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Heterosis study in Cucumber (*Cucumis sativus* L.)

Preethi, G. P.[1*], Anjanappa, M.[1], Pitchaimuthu, M.[2], Devappa, V.[3], Ramachandra , R.K.[4], and Venugopalan, R.[5]

[1]Department of Vegetable Science, [3]Department of Plant Pathology,
College of Horticulture, UHS campus, GKVK (PO), Bengaluru, India

[2]Division of Vegetable Crops, [5]Division of Statistics, IIHR, Hessaraghatta, Bengaluru 560089, India

[4]Department of Crop improvement and Bio-technology, College of Horticulture,
Yelachanahally, Yelwala, Mysore 571130, India

*Corresponding Author E-mail: preethigp2407@gmail.com

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ABSTRACT

The present investigation on heterosis was undertaken at College of horticulture, Bangalore during 2016-17. Twenty five hybrids developed by crossing five lines with five testers in L × T fashion were evaluated along with the parents in randomized complete block design with two replications. The magnitude of heterosis over the commercial check for node of female flower appearance (-28.95 to 28.07), days to female flower anthesis (-9.67 to -28.46), days to first fruit harvest (-3.14 to -23.74), number of fruits per plant (-17.68 to 44.44), fruit yield per plant (-55.16 to 55.79). Significant heterosis was recorded over better parent (BP) and commercial check (SH). In order of merit F_1 hybrids Green long × Poinsette (55.79 %), Green long × Pusa Uday (54.30 %), Pondicherry 1 × Punjab Naveen (50.47 %) were recorded to be three best performing F_1 hybrids for fruit yield per plant. The higher yield recorded by these hybrids could be due to increased number of fruits per plant. The best performing F_1 hybrid Green long × Poinsette which recorded 55.79 per cent higher yield over commercial check may be exploited for commercial cultivation.

Keywords: *Cucumber, Heterosis, F_1 hybrids, Vegetables*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most popular vegetable of the family Cucurbitaceae, with native home in the India. India is the centre of origin of many Cucurbitaceous vegetables, where the Cucurbits are capable of thriving and performing well even under the hot summer. In this crop there is a wide range of variability in fruit and vegetative characters exits, but there has been not assessed and utilized. One hundred gram of edible cucumber fruit contain 96g water, 0.6g protein, 0.1g fat, 2.2g carbohydrate, 45 IU Vitamin A, 0.03mg Vitamin B1, B2, 0.3mg Niacin, 12mg vitamin C, 12mg Calcium, 0.3mg Iron, 15mg Magnesium and 24mg Phosphorus (Alcazar et al., 1983).

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Seeds contain oil, which is helpful for brain development and body smoothness. Hence, it is being used in Ayurvedic preparations (Robinson & Decker-Walter, 1999). Besides this, the whole fruit is used in cosmetic and soap industries.

In cucumber heterosis breeding is one of the most efficient tools to exploit the genetic diversity. Being cross pollinated and monoecious in sex expression, it provides ample scope for the utilization of hybrid vigor. Heterosis breeding has been recognized as practical tool in providing breeder a means for increasing yield and other economic traits. Thus Line × Tester analysis was undertaken to study magnitude and nature of heterosis in cucumber, with a view to recognise the heterotic hybrids, which is used to build the population with favourable fixable genes for the yield improvement.

MATERIALS AND METHODS

The experiment was undertaken in *Kharif* and *rabi* season of 2016-17 at the PG research Block of the Department of Vegetable Science, College of Horticulture, Bengaluru under open field condition. Among the ten genotypes, five genotypes namely, IIHR-285 (L_1), IIHR-341 (L_2), IIHR-304 (L_3), Green Long (L_4), Pondicherry-1 (L_5) were used as lines. Other five genotypes which were used as testers namely, Poinsette (T_1), Phule Shubhangi (T_2), Punjab Naveen (T_3), Pusa Uday(T_4), Kerala-1 (T_5) and one standard check used named as Chitra. The 25 hybrids, Chitra along with ten parental lines consisting of Line X Tester set were grown in randomized block design with two replications. The plants were spaced at a distance of 1.5 m between rows and 1.0 m within a row. The recommended cultural practices and plant protection measures were followed as and when required for better crop growth and yield.

