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Heterosis for important quantitative traits in cucumber (*Cucumis sativus* L.)

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Abstract
The present investigation entitled "Heterosis for important quantitative traits in cucumber (*Cucumis sativus* L.)" was carried out at All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. The study was undertaken on 45 crosses made by 10 x 10 half diallel method and their parents of cucumber along with two commercial hybrids namely Gypsy and Chitra over two growing seasons i.e. *kharif* 2022 and summer 2023. Study explores the heterosis for various important quantitative traits in cucumber *viz*., length of vine (m), Number of nodes per vine, days to 1st female flower, number of fruits/vine, fruit length (cm) fruit diameter (cm), weight of fruit (g), yield/vine (kg), yield/plot (kg) and yield/hectare (t) etc. The F_1 hybrids *viz*. P_1 x P_9 (Cucumber-1 x Cucumber-9), P_2 x P_3 (Cucumber-2 x Cucumber-3), P_4 x P_8 (Cucumber-4 x Cucumber-8), P_4 x P_{10} (Cucumber-4 x Cucumber-10), P_5 x P_7 (Cucumber-5 x Cucumber-7), and P_5 x P_9 (Cucumber-5 x Cucumber-9) showed best *per se* performance and estimates of heterosis for earliness, yield and yield attributing characters. Persent study displayed direct relationship between *per se* performance and heterosis of hybrids for several traits.

Keywords: Heterosis, cucumber, quantitative traits, half diallel etc.

Introduction
Among the cucurbits, cucumber is distinct with a unique sex mechanism and this feature can easily be manipulated for production of F_1 hybrid seeds. Further, the crop is advantageous in having low inbreeding depression, high heterosis percentage, large number of seeds per fruit and low seed rate requirement per unit area favours commercial exploitation of heterosis in cucumber. The fruits and seeds possess cooling, astringent and antipyretic properties and the fruits are good for people suffering from constipation, jaundice and indigestion (Vashista, 1974) [9]. Considerable heterosis has been manifested in cucumber for various traits such as number of fruits, early and high yield. Heterosis in cucumber has been exploited to maximum advantage in developed countries. The first commercial hybrid in vegetables released for cultivation was in cucumber in 1935 in japan. India, being a Native place of cucumber, possesses great range of genetic variability for qualitative and quantitative characters (Munshi *et al*. 2007) [5]. In spite of this, very little effort has been made for genetic improvement of this crop through exploitation of hybrid vigour. India is the second largest producer of vegetables in the world next only to China, producing 199.88 million tonnes of vegetables annually from an area of 11.06 million hectares (Anon., 2022) [3].
Heterosis is more pronounced in cross pollinated species than selfed ones. The selection of parents on the basis of performance alone may not necessarily lead to fruitful results. Information on genetic association among components of yield and its attributes are invariably useful in improving selection efficiency. Combining ability is one of the powerful tools in identifying the best combiners that may be used to exploit heterosis or to accumulate fixable genes. The plant breeding programme attempts to improve current kinds and create new types that are superior to commercial cultivars. Variability is required for such crop development programmes. Breeders can easily utilise sufficient variability if it exists. Otherwise, variety is created by the use of several breeding strategies, the most common of which is hybridization, which remains the principal tool for plant breeders.
Cucumber has a broad range of diversity, making it suitable for hybridization. Early maturity, fruit yield and fruit qualities are the decisive elements whether variety will succeed

or fail. Knowledge of the nature of gene influence for yield and their contributing qualities is always beneficial in the selection of effective and efficient breeding procedures. Keeping this in mind, the current study is being conducted to investigate the heterosis, combining ability and gene action for quantitative features, as well as to estimate heritability for yield contributing characters and to check the disease and pest tolerance in the F_1 hybrids of cucumber along with the parents.

Although, many researchers have explored the heterosis in cucumber, but the aim of this study was to find out the outstanding F_1 crosses which are suitable for the Maharashtra state weather condition. Also to find out the parents which can be used in different breeding programme.

Materials and Methods

The present investigation on ''Heterosis for important quantitative traits in cucumber (*Cucumis sativus* L.)" was carried out at All India Co-ordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during *kharif* 2022 and summer 2023. Geographically experimental field has an altitude of 532 m above mean sea level, latitude of 19^0 47' to 19^0 57' N and longitude of 74^0 82' to 74^0 91' E. Rahuri comes under arid and tropical region and having temperature range 7.30 °C to 39.30 °C with 65% relative humidity. The average day length is of 8 hours and 30 minutes. Annual rainfall varies from 307 to 619 mm and average rainfall is 475 mm. Most of this rainfall is received through south-west monsoon. The experiment was conducted on medium black soil with appropriate drainage. The plot was ploughed and harrowed twice to bring the fine tilth of soil.

The inbred lines of ten genotypes were selected for the purpose of crossing programme and sown in crossing block at All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. Recommended dose of fertilizers and plant protection measures were taken up. The female and male flowers due to opening next morning were aged separately in the evening. Next day, the female flowers were hand pollinated in the morning after anthesis with pollens collected from previously bagged, male flowers and repeating it in the next morning to ensure good fruit set. The parents were also selfed simultaneously to obtain pure seeds of each genotype. The pedicel of each pollinated flower was tied with label bearing the information of female and male parents and date of crossing for identification. Crossing was made in diallel fashion (without reciprocals).

Experiment was laid in randomized block design with two replications having a plant spacing of 1.5 X 0.5 m^2 and plot size of 1.5 X 5 m^2, where the total numbers of treatments are 57 in which 45 F_1 hybrids, 10 parents and 2 standard checks.

Results and Discussion

Mean performance of Parent and hybrids for important quantitative traits

Length of vine (m)

In *kharif* season, Cucumber-8 (P_8) (2.93 m) and in the summer season Cucumber-7 (P_7) (2.61 m) recorded significantly maximum length of vine. In *kharif* season, hybrid combination P_5 x P_9 (3.92 m) recorded significantly maximum length of vine. Among the 45 crosses, the cross P_5 x P_9 (3.53 m) recorded a significant maximum length of vine in summer. Similar results of parents and hybrids for length of vine were reported by Singh and Tiwari (2006) [7], Tiwari and Singh (2015) [8].

Number of fruits/vine

During *kharif*, the significant maximum number of fruits per vine were produced by parent cucumber6 (P_6) (13.8) In summer season, the significantly maximum number of fruits per vine were produced by parent cucumber-2 (P_2) (16.2). In *kharif* season, the cross combination P_2 x P_3 (17.1) recorded significantly more number of fruits per vine. Whereas among all the crosses, the cross combination P_2 x P_3 (18.6), P_1 x P_4 (18.6) recorded a significantly maximum number of fruits per vine during summer season. Similar results were found by Sawant *et al*. (2017) [6].

Length of fruit (cm)

During both the season, the significant maximum length of fruit was found in parent cucumber-8 (19.5cm and 19.7cm respectively in *kharif* and summer). The result more or less same obtained by Al-Araby *et al.* (2017) [2] and Gharib *et al.* (2020) [4].

Diameter of fruit (cm)

During kharif, the significant maximum diameter of fruit was found in parent cucumber-2 (P2) (4.86cm). In summer season, the significantly maximum diameter of fruit were produced by parent cucumber-3 (P3) (6.06cm). In kharif season, the cross combination P4 x P6 (5.16cm) recorded significantly maximum diameter of fruit. Whereas among all the crosses, the cross combination P4 x P10 (5.49cm) recorded a significantly maximum diameter of fruit during summer season. Same results were obtained by Sawant *et al*. (2017) [6] and Abd Rabou (2018) [1].

Weight of fruit (g)

During kharif, the significant maximum weight of fruit was found in parent cucumber-2 (P2) (196.6g). In summer season, the significantly maximum weight of fruit was found in parent cucumber-7 (P7) (197.8g). In kharif season, the cross combination P4 x P10 (209.2g) recorded significantly maximum weight of fruit. Whereas among all the crosses, the cross combination P5 x P10 (210.4g) recorded a significantly maximum weight of fruit during summer season. The result coincides in with following studies Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7], Al-Araby *et al*. (2017) [2], Gharib *et al*. (2020) [4].

Weight of fruit per vine (kg)

During kharif, the significant maximum weight of fruit per vine was found in parent cucumber-2 (P2) (2.43 kg). In summer season, the significantly maximum weight of fruit per vine were produced by parent cucumber-2 (P2) (2.81 kg). In kharif season, the cross combination P2 x P3 (2.85 kg) recorded significantly maximum weight of fruit per vine. Whereas among all the crosses, the cross combination P2 x P3 (3.15 kg) recorded a significantly maximum weight of fruit per vine during summer season. Parallel results were obtained by Sawant *et al*. (2017) [6] and Abd Rabou (2018) [1].

