber'. Ph D dissertation, University of Wisconsin, Madison, USA.

Hayes H K and Jones D F. 1916. First generation crosses in cucumber. *Republic Conferance of Agricultural Experiment Statistics* **5**:319–22.

Hormuzdi S G and More T A. 1989. Heterosis studies in cucumber (*Cucumis sativus* L.). *Indian Journal of Horticulture* **46**(1): 73–9.

Kumar J, Munshi A D, Kumar R and Sureja A K. 2010. Studies on heterosis in slicing cucumber. *Indian Journal of Horticulture* **67**(2):197–201.

Kumbhar H C, Dimbre A D and Patil H E. 2005. Heterosis and combining ability studies in cucumber (*Cucumis sativus* L.). *Journal of Maharashtra Agricultural Universities* **30**:272–5.

Mohanty B K and Mishra R S. 1999. Studies on heterosis for yield and yield attributes in Pumpkin (*Cucurbita moschata* duc. Ex Poir.). *Indian Journal of Horticulture* **56**(2):171–8.

More T A. 2002. Development and exploitation of tropical gynoecious lines in F_1 hybrid of cucumber. *Acta-Horticulturae.* **588**:261–7.

Munshi A D, Kumar R and Panda B. 2005. Heterosis for yield and its component in cucumber (*Cucumis sativus* L.). *Vegetable Science* **32**(2):133–5.

Singh A K, Guatam N C and Singh R D. 1999. Heterosis in cucumber (*Cucumis sativus* L.). *Vegetable Science* **26**:126–8.