Five plants of each parents and F_1 hybrids were selected randomly for data recording for 15 characters (Table 1). Observations on individual plant basis were recorded on vine length (cm), number of branches per plant, number of nodes per vine, node of first female flower appearance, node of first male flower appearance, days to first female flower anthesis, number of fruits per plant, sex ratio, fruit diameter (cm), fruit length (cm), days to first fruit harvest, average fruit weight (g), fruit yield per plant (kg), shelf life (days) and cavity thickness (cm). Heterosis was calculated as the deviation of the mean performance of F_1's from their better parent (BP) and standard check (SC).

RESULTS AND DISCUSSION

Performance of 10 parental lines, 25 F_1 hybrids and 1 check is given in Table 1. The ideotype in cucumber should have more vine length, more number of branches, early flowering, greater fruit length, high fruit weight, more number of fruits per vine and highest fruit yield per vine. The vine length was measured at time of harvest and the parent range of vine length was 148.60 cm to 205.60 cm. The vine length of the crosses ranged from 175.30 cm to 241.20 cm. The maximum vine length was exhibited by the hybrid Pondicherry -1 × Pusa Uday (241.20 cm). Green Long × Pusa Uday (19.91%) followed by Pondicherry 1 × Punjab Naveen (16.58 %) exhibited the significant positive standard heterosis over check Chitra (Tabel 2). Vine length is an important growth parameter from productivity point of view which was reported by several workers, to be an important yield component as it was significantly associated with fruit yield. This results in line with the findings of Sharma et al. (2012), Arya & Singh (2014) and Jat et al. (2015).

The parents had the range of 4.05 to 5.30 for number of branches per vine. The maximum *per se* performance of parent was observed in Pondicherry 1 (5.30), while the hybrids had the range of 4.80 to 6.50 (Tabel 1). Green long × Phule Shubhangi (25.00 %) followed by Pondicherry 1 × Punjab Naveen (22.12 %) exhibited the significant standard heterosis over check Chitra (Tabel 2). The parents had the range of 15.75 to 20.55 nodes per vine. Pondicherry- 1 × Phule Shubhangi (46.50 %) followed by Pondicherry 1 × Pusa Uday (45.00 %) exhibited the significant standard heterosis over check Chitra.

Tabel 1: Mean values of F_1 hybrids and parents for earliness, growth and yield parameters in cucumber