Mean performance of parents and their crosses in 10x10 half diallel for various characters in cucumber

Sr. No.	Parents/ Hybrids	Length of vine (m)		Number of fruits/vine		Length of Fruit (cm)		Diameter of Fruit (cm)		Average weight of fruit (g)		Weight of fruit/vine (kg)		Weight of fruit/plot (kg)	
		Kharif	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer
Parents															
1.	P_1	2.18	2.36	12.2	11.2	16.6	17.1	4.25	3.96	135.8	144.0	1.66	1.91	16.09	19.31
2.	P_2	2.07	1.91	11.6	16.2	15.4	12.7	4.86	4.55	196.6	175.4	2.43	2.81	22.83	27.84
3.	P_3	1.80	1.87	10.4	9.8	15.2	15.2	3.97	6.06	146.4	169.6	1.46	1.70	13.43	16.53
4.	P_4	2.15	2.18	12.0	9.2	14.2	14.2	3.99	5.83	143.2	140.6	1.43	1.27	13.01	12.65
5.	P_5	2.59	2.07	12.2	11.6	17.6	18.3	4.33	5.19	183.6	178.4	1.96	1.85	18.08	17.30
6.	P_6	2.43	2.12	13.8	15.2	15.8	18.4	3.95	4.47	153.0	175.6	2.08	2.60	19.28	24.60
7.	P_7	2.20	2.61	9.0	10.6	16.4	16.2	3.68	5.95	177.4	197.8	1.59	2.11	14.27	21.08
8.	P_8	2.93	2.09	9.4	11.4	19.5	19.7	3.81	5.13	164.0	149.2	1.47	1.64	13.31	17.01
9.	P_9	2.26	2.28	12.6	14.8	16.6	18.1	4.18	5.16	182.8	151.4	2.22	2.23	21.31	21.37
10.	P_{10}	2.45	2.22	9.2	11.2	18.8	16.2	4.34	5.51	164.6	157.6	1.48	1.73	13.28	17.65
Hybrids															
11.	1 x 2	1.85	1.64	13.2	15.0	18.2	15.8	4.32	3.69	167.0	136.8	2.17	2.05	19.39	18.64
12.	1 x 3	1.65	1.79	14.6	16.0	16.6	15.7	4.22	4.02	176.4	148.4	2.51	2.37	24.40	22.94
13.	1 x 4	2.79	2.53	15.8	18.6	18.6	15.6	3.37	3.65	162.4	142.2	2.43	2.56	23.80	25.48
14.	1 x 5	2.18	1.90	13.0	12.8	14.4	16.9	3.96	4.18	138.8	161.4	1.80	1.94	16.56	18.46
15.	1 x 6	1.63	1.71	14.2	14.8	14.8	15.6	3.83	4.23	132.2	147.2	1.85	2.06	17.05	18.99
16.	1 x 7	1.52	1.61	10.4	8.4	17.6	15.6	3.21	3.42	188.8	183.4	1.88	1.65	18.01	15.77
17.	1 x 8	1.83	2.28	16.6	12.8	17.8	16.7	4.15	3.62	154.0	179.4	2.61	2.26	24.25	21.31
18.	1 x 9	2.45	2.24	14.4	16.4	18.4	16.1	4.12	4.44	188.0	190.2	2.63	3.04	25.92	29.16
19.	1 x 10	2.67	2.32	11.8	13.4	18.2	16.8	4.18	4.66	201.0	202.4	2.37	2.83	25.31	27.61
20.	2 x 3	2.52	2.81	17.1	18.6	16.8	16.8	4.36	4.09	190.2	180.8	2.85	3.15	26.67	29.26
21.	2 x 4	2.73	2.42	11.0	13.4	16.2	14.2	3.89	4.00	145.4	134.2	1.59	1.74	16.03	17.55
22.	2 x 5	2.30	2.95	15.4	13.2	15.2	15.2	4.14	4.22	148.8	181.4	2.52	2.36	24.73	23.44
23.	2 x 6	2.94	2.55	13.0	11.6	15.4	16.1	4.02	4.47	150.0	142.0	1.95	1.73	17.54	16.85
24.	2 x 7	2.64	2.24	12.2	13.6	17.2	14.9	5.08	5.44	170.8	166.2	2.04	2.16	19.89	21.52
25.	2 x 8	2.63	1.97	16.0	13.8	18.8	16.3	4.14	3.41	124.0	145.4	1.61	2.04	16.72	19.68
26.	2 x 9	2.07	1.70	13.2	13.4	14.8	14.6	3.85	4.20	148.4	146.4	1.92	1.90	18.16	17.62
27.	2 x 10	2.50	2.21	12.2	13.8	16.6	15.0	4.23	3.54	172.2	187.4	2.18	2.62	21.51	26.80
28.	3 x 4	2.37	2.26	13.6	12.6	16.0	14.5	4.54	4.10	191.4	178.4	2.48	2.19	23.96	20.61
29.	3 x 5	2.23	2.03	12.4	11.6	17.2	13.5	4.57	4.23	167.2	156.8	2.00	1.72	18.19	16.84
30.	3 x 6	2.19	1.94	15.0	14.0	16.4	16.7	3.94	4.57	163.2	157.8	2.44	2.21	23.45	21.62
31.	3 x 7	2.36	2.07	12.4	12.4	17.6	16.1	3.81	4.07	187.8	188.8	2.25	2.27	21.94	22.84
32.	3 x 8	2.69	2.43	15.2	14.4	18.6	16.5	3.07	3.37	153.2	142.2	2.29	1.99	23.14	20.76
33.	3 x 9	2.60	2.51	13.4	11.6	15.8	15.3	4.13	3.98	1580	157.4	2.05	1.73	19.99	16.53
34.	3 x 10	2.13	1.74	11.0	12.8	16.4	14.7	3.97	4.23	187.7	183.4	2.06	2.20	21.08	22.97
35.	4 x 5	2.54	2.51	13.6	11.8	17.6	14.6	4.23	3.88	164.0	165.2	2.13	1.96	20.19	19.265
36.	4 x 6	3.65	2.91	14.4	16.3	14.8	15.3	5.16	3.89	168.6	148.0	2.36	2.39	22.07	22.885
37.	4 x 7	3.01	2.44	15.6	16.0	16.4	14.8	3.69	4.00	150.6	141.0	2.25	2.26	22.01	22.42
38.	4 x 8	2.51	2.43	13.2	11.6	14.6	15.5	4.35	4.38	195.4	208.8	2.33	2.63	22.28	25.38
39.	4 x 9	2.27	1.79	11.6	11.2	15.6	14.3	3.92	4.15	158.0	156.0	1.73	1.56	18.51	14.82
40.	4 x 10	2.71	2.23	12.6	13.6	19.2	15.3	4.24	5.49	209.2	202.2	2.43	2.73	24.03	26.34
41.	5 x 6	3.37	2.95	13.6	12.8	16.6	20.3	4.19	4.09	176.6	202.2	2.33	2.63	22.11	25.45
42.	5 x 7	3.43	2.90	14.2	12.6	17.4	17.7	4.77	4.80	199.8	194.0	2.79	2.33	26.44	22.40
43.	5 x 8	3.55	2.70	12.4	10.4	16.8	18.6	4.11	4.21	188.8	181.8	2.30	1.96	21.61	18.61
44.	5 x 9	3.92	3.53	13.2	15.4	17.4	17.8	4.70	4.32	196.0	200.4	2.54	3.01	24.39	29.66
45.	5 x 10	3.57	3.17	14.2	10.4	15.2	20.6	4.18	4.66	171.4	210.4	2.39	2.19	22.37	21.21
46.	6 x 7	2.32	2.41	11.8	12.2	17.0	17.9	4.12	4.25	206.0	175.8	2.26	2.11	21.94	21.27
47.	6 x 8	2.61	2.05	14.2	13.6	18.6	17.0	4.47	5.08	186.8	188.4	2.61	2.45	25.05	23.33
48.	6 x 9	2.64	2.17	12.4	11.6	15.6	17.8	4.16	4.81	207.2	207.8	2.51	2.29	23.96	21.69
49.	6 x 10	2.85	2.16	12.6	13.6	20.0	18.3	4.39	4.96	202.4	200.0	2.42	2.60	23.16	25.80
50.	7 x 8	3.55	3.29	10.4	13.6	19.2	20.8	3.95	5.28	181.0	149.8	1.88	1.95	18.06	19.77
51.	7 x 9	2.52	2.85	10.6	12.4	19.8	22.6	4.35	5.14	188.8	207.6	2.03	2.61	18.86	26.10
52.	7 x10	3.35	2.72	9.40	12.2	19.6	21.2	3.89	4.79	206.2	164.0	1.88	1.97	17.82	18.78
53.	8 x 9	2.40	2.37	9.40	15.6	19.8	20.9	4.24	4.99	203.8	168.4	2.09	2.53	18.85	24.80
54.	8 x 10	3.91	2.63	13.0	11.8	20.2	20.2	4.01	5.23	183.8	192.4	2.34	2.23	22.22	21.67
55.	9 x 10	2.81	3.21	8.40	10.4	22.2	19.8	3.97	5.19	201.6	167.8	1.75	1.68	15.93	15.18
Std. Check - 1		2.46	2.34	11.4	12.6	14	15.2	4.08	4.04	153.4	131.6	1.68	1.71	16.47	16.71
Std. Check - 2		2.89	2.51	13.2	15.2	17.8	18.8	4.17	4.38	161.8	168.2	2.1	2.52	20.86	25.57
General mean		2.63	2.34	12.81	13.11	17.77	17.30	4.13	4.51	173.39	171.73	2.13	2.19	20.38	21.36
S.E. ±		0.32	0.27	0.89	0.88	0.72	0.80	0.17	0.18	6.27	6.79	0.13	0.16	1.06	1.36
C.D. 5%		0.92	0.79	2.53	2.49	2.04	2.28	0.50	0.51	17.77	19.26	0.39	0.46	3.02	3.86
C.D. 1%		1.22	1.05	3.37	3.32	2.72	3.03	0.67	0.68	23.65	25.64	0.52	0.61	4.03	5.14