Sl. No.	Genotypes	Vine length (cm)	No. of branches per vine	No. of nodes per vine	Node of female flower appearance	Node of male flower appearance	Days to first fruit harvest	Sex ratio	Days to female flower anthesis	Number of fruits per plant	Fruit diameter (cm)	Fruit length (cm)	Avg. fruit weight (g)	Fruit yield per plant (kg)	Shelf life (days)	Cavity thickness (cm)
1.	$L_1 \times T_1$	194.30	5.10	26.10	5.10	2.30	49.75	4.17	42.65	4.07	4.35	18.35	256.35	1.35	4.10	1.75
2.	$L_1 \times T_2$	180.35	5.30	19.30	5.80	3.65	50.80	4.23	44.8	4.25	4.70	19.25	260.60	1.40	5.70	1.86
3.	$L_1 \times T_3$	214.15	5.30	24.50	4.40	2.30	53.10	4.36	44.95	5.20	5.00	20.36	386.05	1.59	5.20	1.85
4.	$L_1 \times T_4$	223.13	5.10	25.30	4.95	2.45	52.55	4.39	45.05	7.05	4.50	21.75	415.15	2.80	4.65	1.86
5.	$L_1 \times T_5$	211.10	5.10	22.10	4.85	1.95	51.60	4.31	45.60	6.07	5.25	20.75	520.65	3.10	5.65	1.84
6.	$L_2 \times T_1$	175.30	5.70	20.68	5.20	2.15	49.40	3.74	41.90	6.60	5.30	18.13	292.75	3.10	5.25	1.78
7.	$L_2 \times T_2$	212.10	6.00	26.80	4.80	3.25	58.30	3.74	44.10	8.15	5.50	24.10	278.80	2.75	5.35	1.90
8.	$L_2 \times T_3$	217.10	5.50	26.30	4.75	3.40	51.65	3.68	45.65	7.40	5.35	20.36	403.05	3.45	5.35	1.82
9.	$L_2 \times T_4$	219.00	5.50	27.30	4.50	1.95	48.75	4.31	48.85	7.10	5.35	22.05	522.30	3.15	5.75	1.88
10.	$L_2 \times T_5$	214.40	5.50	22.25	4.40	1.90	53.15	3.94	45.10	7.25	4.85	21.65	358.15	3.65	6.30	1.88
11.	$L_3 \times T_1$	206.15	5.00	18.45	5.35	3.25	50.80	4.32	43.35	6.35	5.00	18.70	293.65	2.00	5.70	1.87
12.	$L_3 \times T_2$	184.15	5.15	17.70	5.25	1.85	52.25	4.71	47.10	7.15	4.36	19.35	327.05	1.75	5.50	1.87
13.	$L_3 \times T_3$	211.65	4.80	21.40	5.75	1.80	49.40	4.95	42.80	5.30	5.05	20.04	250.80	1.55	6.15	1.86
14.	$L_3 \times T_4$	219.35	5.30	18.70	6.80	1.75	53.65	4.81	45.20	6.20	4.21	19.93	369.30	2.75	5.45	1.87
15.	$L_3 \times T_5$	211.25	5.50	19.30	5.55	2.25	54.55	4.65	50.00	4.75	4.15	20.70	515.70	2.35	6.20	1.90
16.	$L_4 \times T_1$	221.30	5.40	24.60	4.05	2.55	46.10	4.07	39.60	7.50	4.80	27.87	557.05	4.65	6.70	1.88
17.	$L_4 \times T_2$	226.10	6.50	24.30	4.60	3.45	54.75	4.44	48.75	5.30	5.30	24.75	670.70	2.70	6.80	1.81
18.	$L_4 \times T_3$	233.00	6.30	22.60	4.70	3.25	55.15	4.55	45.80	5.45	5.00	26.27	601.75	3.35	6.95	1.80
19.	$L_4 \times T_4$	241.20	6.20	26.70	4.50	2.40	46.25	4.67	41.45	6.35	5.60	28.60	698.65	4.63	7.15	1.82
20.	$L_4 \times T_5$	223.25	5.60	28.40	4.40	2.50	54.00	4.64	49.50	6.35	5.40	25.06	599.20	4.05	7.15	1.79
21.	$L_5 \times T_1$	228.50	5.75	27.70	5.35	3.50	57.60	4.93	47.85	3.20	6.40	23.67	717.65	2.25	6.00	1.88
22.	$L_5 \times T_2$	231.00	6.30	29.30	4.20	2.55	58.55	4.97	44.00	5.20	5.90	24.01	747.75	3.95	5.75	1.88
23.	$L_5 \times T_3$	234.50	6.35	28.60	4.60	3.65	46.35	4.82	41.00	7.15	5.95	25.25	699.25	4.50	6.15	1.88
24.	$L_5 \times T_4$	226.00	6.20	29.00	7.30	3.30	56.35	5.22	43.50	5.15	6.00	24.33	683.85	3.75	6.70	1.84
25.	$L_5 \times T_5$	223.15	5.60	24.50	7.25	3.40	55.75	5.27	51.55	5.25	5.85	22.65	547.65	4.40	6.55	1.89
26.	L_1	182.60	4.50	17.70	6.10	2.20	60.45	5.69	54.10	6.05	4.11	16.40	202.75	2.05	4.25	2.05
27.	L_2	186.00	4.05	18.55	4.75	2.10	58.35	5.46	48.05	7.15	4.29	16.50	206.10	2.10	4.65	2.02
28.	L_3	148.60	4.38	16.50	6.15	2.70	59.35	5.43	49.80	5.25	4.32	16.20	344.80	2.25	4.55	2.21
29.	L_4	180.80	4.85	18.33	4.35	2.35	56.85	5.93	51.05	5.25	4.55	19.01	480.75	2.55	5.85	2.32
30.	L_5	205.20	5.30	20.55	7.15	3.15	55.45	5.86	54.20	5.35	5.05	20.66	515.70	2.68	6.10	2.24
31.	T_1	163.25	4.82	20.55	5.35	2.45	56.15	6.15	47.55	5.10	4.20	18.21	330.70	1.25	4.50	2.12
32.	T_2	169.93	4.50	18.25	5.50	3.40	56.15	6.83	50.40	5.25	4.15	19.24	377.90	1.75	4.90	2.11
33.	T_3	186.10	4.90	15.75	6.15	2.45	57.45	5.37	49.85	5.45	4.10	18.15	376.75	1.60	4.65	2.04
34.	T_4	186.10	5.05	19.20	5.40	2.45	56.65	5.69	49.80	5.30	4.85	19.55	405.70	1.58	5.45	2.15
35.	T_5	197.50	4.95	19.90	6.35	3.45	58.10	6.24	52.10	5.35	5.15	18.18	402.85	1.63	5.15	2.17
36.	Chitra	201.50	5.20	20.00	5.70	3.45	60.45	4.75	55.35	5.95	5.15	20.15	510.35	3.00	5.50	2.1
	S.Em+_	3.94	0.30	0.48	0.24	0.12	2.24	0.26	1.96	0.26	0.30	0.48	7.92	0.94	0.70	0.08
	CD at 5%	8.15	0.62	1.00	0.50	0.26	4.64	0.53	4.05	0.55	0.62	1.01	16.35	1.95	1.46	0.16
	CD at 1%	11.04	0.84	1.36	0.68	0.35	6.29	0.72	5.49	0.74	0.84	1.36	22.16	2.65	1.98	0.22

Appearance of first female flower at lower node is prime objective in development of early hybrid. For the development of early fruiting genotypes, negative heterosis is desirable for node number at which first female flower appear (Arya & Singh, 2014). The crosses IIHR 285 × Punjab Naveen (-27.87 %) and Pondicherry 1 × Punjab Naveen (-24.59%) exhibited the significant heterobeltiosis in negative direction (Tabel 2 & 3). This is in accordance with the research findings of Bairagi et al. (2005), Hanchinamani & Patil (2009), Kumar et al. (2010), Singh et al. (2010) and Singh et al. (2015).

For days to first harvest negative estimates of heterosis is a well-recognized and prime objective of any breeding programme as it helps the grower to earn a good early market price (Airina et al., 2013). Among parent Pondicherry- 1 (55.45) shows the early harvest while IIHR 285 (60.45) shows more days to first harvest (Tabel 1). Heterosis in negative direction is desirable for days to first harvest. The cross Green long × Poinsette exhibited the significant negative heterobeltiosis (-20.65%)

as well as standard heterosis (-23.74 %) over the check Chitra (Tabel 2 & 3). This is in line with the research findings with Kumar et al. (2010) and Jat et al. (2015) in cucumber. For sex ratio, out of 25 crosses, 10 crosses over better parent and 9 crosses over commercial check exhibited significant negative heterosis.

Heterosis in negative direction is preferred for days to female flower anthesis. The parent Poinsette (47.55) showed significant negative heterosis. The crosses Green Long × Poinsette (39.60) and Pondicherry 1 × Punjab Naveen (41.00) exhibited the significant negative heterosis (Tabel 1). The crosses showing no heterosis indicated that the parent involved in the cross do not differ in the gene frequency with respect character under study (Pandey et al. 2005). Number of fruits is important parameter which directly contributes to the yield. The more number of fruits was recorded in the parents like IIHR 341 (7.15) followed by Poinsette (6.75). IIHR 341 × Phule Shubhangi (64.65%) exhibited the significant standard heterosis over the check (Tabel 2 & 3). Higher heterobeltiosis for number of fruits was observed in Pondicherry 1 × Punjab Naveen (31.19 %) , Green Long × Kerala -2 (18.69 %) similar result was reported by Hanchinamani & Patil (2009), Kushwaha et al. (2011), Mule et al. (2012), Singh et al. (2012), Airina et al. (2013) and Singh et al. (2015).

For fresh consumption less fruit diameter is preferred (Arya & Singh, 2014). Hence, negative direction of heterosis consider to be desirable. Among parent lesser fruit diameter is observed in Punjab Naveen (4.10 cm) with respect to crosses lesser fruit diameter was observed in IIHR 304 × Kerala -2 (4.15). Fruit length is one of the important traits which contribute towards yield and heterosis in positive direction is desirable. Highest significant positive heterosis was recorded in the crosses Green long × Pusa Uday (41.94 %) over check (Tabel 2 & 3).