Weight of fruit per plot (kg)

During kharif, the significant maximum weight of fruit per plot was found in parent cucumber-2 (P2) (22.83 kg). In summer season, the significantly maximum weight of fruit per plot were produced by parent cucumber-2 (P2) (27.84 kg). In kharif season, the cross combination P2 x P3 (26.67 kg) recorded significantly maximum weight of fruit per plot. Whereas among all the crosses, the cross combination P2 x P3 (29.26 kg) recorded a significantly maximum weight of fruit per plot during summer season. Results were same with Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7].

Heterosis of Important quantitative traits

Length of vine (m)

Heterosis over better parent ranged from -39.28 to 50.21%, over top parent ranged from -57.66 to 28.69%, heterosis range over standard hybrid check-1 were -38.21 to 59.55% and heterosis range over standard hybrid check-2 were -47.40 to 35.81% during the kharif season. On other hand range of heterosis over better parent was -38.31 to 47.12%, over top parent -47.90 to 14.24%, heterosis range over standard hybrid check-1 was -29.91 to 40.60% and heterosis range over standard hybrid check-2 were -35.86 to 40.64% summer during season.

In kharif the cross P4 x P6 (50.21%) showed significant positive heterosis over better parent, cross P5 x P9 (28.69%) showed significant positive heterosis over top parent, the cross P5 x P9 (59.55%) showed significant positive heterosis over standard hybrid check-1 and the cross P5 x P9 (35.81%) showed significant positive heterosis over standard hybrid check-2. In summer the crosses P2 x P3 (47.12%) showed highest significant positive heterosis over better parent, cross P5 x P9 (14.24%) showed significant positive heterosis over top parent, the cross P5 x P9 (40.17%) showed significant positive heterosis over standard hybrid check-1 and P5 x P9 (40.64%) showed significant positive heterosis over standard hybrid check-2.

Length of vine is one of the most important yield contributing traits along with a number of nodes per vine which influence the yield. The results were in correspondence with Singh and Tiwari (2006) [7], Tiwari and Singh (2015) [8], Al-Araby *et al*. (2017) [2], Sawant *et al*. (2017) [6], and Abd Rabou (2018) [1], Gharib *et al*. (2020) [4].

Number of fruits per plant

Heterosis ranges over better parent from -33.33 to 56.67 percent, heterosis over top parent ranged from -39.13 to 36.23 percent, heterosis range over standard hybrid check-1 were -34.63 to 46.30 percent and heterosis range over standard hybrid check-2 were -36.36 to 42.42 percent during the summer where as in kharif season over better parents ranged from -29.73 to 56.83 percent heterosis, over top parent ranged from -48.15 to 14.81 percent, heterosis range over standard hybrid check-1 were -33.33 to 47.62 percent and heterosis range over standard hybrid check-2 were -44.74 to 22.37 percent.

In kharif the cross P4 x P8 showed significant positive heterosis over better parent (56.67%), top parent (36.23%), standard hybrid check-1 (46.30%) and standard hybrid check-2 (42.42%). In summer the crosses P1 x P4 (56.83%) showed highest significant positive heterosis over better parent, the crosses P2 x P3 showed significant positive heterosis over top parent (14.81%), standard hybrid check-1 (47.62%) and standard hybrid check-2 (22.37%).

Number of fruit per plant is one of the most important yield contributing character which is directly related with increment in yield per unit area hence significantly positive heterosis effect is highly desirable for this character. Similar results were obtained by Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7], Tiwari and Singh (2015) [8], Al-Araby *et al*. (2017) [2].

Length of fruit (cm)

Heterosis ranges over better parents from -36.52 to 29.63 percent, over top parent ranged from -37.39 to 21.74 percent, heterosis range over standard hybrid check-1 were 2.86 to 77.14 percent and heterosis range over standard hybrid check-2 were -19.10 to 39.33 percent during the kharif where as in summer season over better parents ranged from -43.51 to 32.99 percent heterosis, over top parent ranged from -48.47 to 16.79 percent, heterosis range over standard hybrid check-1 were -19.88 to 57.63 percent and heterosis range over standard hybrid check-2 were -28.19 to 41.28 percent.

In *kharif* the cross P9 x P10 (29.63%) showed significant positive heterosis over better parent, P9 x P10 (21.74%) showed significant positive heterosis over top parent, the cross P7 x P9 showed significant positive heterosis over standard hybrid check-1 (77.14%) and standard hybrid check-2 (39.33%). In summer the crosses P8 x P10 (32.99%) showed highest significant positive heterosis over better parent, the cross P7 x P9 showed significant positive heterosis over top parent (16.79%), standard hybrid check-1 (57.63%) and standard hybrid check-2 (41.28%).

Fruit length is the most crucial character in accordance with yield, maximum the fruit length higher the yield. It is similar to earlier findings of Sawant *et al*. (2017) [6], Al-Araby *et al.* (2017) [2], Abd Rabou (2018) [1], Gharib *et al.* (2020) [4].

Diameter of fruit (cm)

Heterosis over better parents ranging from -24.47 to 29.32 percent, over top parent ranged from -36.83 to 6.17 percent, heterosis range over standard hybrid check-1 were -24.75 to 26.47 percent and heterosis range over standard hybrid check-2 were -26.38 to 23.74 percent during the *kharif* where as in summer season over better parents ranged from -44.39 to 3.19 percent heterosis, over top parent ranged from -44.39 to 1.32 percent, heterosis range over standard hybrid check-1 were -16.58 to 51.98 percent and heterosis range over standard hybrid check-2 were -23.06 to 40.18 percent.

In *kharif* the crosses P4 x P6 showed significant positive heterosis over better parent (29.32%), top parent (6.17%), standard hybrid check-1 (26.47%) and standard hybrid check-2 (23.74%). In summer the crosses P7 x P9 showed highest significant positive heterosis over better parent (3.19%), top parent (1.32%), standard hybrid check-1 (51.98%) and standard hybrid check-2 (40.18%).

Fruit diameter is the most important yield contributing character, maximum the fruit diameter higher the yield hence heterosis in positive direction is desirable. The results obtained for diameter of fruit were in agreement with results obtained Sawant *et al*. (2017) [6], Al-Araby *et al.* (2017) [2], Abd Rabou (2018) [1], Gharib *et al.* (2020) [4].

Heterosis (%) over better parent, top parent and SC-1 & SC-2 in Cucumber for different quantitative traits over two seasons

Crosses	Length of vine (m)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	-15.14	-48.47 **	-24.80	-35.99*	-30.51	-46.93**	-29.91	-34.66*
1 X 3	-24.31	-54.04 **	-32.93	-42.91**	-24.15	-42.07**	-23.50	-28.69
1 X 4	27.98	-22.28	13.41	-3.46	7.20	-18.12	8.12	0.80
1 X 5	-39.28 **	-39.28 **	-11.38	-24.57	-38.11 **	-38.51**	-18.80	-24.3
1 X 6	-32.92	-54.60 **	-33.74	-43.60**	-27.54	-44.66**	-26.92	-31.87*
1 X 7	-30.91	-57.66 **	-38.21*	-47.40**	-38.31 *	-47.90**	-31.20	-35.86*
1 X 8	-37.54 *	-49.03 **	-25.61	-36.68*	-26.21 *	-26.21*	-2.56	-9.16
1 X 9	-24.85	-31.75 *	-0.41	-15.22	-5.08	-27.51*	-4.27	-10.76
1 X 10	8.98	-25.63 *	8.54	-7.61	-1.69	-24.92	-0.85	-7.57
2 X 3	21.74	-29.81 *	2.44	-12.80	47.12 *	-9.06	20.09	11.95
2 X 4	26.98	-23.96	10.98	-5.54	11.01	-21.68	3.42	-3.59
2 X 5	-35.93 **	-35.93 **	-6.50	-20.42	-3.91	-4.53	26.07	17.53
2 X 6	20.99	-18.11	19.51	1.73	20.28	-17.48	8.97	1.59
2 X 7	20.00	-26.46 *	7.32	-8.65	-14.18	-27.51*	-4.27	-10.76
2 X 8	-10.24	-26.74 *	6.91	-9.00	-36.25 **	-36.25**	-15.81	-21.51
2 X 9	-36.50 *	-42.34 **	-15.85	-28.37	-25.44	-44.98**	-27.35	-32.27*
2 X 10	2.04	-30.36 *	1.63	-13.49	-0.45	-28.48*	-5.56	-11.95
3 X 4	10.23	-33.98 **	-3.66	-17.99	3.67	-26.86*	-3.42	-9.96
3 X 5	-37.88 **	-37.88 **	-9.35	-22.84	-33.88 *	-34.30*	-13.25	-19.12
3 X 6	-9.88	-39.00 **	-10.98	-24.22	-8.49	-37.22**	-17.09	-22.71
3 X 7	7.27	-34.26 **	-4.07	-18.34	-20.69	-33.01*	-11.54	-17.53
3 X 8	-8.19	-25.07	9.35	-6.92	-21.36	-21.36	3.85	-3.19
3 X 9	-20.25	-27.58 *	5.69	-10.03	10.09	-18.77	7.26	0.00
3 X 10	-13.06	-40.67 **	-13.41	-26.3	-21.62	-43.69**	-25.64	-30.68
4 X 5	-29.25 *	-29.25 *	3.25	-12.11	-18.24	-18.77	7.26	0.00
4 X 6	50.21 **	1.67	48.37*	26.30	-12.39	-38.19**	-18.38	-23.9
4 X 7	36.82	-16.16	22.36	4.15	-6.51	-21.04	4.27	-2.79
4 X 8	-14.33	-30.08 *	2.03	-13.15	-21.36	-21.36	3.85	-3.19
4 X 9	-30.37 *	-36.77 **	-7.72	-21.45	-21.49	-42.07**	-23.50	-28.69
4 X 10	10.61	-24.51	10.16	-6.23	0.45	-27.83*	-4.70	-11.16
5 X 6	-6.13	-6.13	36.99*	16.61	-36.48 **	-36.89**	-16.67	-22.31
5 X 7	-4.46	-4.46	39.43*	18.69	-5.54	-6.15	23.93	15.54
5 X 8	-1.11	-1.11	44.31*	22.84	-12.62	-12.62	15.38	7.57
5 X 9	28.69 *	28.69 *	59.55**	35.81*	4.56	14.24	40.17*	40.64*
5 X 10	-0.56	-0.56	45.12*	23.53	3.26	2.59	35.47 *	26.29
6 X 7	-4.53	-35.38 **	-5.69	-19.72	-7.66	-22.01	2.99	-3.98
6 X 8	-10.92	-27.30 *	6.10	-9.69	-33.66 *	-33.66*	-12.39	-18.33
6 X 9	-19.02	-26.46 *	7.32	-8.65	-4.82	-29.77*	-7.26	-13.55
6 X 10	16.33	-20.61	15.85	-1.38	-2.70	-30.10*	-7.69	-13.94
7 X 8	21.16	-1.11	44.31*	22.84	6.47	6.47	40.60 *	31.08
7 X 9	-22.70	-29.81 *	2.44	-12.8	9.20	-7.77	21.79	13.55
7 X 10	36.73	-6.69	36.18	15.92	4.21	-11.97	16.24	8.37
8 X 9	-26.38	-33.15 *	-2.44	-16.96	-23.30	-23.30	1.28	-5.58
8 X 10	33.45 *	8.91	58.94**	35.29*	-14.89	-14.89	12.39	4.78
9 X 10	-13.80	-21.73	14.23	-2.77	43.86 *	3.88	37.18*	27.89
S.E.±	0.46	0.46	0.46	0.46	0.40	0.40	0.40	0.40
C.D.5%	0.92	0.92	0.92	0.92	0.80	0.80	0.80	0.80
C.D.1%	1.22	1.22	1.22	1.22	1.06	1.06	1.06	1.06

*and**significant at 5% and 1% respectively.

Crosses	Number of fruits/vine							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	8.20	-4.35	2.72	0.00	-7.41	-7.41	19.05	-1.32
1 X 3	19.67	5.80	13.62	10.61	42.86 **	-1.23	26.98**	5.26
1 X 4	29.51 **	14.49	22.96*	19.70 *	56.83 **	14.81	47.62**	22.37**
1 X 5	6.56	-5.80	1.17	-1.52	10.34	-20.99**	1.59	-15.79
1 X 6	2.90	2.90	10.51	7.58	-2.63	-8.64	17.46	-2.63
1 X 7	-14.75	-24.64 **	-19.07	-21.21 *	-25.00 *	-48.15**	-33.33**	-44.74**
1 X 8	36.07 **	20.29 *	29.18**	25.76 **	12.28	-20.99**	1.59	-15.79
1 X 9	14.29	4.35	12.06	9.09	10.81	1.23	30.16**	7.89
1 X 10	-3.28	-14.49	-8.17	-10.61	19.64	-17.28*	6.35	-11.84
2 X 3	32.76 **	11.59	19.84*	16.67	14.81	14.81	47.62**	22.37**
2 X 4	-8.33	-20.29 *	-14.40	-16.67	-17.28 *	-17.28*	6.35	-11.84
2 X 5	36.07 **	20.29 *	29.18**	25.76 **	-18.52 *	-18.52*	4.76	-13.16
2 X 6	-5.80	-5.80	1.17	-1.52	-28.40 **	-28.40**	-7.94	-23.68**
2 X 7	5.17	-11.59	-5.06	-7.58	-16.05 *	-16.05*	7.94	-10.53
2 X 8	37.93 **	15.94	24.51*	21.21 *	-14.81	-14.81	9.52	-9.21
2 X 9	4.76	-4.35	2.72	0.00	-17.28 *	-17.28*	6.35	-11.84
2 X 10	5.17	-11.59	-5.06	-7.58	-14.81	-14.81	9.52	-9.21
3 X 4	13.33	-1.45	5.84	3.03	17.76	-22.22**	0	-17.11*
3 X 5	1.64	-10.14	-3.50	-6.06	0.00	-28.40**	-7.94	-23.68**
3 X 6	8.70	8.70	16.73	13.64	-7.89	-13.58	11.11	-7.89
3 X 7	19.23	-10.14	-3.50	-6.06	12.73	-23.46**	-1.59	-18.42*
3 X 8	46.15 **	10.14	18.29	15.15	26.32 *	-11.11	14.29	-5.26
3 X 9	6.35	-2.90	4.28	1.52	-21.62 *	-28.40**	-7.94	-23.68**
3 X 10	5.77	-20.29 *	-14.40	-16.67	14.29	-20.99**	1.59	-15.79
4 X 5	11.48	-1.45	5.84	3.03	1.72	-27.16**	-6.35	-22.37**
4 X 6	4.35	4.35	12.06	9.09	7.24	0.62	29.37**	7.24
4 X 7	30.00 **	13.04	21.40*	18.18	45.45 **	-1.23	26.98**	5.26
4 X 8	56.67 **	36.23 **	46.30**	42.42 **	1.75	-28.40**	-7.94	-23.68**
4 X 9	-7.94	-15.94	-9.73	-12.12	-24.32 **	-30.86**	-11.11	-26.32**
4 X 10	5.00	-8.70	-1.95	-4.55	21.43	-16.05*	7.94	-10.53
5 X 6	-1.45	-1.45	5.84	3.03	-15.79	-20.99**	1.59	-15.79
5 X 7	16.39	2.90	10.51	7.58	8.62	-22.22**	0.00	-17.11*
5 X 8	1.64	-10.14	-3.50	-6.06	-10.34	-35.80**	-17.46	-31.58**
5 X 9	4.76	-4.35	2.72	0.00	4.05	-4.94	22.22*	1.32
5 X 10	16.39	2.90	10.51	7.58	-10.34	-35.80**	-17.46	-31.58**
6 X 7	-14.49	-14.49	-8.17	-10.61	-19.74 *	-24.69**	-3.17	-19.74*
6 X 8	2.90	2.90	10.51	7.58	-10.53	-16.05*	7.94	-10.53
6 X 9	-10.14	-10.14	-3.50	-6.06	-23.68 **	-28.40**	-7.94	-23.68**
6 X 10	-8.70	-8.70	-1.95	-4.55	-10.53	-16.05*	7.94	-10.53
7 X 8	10.64	-24.64 **	-19.07	-21.21 *	19.30	-16.05*	7.94	-10.53
7 X 9	-15.87	-23.19 *	-17.51	-19.70 *	-16.22	-23.46**	-1.59	-18.42*
7 X 10	2.17	-31.88 **	-26.85**	-28.79 **	8.93	-24.69**	-3.17	-19.74*
8 X 9	-25.40 *	-31.88 **	-26.85**	-28.79 **	5.41	-3.70	23.81*	2.63
8 X 10	38.30 **	-5.80	1.17	-1.52	3.51	-27.16**	-6.35	-22.37**
9 X 10	-33.33 **	-39.13 **	-34.63**	-36.36 **	-29.73 **	-35.80**	-17.46	-31.58**
S.E.±	1.27	1.27	1.27	1.27	1.25	1.25	1.25	1.25
C.D.5%	2.54	2.54	2.54	2.54	2.51	2.51	2.51	2.51
C.D.1%	3.38	3.38	3.38	3.38	3.35	3.35	3.35	3.35