Table 2: Magnitude of heterobeltiosis (BP) and standard heterosis (SH) in cucumber

Sl. No.	Characters	BP (%)	SH (%)
1.	Vine length (cm)	-5.75 to 26.28	-12.85 to 19.91
2.	No. of branches per plant	-1.94 to 34.02	-7.69 to 25.00
3.	No.of nodes per vine	-10.22 to 44.47	-11.5 to 46.50
4.	Node of female flower appearance	-27.87 to 25.93	-28.95 to 28.07
5.	Node of male flower appearance	-45.59 to 20.37	-49.28 to 5.80
6.	Days to first fruit harvest	-20.65 to 5.69	-3.14 to -23.74
7.	Sex ratio	-33.30 to 11.40	-20.27 to 34.17
8.	Days to female flower anthesis	-17.50 to 2.04	-9.67 to -28.46
9.	Number of fruits per plant	-39.63 to 31.19	-17.68 to 44.44
10.	Fruit diameter (cm)	-19.42 to 28.35	-19.42 to 24.27
11.	Fruit length (cm)	-0.47 to 46.65	-10.05 to 41.94
12.	Average fruit weight (g)	-26.22 to 39.51	-45.37 to 46.52
13.	Fruit yield per plant (kg)	-34.15 to 68.22	-55.16 to 55.79
14.	Shelf life (days)	-14.68 to 32.26	-15.45 to 11.82
15.	Cavity thickness (cm)	-12.38 to -5.00	-15.24 to -12.38

BP- Heterosis over better parent SH- Heterosis over the commercial check (Chitra)

Fruit weight is an important component which ultimately results in higher fruit yield. The maximum average fruit weight was recorded in Pondicherry- 1 (515.50 g) among parents and Pondicherry- 1 × Phule Shubhangi (747.75 g) with respect to hybrids (Tabel 1). More number of crosses exhibited the significant Positive standard heterosis over check Chitra and maximum was recorded in Pondicherry 1 × Phule Shubhangi (46.52 %) (Tabel 2 & 3). It is in line with the findings of Dogra et al. (2011) Arya & Singh (2014) and Jat et al. (2015) in cucumber.

Increase the yield per vine is important to increase the productivity. Pondicherry- 1 (2.68) and Green Long × Pondicherry- 1 (4.65

kg) exhibited the maximum yield potential among parents and hybrids respectively (Tabel 1). Hanchinamani & Patil (2009) reported that the maximum yield attributed to increase in average fruit weight and total number of fruits per plant. Only 16 crosses exhibited the significant standard heterosis over the check Chitra. Among 25 crosses, 13 crosses exhibited the significant positive heterobeltiosis and maximum was observed in Green Long × Poinsette (68.22 %) and over the commercial check Green Long × Poinsette (55.79 %) (Table 2 & 3). For fruit shelf life positive heterosis is desirable in cucumber. Among parents maximum shelf life was observed in Pondicherry- 1 (6.10) and less shelf life was observed in IIHR 285 (4.25).

Table 3: Top three crosses based on high mean performance and percent heterosis for important economic traits

Sl. No.	Cross combinations	Mean performance	Heterosis over	
			BP	SH
Node at first female flower appearance				
1.	Green long × Poinsette	4.05	-5.81	-28.95**
2.	Green long × Pusa Uday	4.20	-10.64**	-26.32**
3.	Pondicherry 1 × Punjab Naveen	4.40	2.33	-22.81**
Days to first female flower appear				
1.	Green long × Poinsette	39.60	-17.50**	-28.46**
2.	Pondicherry 1 × Punjab Naveen	41.00	-16.33**	-25.93**
3.	Green long × Pusa Uday	41.45	-13.65**	-25.11**
Days at first fruit harvest				
1.	Green long × Poinsette	46.1	-20.65**	-23.74**
2.	Pondicherry 1 × Punjab Naveen	46.25	-17.38**	-23.33**
3.	Green long × Pusa Uday	46.35	-18.29**	-23.49**
Number of fruits				
1.	IIHR 341 × Phule Shubhangi	8.15	13.99**	64.65**
2.	IIHR 341× Poinsette	6.60	6.29	53.54**
3.	IIHR 341 × Punjab Naveen	7.40	3.50	49.49**
Fruit length (cm)				
1.	Green long × Pusa Uday	28.60	46.29**	41.94**
2.	Green long × Poinsette	27.87	46.65**	38.31**
3.	Green long × Punjab Naveen	26.27	38.23**	30.37**
Fruit diameter (cm)				
1.	IIHR 304 × Kerala -2	4.15	-19.42**	-19.42**
2.	IIHR 304 × Pusa Uday	4.20	-13.3*	-18.35**
3.	IIHR 304 × Phule Shubhangi	4.30	0.93	-15.44*
Average fruit weight (g)				
1.	Pondicherry 1 × Phule Shubhangi	747.75	45**	46.52**
2.	Pondicherry 1 × Poinsette	717.65	39.16**	40.62**
3.	Pondicherry 1 × Punjab Naveen	699.25	35.59**	37.01**
Fruit yield per plant (kg)				
1.	Pondicherry 1 × Punjab Naveen	4.65	53.83**	55.79**
2.	Green long × Poinsette	4.63	61.57**	54.35**
3.	Green long × Pusa Uday	4.50	68.22**	50.47**