*and**significant at 5% and 1% respectively.

Crosses	Length of fruit (cm)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	9.64	-20.87 **	30.00**	2.25	-7.60	-39.69**	-6.23	-15.96 **
1 X 3	0.00	-27.83 **	18.57*	-6.74	-8.19	-40.08**	-6.82	-16.49 **
1 X 4	12.05	-19.13 **	32.86**	4.49	-8.77	-40.46**	-7.42	-17.02 **
1 X 5	-13.25 *	-37.39 **	2.86	-19.10**	-7.65	-35.50**	0.30	-10.11
1 X 6	-10.84	-35.65 **	5.71	-16.85**	-15.22*	-40.46**	-7.42	-17.02 **
1 X 7	-17.76 **	-23.48 **	25.71**	-1.12	-40.46**	-40.46**	-7.42	-17.02 **
1 X 8	-22.61 **	-22.61 **	27.14**	0.00	-15.23*	-36.26**	-0.89	-11.17
1 X 9	-14.81 **	-20.00 **	31.43**	3.37	-24.77**	-38.55**	-4.45	-14.36 *
1 X 10	-3.19	-20.87 **	30.00**	2.25	-1.75	-35.88**	-0.30	-10.64
2 X 3	9.09	-26.96 **	20.00**	-5.62	10.53	-35.88**	-0.30	-10.64
2 X 4	5.19	-29.57 **	15.71*	-8.99	0.00	-45.80**	-15.73 *	-24.47 **
2 X 5	-8.43	-33.91 **	8.57	-14.61*	-16.94**	-41.98**	-9.79	-19.15 **
2 X 6	-2.53	-33.04 **	10.00	-13.48*	-12.50*	-38.55**	-4.45	-14.36 *
2 X 7	-19.63 **	-25.22 **	22.86**	-3.37	-43.13**	-43.13**	-11.57	-20.74 **
2 X 8	-18.26 **	-18.26 **	34.29**	5.62	-17.26**	-37.79**	-3.26	-13.30 *
2 X 9	-31.48 **	-35.65 **	5.71	-16.85**	-31.78**	-44.27**	-13.35 *	-22.34 **
2 X 10	-11.70 *	-27.83 **	18.57*	-6.74	-7.41	-42.75**	-10.98	-20.21 **
3 X 4	5.26	-30.43 **	14.29*	-10.11	-4.61	-44.66**	-13.95 *	-22.87 **
3 X 5	3.61	-25.22 **	22.86**	-3.37	-26.23**	-48.47**	-19.88 **	-28.19 **
3 X 6	3.80	-28.70 **	17.14*	-7.87	-9.24	-36.26**	-0.89	-11.17
3 X 7	-17.76 **	-23.48 **	25.71**	-1.12	-38.55**	-38.55**	-4.45	-14.36 *
3 X 8	-19.13 **	-19.13 **	32.86**	4.49	-16.24**	-37.02**	-2.08	-12.23 *
3 X 9	-26.85 **	-31.30 **	12.86	-11.24*	-28.50**	-41.60**	-9.20	-18.62 **
3 X 10	-12.77 *	-28.70 **	17.14*	-7.87	-9.26	-43.89**	-12.76	-21.81 **
4 X 5	18.07 **	-14.78 **	40.00**	10.11	-20.22**	-44.27**	-13.35 *	-22.34 **
4 X 6	-6.33	-35.65 **	5.71	-16.85**	-16.85**	-41.60**	-9.20	-18.62 **
4 X 7	-23.36 **	-28.70 **	17.14*	-7.87	-43.51**	-43.51**	-12.17	-21.28 **
4 X 8	-36.52 **	-36.52 **	4.29	-17.98**	-21.32**	-40.84**	-8.01	-17.55 **
4 X 9	-27.78 **	-32.17 **	11.43	-12.36*	-33.18**	-45.42**	-15.13 *	-23.94 **
4 X 10	-8.51	-25.22 **	22.86**	-3.37	-5.56	-41.60**	-9.20	-18.62 **
5 X 6	0.00	-27.83 **	18.57*	-6.74	10.33	-22.52**	20.47 **	7.98
5 X 7	-18.69 **	-24.35 **	24.29**	-2.25	-32.44**	-32.44**	5.04	-5.85
5 X 8	-26.96 **	-26.96 **	20.00**	-5.62	-5.58	-29.01**	10.39	-1.06
5 X 9	-19.44 **	-24.35 **	24.29**	-2.25	-16.82**	-32.06**	5.64	-5.32
5 X 10	-19.15 **	-33.91 **	8.57	-14.61*	12.57*	-21.37**	22.26 **	9.57
6 X 7	-20.56 **	-26.09 **	21.43**	-4.49	-31.68**	-31.68**	6.23	-4.79
6 X 8	-19.13 **	-19.13 **	32.86**	4.49	-13.71*	-35.11**	0.89	-9.57
6 X 9	-27.78 **	-32.17 **	11.43	-12.36*	-16.82**	-32.06**	5.64	-5.32
6 X 10	6.38	-13.04 **	42.86**	12.36*	-0.54	-30.15**	8.61	-2.66
7 X 8	5.22	5.22	72.86**	35.96**	-20.61**	-20.61**	23.44 **	10.64
7 X 9	14.81 **	7.83	77.14**	39.33**	16.79**	16.79**	57.63 **	41.28 **
7 X 10	14.95 **	6.96	75.71**	38.20**	-17.56**	-17.56**	28.19 **	14.89 *
8 X 9	7.83	7.83	77.14**	39.33**	7.01	-12.60**	35.91 **	21.81 **
8 X 10	-12.17 **	-12.17 **	44.29**	13.48*	32.99**	0.00	52.82 **	36.97 **
9 X 10	29.63 **	21.74 **	55.71**	22.47**	-7.48	-24.43**	17.51 *	5.32
S.E.±	1.00	1.00	1.00	1.00	1.13	1.13	1.13	1.13
C.D.5%	2.00	2.00	2.00	2.00	2.27	2.27	2.27	2.27
C.D.1%	2.67	2.67	2.67	2.67	3.03	3.03	3.03	3.03

*and**significant at 5% and 1% respectively.

Crosses	Diameter of fruit (cm)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	-11.11 *	-11.11 *	5.88	3.60	-18.90**	-39.11**	-8.66	-15.75**
1 X 3	-0.71	-13.17 *	3.43	1.20	-33.66**	-33.66**	-0.50	-8.22
1 X 4	-20.71 **	-30.66 **	-17.40 **	-19.18 **	-37.39**	-39.77**	-9.65	-16.67**
1 X 5	-8.55	-18.52 **	-2.94	-5.04	-19.46**	-31.02**	3.47	-4.57
1 X 6	-9.88	-21.19 **	-6.13	-8.15	-5.37	-30.20**	4.70	-3.42
1 X 7	-24.47 **	-33.95 **	-21.32 **	-23.02 **	-42.52**	-43.56**	-15.35*	-21.92**
1 X 8	-2.35	-14.61 **	1.72	-0.48	-29.43**	-40.26**	-10.4	-17.35**
1 X 9	-3.06	-15.23 **	0.98	-1.20	-13.95**	-26.73**	9.90	1.37
1 X 10	-3.69	-13.99 *	2.45	0.24	-15.43**	-23.10**	15.35*	6.39
2 X 3	-10.29	-10.29	6.86	4.56	-32.51**	-32.51**	1.24	-6.62
2 X 4	-19.96 **	-19.96 **	-4.66	-6.71	-31.39**	-33.99**	-0.99	-8.68
2 X 5	-14.81 **	-14.81 **	1.47	-0.72	-18.69**	-30.36**	4.46	-3.65
2 X 6	-17.28 **	-17.28 **	-1.47	-3.60	-1.76	-26.24**	10.64	2.05
2 X 7	4.53	4.53	24.51 **	21.82 **	-8.57	-10.23*	34.65**	24.20**
2 X 8	-14.81 **	-14.81 **	1.47	-0.72	-33.53**	-43.73**	-15.59*	-22.15**
2 X 9	-20.78 **	-20.78 **	-5.64	-7.67	-18.60**	-30.69**	3.96	-4.11
2 X 10	-12.96 *	-12.96 *	3.68	1.44	-35.75**	-41.58**	-12.38	-19.18**
3 X 4	13.78 *	-6.58	11.27	8.87	-32.34**	-32.34**	1.49	-6.39
3 X 5	5.54	-5.97	12.01	9.59	-30.20**	-30.20**	4.70	-3.42
3 X 6	-0.76	-18.93 **	-3.43	-5.52	-24.59**	-24.59**	13.12*	4.34
3 X 7	-4.03	-21.60 **	-6.62	-8.63	-32.84**	-32.84**	0.74	-7.08
3 X 8	-22.67 **	-36.83 **	-24.75 **	-26.38 **	-44.39**	-44.39**	-16.58*	-23.06**
3 X 9	-1.20	-15.02 **	1.23	-0.96	-34.32**	-34.32**	-1.49	-9.13
3 X 10	-8.53	-18.31 **	-2.70	-4.80	-30.20**	-30.20**	4.70	-3.42
4 X 5	-2.31	-12.96 *	3.68	1.44	-33.45**	-35.97**	-3.96	-11.42
4 X 6	29.32 **	6.17	26.47 **	23.74 **	-33.28**	-35.81**	-3.71	-11.19
4 X 7	-7.52	-24.07 **	-9.56	-11.51	-32.77**	-33.99**	-0.99	-8.68
4 X 8	9.02	-10.49	6.62	4.32	-24.87**	-27.72**	8.42	0.00
4 X 9	-6.22	-19.34 **	-3.92	-6.00	-28.82**	-31.52**	2.72	-5.25
4 X 10	-2.30	-12.76 *	3.92	1.68	2.74	-1.16	48.27**	36.76**
5 X 6	-3.23	-13.79 *	2.70	0.48	-21.19**	-32.51**	1.24	-6.62
5 X 7	10.16	-1.85	16.91 **	14.39 *	-19.33**	-20.79**	18.81**	9.59
5 X 8	-5.08	-15.43 **	0.74	-1.44	-18.88**	-30.53**	4.21	-3.88
5 X 9	8.55	-3.29	15.20 *	12.71 *	-16.76**	-28.71**	6.93	-1.37
5 X 10	-3.69	-13.99 *	2.45	0.24	-15.43**	-23.10**	15.35*	6.39
6 X 7	4.30	-15.23 **	0.98	-1.20	-28.57**	-29.87**	5.20	-2.97
6 X 8	13.16 *	-8.02	9.56	7.19	-0.97	-16.17**	25.74**	15.98**
6 X 9	-0.48	-14.40 **	1.96	-0.24	-6.78	-20.63**	19.06**	9.82
6 X 10	1.15	-9.67	7.60	5.28	-9.98*	-18.15**	22.77**	13.24*
7 X 8	3.67	-18.72 **	-3.19	-5.28	-11.26*	-12.87**	30.69**	20.55**
7 X 9	4.07	-10.49	6.62	4.32	3.19	1.32	51.98**	40.18**
7 X 10	-10.37	-19.96 **	-4.66	-6.71	-19.50**	-20.96**	18.56**	9.36
8 X 9	1.44	-12.76 *	3.92	1.68	-3.29	-17.66**	23.51**	13.93*
8 X 10	-7.60	-17.49 **	-1.72	-3.84	-5.08	-13.70**	29.46**	19.41**
9 X 10	-8.53	-18.31 **	-2.70	-4.80	-5.81	-14.36**	28.47**	18.49**
S.E.±	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
C.D.5%	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
C.D.1%	0.69	0.69	0.69	0.69	0.68	0.68	0.68	0.68

*and**significant at 5% and 1% respectively.

Crosses	Average weight of fruit (g)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	-24.64 **	-24.64 **	8.87	3.21	-22.01**	-35.10**	-7.41	-18.67**
1 X 3	20.49 **	-20.40 **	14.99 *	9.02	-14.71*	-29.60**	0.44	-11.77*
1 X 4	13.41 *	-26.71 **	5.87	0.37	-18.28**	-32.54**	-3.76	-15.46**
1 X 5	-15.16 **	-37.36 **	-9.52	-14.22 *	-7.24	-23.43**	9.24	-4.04
1 X 6	-13.59 *	-40.34 **	-13.82 *	-18.29 **	-16.17**	-30.17**	-0.37	-12.49*
1 X 7	6.43	-14.80 **	23.08 **	16.69 **	-13.00**	-13.00**	24.13 **	9.04
1 X 8	-6.10	-30.51 **	0.39	-4.82	3.10	-14.90**	21.42 **	6.66
1 X 9	2.84	-15.16 **	22.56 **	16.19 **	9.31	-9.77*	28.73 **	13.08*
1 X 10	22.11 **	-9.30 *	31.03 **	24.23 **	24.94**	3.13	47.14 **	29.25**
2 X 3	-14.17 **	-14.17 **	23.99 **	17.55 **	3.08	-14.23**	22.37 **	7.49
2 X 4	-34.39 **	-34.39 **	-5.22	-10.14	-23.49**	-36.34**	-9.17	-20.21**
2 X 5	-32.85 **	-32.85 **	-3.00	-8.03	3.42	-13.95**	22.77 **	7.85
2 X 6	-32.31 **	-32.31 **	-2.22	-7.29	-19.13**	-32.64**	-3.89	-15.58**
2 X 7	-22.92 **	-22.92 **	11.34	5.56	-21.16**	-21.16**	12.49	-1.19
2 X 8	-44.04 **	-44.04 **	-19.17 **	-23.36 **	-17.10**	-31.02**	-1.59	-13.56*
2 X 9	-33.03 **	-33.03 **	-3.26	-8.28	-16.53**	-30.55**	-0.91	-12.96*
2 X 10	-22.29 **	-22.29 **	12.26 *	6.43	6.84	-11.10*	26.84 **	11.41
3 X 4	23.45 **	-13.63 **	24.77 **	18.29 **	5.19	-15.37**	20.74 **	6.06
3 X 5	2.20	-24.55 **	9.00	3.34	-7.55	-25.62**	6.13	-6.78
3 X 6	6.67	-26.35 **	6.39	0.87	-10.14	-25.14**	6.80	-6.18
3 X 7	5.86	-15.25 **	22.43 **	16.07 **	-10.44*	-10.44*	27.78 **	12.25*
3 X 8	-6.59	-30.87 **	-0.13	-5.32	-16.16**	-32.54**	-3.76	-15.46**
3 X 9	-13.57 **	-28.70 **	300	-2.35	-7.19	-25.33**	6.53	-6.42
3 X 10	14.03 *	-15.30 **	22.36 **	16.01 **	8.14	-13.00**	24.13 **	9.04
4 X 5	0.24	-25.99 **	6.91	1.36	-1.90	-21.63**	11.81	-1.78
4 X 6	10.20	-23.92 **	9.91	4.20	-15.72**	-29.79**	0.17	-12.01*
4 X 7	-15.11 **	-32.04 **	-1.83	-6.92	-33.11**	-33.11**	-4.57	-16.17**
4 X 8	-5.24	-29.87 **	1.30	-3.96	46.65**	4.08	48.49 **	30.44**
4 X 9	-13.57 **	-28.70 **	3.00	-2.35	3.04	-26.00**	5.58	-7.25
4 X 10	30.74 **	-8.30 *	49.76**	43.88 **	28.30**	-4.08	36.85 **	20.21**
5 X 6	7.95	-20.31 **	15.12 *	9.15	15.15**	-4.08	36.85 **	20.21**
5 X 7	12.63 *	-9.84 *	30.25 **	23.49 **	-7.97	-7.97	31.30 **	15.34*
5 X 8	15.12 **	-14.80 **	23.08 **	16.69 **	7.96	-13.76**	23.05 **	8.09
5 X 9	7.22	-11.55 **	27.77 **	21.14 **	19.00**	-4.93	35.63 **	19.14**
5 X 10	4.13	-22.65 **	11.73 *	5.93	30.29**	3.80	48.09 **	30.08**
6 X 7	16.12 **	-7.04	34.29 **	27.32 **	-16.60**	-16.60**	18.98 **	4.52
6 X 8	13.90 *	-15.70 **	21.77 **	15.45 **	7.29	-10.63*	27.51 **	12.01*
6 X 9	14.44 **	-5.60	36.38 **	29.30 **	18.34**	-1.42	40.64 **	23.54**
6 X 10	22.96 **	-8.66 *	31.94 **	25.09 **	13.90*	-5.12	35.36 **	18.91**
7 X 8	2.03	-18.32 **	17.99 **	11.87 *	-28.94**	-28.94**	1.39	-10.94
7 X 9	3.28	-14.80 **	23.08 **	16.69 **	3.23	3.23	47.28 **	29.37**
7 X 10	16.23 **	-6.95	34.42 **	27.44 **	-22.20**	-22.20**	11.00	-2.50
8 X 9	27.35 **	5.05	32.46 **	25.59 **	11.23	-20.11**	13.98 *	0.12
8 X 10	11.66 *	-17.06 **	19.82 **	13.60 *	22.08**	-8.73	30.22 **	14.39*
9 X 10	20.13 **	-0.90	43.16 **	35.72 **	6.47	-20.40**	13.57 *	-0.24
S.E.±	8.98	8.98	8.98	8.98	9.70	9.70	9.70	9.70
C.D.5%	18.00	18.00	18.00	18.00	19.45	19.45	19.45	19.45
C.D.1%	23.97	23.97	23.97	23.97	25.90	25.90	25.90	25.90