BP- Heterosis over better parent SH- Heterosis over the commercial check (Chitra)

*and ** indicate significance of values at p=0.05 and p=0.01, respectively

REFERENCES

Airina, C.K., Pradeepkumar, T., George, T.E., Sadhankumar, P.G., & Krishnan, S. (2013). Heterosis breeding exploiting gynoecy in cucumber (*Cucumis sativus* L.). *J. Trop. Agric.*, *51*(1-2), 144-148.

Alcazar, E.J.T., & Gulick, P.J. (1983).Genetic resources of cucurbitaceae-a global report, Rome, International Board for Plant Genetic Resources, Rome. pp 101. analysis in bitter gourd. *Indian J. Hort*., *67*(3), 399-401.

Arya, K., & Singh, D. K. (2014). Exploitation of Heterosis among parthinocarpic and monoecious genotypes of cucumber (*Cucumis sativus* L.) under polyhouse. *Int. J. Basic and applied Agri. Resc.*, *12*(1), 68-71.

Bairagi, S. K., Hariharram, Singh, D. K., & Maurya, S. K. (2005). Exploitation of hybrid vigour for yield and attributing traits in cucumber. *Indian J. Hort*., *62*(1), 41-45.

Dogra, B. S., & Kanwar, M.S. (2011). Exploiting Heterosis for Yield and Horticultural Traits in Cucumber (*Cucumis sativus* L.). *Indian J. Plant Genet. Resou*r., *24*(3), 332–339.

Hanchinamani, E. N., & Patil, M. G. (2009). Heterosis in cucumber (*Cucumis sativus* L.) *Asian J. Hort*., *4*, 21-24.

Jat, G. S., Munshi, A. D., Behera, T.K., Choudhary, H., & Dev, B. (2015). Exploitation of heterosis in cucumber for earliness, yield and yield components utilizing gynoecious lines. *Indian J. Hort*., *72*(4), 494-499.

Kumar, J., Munshi, A.D., Kumar, R., & Surelia, A.K. (2010). Studies on Heterosis in slicing cucumber. *Indian J. Hort*. *67*(2), 197-201.

Kushwaha, M. L., & Hariharram, (2002). Heterosis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Prog. Hort*., *34*(2), 174-178.

Mule , P. N., Khandelwal, V., Lodam, V. A., Shindhe, D. A., Patil, P. P., & Patil, A. B. (2012). Heterosis and combining ability in cucumber (*Cucumis sativus* L.). *Madras Agri. J*., *99*(7-9), 420-423.

Pandey, S., Singh, B., Singh, M., & Rai, M. (2005). Heterosis in cucumber (*Cucumis sativus* L.). *Veg. Sci*., *32*(2), 143-145.

Robinson, R.W., & Decker-Walter, D.S. (1999). *Cucurbits*. Cab International, University Press, Cambridge.

Sharma, D.R., Choudhary, M.R., Jakhar, M.L., & Dadheech S. (2012). Heterosis in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *Int. J. Life Sci*., *1*(3), 212-216.

Singh, P. P., & Singh, S. P. (2009). Combining ability analysis in relation to heterosis for yield and its components in bottle gourd. *Veg. Sci*., *36*(1), 98-99.

Singh, S. K., Kishor, G. R., & Srivastava, J. P. (2010). Commercial exploitation of hybrid vigour in cucumber. *Prog. Agric*. (Special Issue), *10*, 266-269.

Singh, S. K., Singh, S. V., & Srivastava, J. P. (2015). Studies on Heterosis and inbreeding depression in cucumber (*Cucumis sativus* L.) *Agriways*, *3*(2), 107-111.

Singh, S.K., Upadhyay, A. K., Pandey, J., & Pandey, A.K. (2012). Studies on heterosis and combining ability in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) for yield traits. *Ann. Horti*., *5*(2), 246-251.