*and**significant at 5% and 1% respectively.

Crosses	Weight of fruit per vine (kg)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	-10.70	-10.7	11.57	3.33	-27.05 **	-27.05**	0.99	-18.65*
1 X 3	50.75**	3.29	29.05**	19.52 *	24.08	-15.66	16.75	-5.95
1 X 4	45.95**	0.00	24.94*	15.71	34.03 **	-8.90	26.11 *	1.59
1 X 5	-8.16	-25.93 **	-7.46	-14.29	1.57	-30.96**	-4.43	-23.02*
1 X 6	-11.06	-23.87 **	-4.88	-11.90	-20.77 *	-26.69**	1.48	-18.25
1 X 7	12.91	-22.63 **	-3.34	-10.48	-21.80	-41.28**	-18.72	-34.52**
1 X 8	56.76**	7.41	34.19**	24.29 *	18.32	-19.57*	11.33	-10.32
1 X 9	18.47*	8.23	35.22**	25.24 **	36.02 **	8.19	49.75 **	20.63*
1 X 10	42.64**	-2.26	22.11*	13.10	48.17 **	0.71	39.41 **	12.30
2 X 3	17.28*	17.28 *	46.53**	35.71 **	12.28	12.28	55.42 **	25.20**
2 X 4	-34.57**	-34.57 **	-18.25	-24.29 *	-38.08 **	-38.08**	-14.29	-30.95**
2 X 5	3.70	3.70	29.56**	20.00 *	-16.01	-16.01	16.26	-6.35
2 X 6	-19.75*	-19.75 *	0.26	-7.14	-38.26 **	-38.26**	-14.53	-31.15**
2 X 7	-16.05*	-16.05 *	4.88	-2.86	-23.13 **	-23.13**	6.40	-14.29
2 X 8	-33.74**	-33.74 **	-17.22	-23.33 *	-27.40 **	-27.40**	0.49	-19.05*
2 X 9	-20.99**	-20.99 *	-1.29	-8.57	-32.38 **	-32.38**	-6.40	-24.60**
2 X 10	-10.08	-10.08	12.34	4.05	-6.76	-6.76	29.06 *	3.97
3 X 4	49.66**	2.06	12.34	18.10	29.12 *	-21.89*	8.13	-12.90
3 X 5	2.04	-17.70 *	2.83	-4.76	-7.03	-38.79**	-15.27	-31.75**
3 X 6	17.31	0.41	25.45*	16.19	-15.00	-21.35*	8.87	-12.30
3 X 7	41.51**	-7.41	15.68	7.14	7.58	-19.22*	11.82	-9.92
3 X 8	55.78**	-5.76	17.74	9.05	17.06	-29.18**	-1.97	-21.03*
3 X 9	-7.66	-15.64	5.40	-2.38	-22.60 *	-38.43**	-14.78	-31.35**
3 X 10	39.19**	-15.23	5.91	-1.90	27.17	-21.71*	8.37	-12.70
4 X 5	8.67	-12.35	9.51	1.43	6.22	-30.07**	-3.20	-22.02*
4 X 6	13.46	-2.88	21.34*	12.38	-7.88	-14.77	17.98	-4.96
4 X 7	41.51**	-7.41	15.68	7.14	7.11	-19.57*	11.33	-10.32
4 X 8	58.50**	-4.12	19.79*	10.95	48.17 **	-6.41	19.70	4.37
4 X 9	-22.07*	-28.81 **	-11.05	-17.62	-30.20 **	-44.48**	-23.15	-38.10**
4 X 10	64.19**	0.00	24.94*	15.71	46.24 **	-2.85	24.63 *	8.33
5 X 6	12.26	-3.91	20.05*	11.19	1.15	-6.41	29.56 *	4.37
5 X 7	42.35**	14.81	43.44**	32.86 **	10.43	-17.08*	14.78	-7.54
5 X 8	17.35	-5.35	18.25	9.52	6.22	-30.07**	-3.20	-22.02*
5 X 9	14.41	4.53	30.59**	20.95 *	34.68 **	7.12	48.28 **	19.44*
5 X 10	21.94*	-1.65	22.88*	13.81	18.38	-22.06**	7.88	-13.10
6 X 7	8.65	-7.00	16.20	7.62	-18.85 *	-24.91**	3.94	-16.27
6 X 8	25.48**	7.41	34.19**	24.29 *	-5.77	-12.81	20.69	-2.78
6 X 9	13.06	3.29	29.05**	19.52 *	-11.92	-18.51*	12.81	-9.13
6 X 10	16.35	-0.41	24.42*	15.24	0.00	-7.47	28.08 *	3.17
7 X 8	18.24	-22.63 **	-3.34	-10.48	-7.58	-30.60**	-3.94	-22.62*
7 X 9	-8.56	-16.46 *	4.37	-3.33	16.78	-7.12	28.57 *	3.57
7 X 10	18.24	-22.63 **	-3.34	-10.48	-6.64	-29.89**	-2.96	-21.83*
8 X 9	-5.86	-13.99	7.46	-0.48	13.2	-9.96	24.63 *	0.40
8 X 10	58.45**	-3.50	20.57*	11.67	28.90 *	-20.64*	9.85	-11.51
9 X 10	-21.17*	-27.98 **	-10.03	-16.67	-24.83 *	-40.21**	-17.24	-33.33**
S.E.±	0.19	0.19	0.19	0.19	0.23	0.23	0.23	0.23
C.D.5%	0.39	0.39	0.39	0.39	0.47	0.47	0.47	0.47
C.D.1%	0.52	0.52	0.52	0.52	0.62	0.62	0.62	0.62

*and**significant at 5% and 1% respectively.

Crosses	Weight of fruit per plot (kg)							
	Kharif				Summer			
	B.P.	T.P.	S.C. 1	S.C. 2	B.P.	T.P.	S.C. 1	S.C. 2
1 X 2	-15.07*	-15.07 *	7.90	-7.05	-33.05**	-33.05**	-7.70	-27.10**
1 X 3	42.76**	6.90	35.81**	16.99 *	18.8	-17.60*	13.59	-10.29
1 X 4	39.22**	4.25	32.44**	14.09	31.95**	-8.48	26.17 **	-0.35
1 X 5	-8.41	-27.46 **	-7.85	-20.61 **	-4.40	-33.69**	-8.59	-27.81**
1 X 6	-11.57	-25.32 **	-5.12	-18.26 *	-22.82**	-31.79**	-5.97	-25.73**
1 X 7	5.35	-21.11 **	0.22	-13.66	-25.19**	-43.35**	-21.91 *	-38.33**
1 X 8	41.85**	6.22	34.95**	16.25 *	10.38	-23.44**	5.55	-16.64*
1 X 9	21.63**	13.53 *	44.24**	24.26 **	36.42**	4.74	44.39 **	14.04
1 X 10	48.05**	10.86	40.85**	21.33 **	42.98**	-0.83	36.72 **	7.98
2 X 3	16.84*	16.84 *	48.44**	27.88 **	5.10	5.10	44.89 **	14.43
2 X 4	-29.79**	-29.79 **	-10.80	-23.15 **	-36.96**	-36.96**	-13.10	-31.36**
2 X 5	8.32	8.32	37.62**	18.55 *	-15.80*	-15.80*	16.07	-8.33
2 X 6	-23.17**	-23.17 **	-2.39	-15.92 *	-39.48**	-39.48**	-16.56	-34.10**
2 X 7	-12.88	-12.88	10.68	-4.65	-22.70**	-22.70**	6.56	-15.84*
2 X 8	-26.76**	-26.76 **	-6.96	-19.85 **	-29.31**	-29.31**	-2.55	-23.03**
2 X 9	-20.46**	-20.46 **	1.06	-12.94	-36.71**	-36.71**	-12.75	-31.09**
2 X 10	-5.78	-5.78	19.70*	3.12	-3.74	-3.74	32.71 **	4.81
3 X 4	60.48**	4.95	33.33**	14.86 *	24.68*	-25.97**	2.05	-19.40*
3 X 5	0.61	-20.32 **	1.22	-12.8	-2.66	-39.51**	-16.61	-34.14**
3 X 6	21.63**	2.72	30.50**	12.42	-12.13	-22.34**	7.06	-15.45*
3 X 7	46.22**	-3.90	22.09*	5.18	8.35	-17.96*	13.10	-10.68
3 X 8	54.99**	1.36	28.77**	10.93	22.05	-25.43**	2.80	-18.81*
3 X 9	-6.19	-12.44	11.24	-4.17	-22.67*	-40.63**	-18.15	-35.35**
3 X 10	41.19**	-7.67	17.31*	1.05	30.14**	-17.49*	13.74	-10.17
4 X 5	11.67	-11.56	12.35	-3.21	11.36	-30.80**	-4.61	-24.66**
4 X 6	14.47	-3.33	22.82**	5.80	-6.99	-17.80*	13.32	-10.50
4 X 7	46.68**	-3.59	22.48*	5.51	6.36	-19.47**	11.02	-12.32
4 X 8	55.70**	-2.41	23.98**	6.81	49.21**	-8.84	25.67 *	-0.74
4 X 9	-13.14	-18.92 **	3.01	-11.27	-30.67**	-46.77**	-26.62 **	-42.04**
4 X 10	66.88**	5.26	33.72**	15.20 *	49.24**	-5.39	30.43 **	3.01
5 X 6	14.68	-3.15	23.04**	5.99	3.43	-8.58	26.02 **	-0.47
5 X 7	46.24**	15.81 *	47.13**	26.75 **	6.26	-19.54**	10.92	-12.40
5 X 8	19.55*	-5.32	20.28*	3.62	7.57	-33.15**	-7.85	-27.22**
5 X 9	14.45*	6.83	35.73**	16.92 *	38.76**	6.54	46.87 **	16.00*
5 X 10	23.73**	-2.01	24.49**	7.24	20.17	-23.81**	5.03	-17.05*
6 X 7	13.80	-3.90	22.09*	5.18	-13.55	-23.60**	5.32	-16.82*
6 X 8	29.93**	9.72	39.40**	20.09 **	-5.18	-16.20*	15.52	-8.76
6 X 9	12.44	4.95	33.33**	14.86 *	-11.85	-22.09**	7.40	-15.17
6 X 10	20.12*	1.45	28.88**	11.03	4.86	-7.33	27.75 **	0.90
7 X 8	20.36	-20.89 **	0.50	-13.42	-6.21	-28.99**	-2.10	-22.68**
7 X 9	-11.50	-17.39 *	4.95	-9.59	22.11*	-6.25	29.24 **	2.07
7 X 10	18.79	-21.92 **	-0.81	-14.55	-10.91	-32.54**	-7.01	-26.55**
8 X 9	-11.54	-17.43 *	4.90	-9.64	16.02	-10.92	22.80 *	-3.01
8 X 10	54.34**	-2.65	23.68**	6.54	22.80*	-22.14**	7.33	-15.23
9 X 10	-25.25**	-30.22 **	-11.35	-23.63 **	-28.98**	-45.47**	-24.83 *	-40.63**
S.E.±	1.53	1.53	1.53	1.53	1.95	1.95	1.95	1.95
C.D.5%	3.07	3.07	3.07	3.07	3.91	3.91	3.91	3.91
C.D.1%	4.09	4.09	4.09	4.09	5.20	5.20	5.20	5.20

*and**significant at 5% and 1% respectively. (Where, BP- Better parent, TP- Top Parent, SC.1- Standard check-1 i.e. Gypsy, SC.2- Standard check-2 i.e. Chitra)

Average fruit weight (g)

Heterosis ranged over better parents from -44.04 to 30.74 percent heterosis, over top parent ranged from -44.04 to 5.05 percent, heterosis range over standard hybrid check-1 were -19.17 to 49.76 percent and heterosis range over standard hybrid check-2 were -23.36 to 43.88 percent during the summer where as in *kharif* season over better parents ranged from -33.11 to 46.65 percent heterosis, over top parent ranged from -36.34 to 4.08 percent, heterosis range over standard hybrid check-1 were -9.17 to 48.49 percent and heterosis range over standard hybrid check-2 were -20.21 to 30.44 percent in summer season.

The crosses P4 x P10 showed significant positive heterosis over better parent (30.74%), standard hybrid check-1 (49.76%) and standard hybrid check-2 (43.88%) while on top parent (5.05%), the cross P8 x P9 showed significant positive heterosis in *kharif*. On other hand in summer the crosses P4 x P8 showed highest significant positive heterosis over better parent (46.65%), top parent (4.08%), standard hybrid check-1 (48.49%) and standard hybrid check-2 (30.44%).

Average weight of fruit is one of the most important yield contributing character which is directly related with increment in yield hence significantly positive heterosis effect would be highly desirable. Correspondence result for significant positive heterosis for average weight of fruit in cucumber were also reported by Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7], Al-Araby *et al.* (2017) [2], Gharib *et al.* (2020) [4].

Weight of fruit per vine (kg)

Heterosis over better parents ranging from -34.57 to 64.19 percent, over top parent ranged from -34.57 to 17.28 percent, heterosis range over standard hybrid check-1 were -18.25 to 46.53 percent and heterosis range over standard hybrid check-2 were -24.29 to 35.71 percent during the *kharif* where as in summer season over better parents ranged from -38.26 to 48.17 percent heterosis, over top parent ranged from -44.48 to 12.28 percent, heterosis range over standard hybrid check-1 were -23.15 to 55.42 percent and heterosis range over standard hybrid check-2 were -38.10 to 25.20 percent.

In *kharif* the crosses P4 x P10 (64.19%) showed significant positive heterosis over better parent, the cross P2 x P3 showed significant positive heterosis over top parent (17.28%), standard hybrid check-1 (46.53%) and standard hybrid check-2 (35.71%). In summer the crosses P4 x P8 (48.17%) showed highest significant positive heterosis over better parent, the cross P2 x P3 showed significant positive heterosis over top parent (12.28%), standard hybrid check-1 (55.42%) and standard hybrid check-2 (25.20%).

Fruit yield per plot is most important trait in cucumber crop hence the heterosis is need to be in positive direction. In current study the magnitude and direction of heterosis over better parent and standard check were in significantly positive direction, due to the presence of dominance genes in parents. Results are similar in accordance with Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7], Abd Rabou (2018) [1].

Weight of fruit per plot (kg)

Heterosis over better parents ranging from -29.79 to 66.88 percent, over top parent ranged from -30.22 to 16.84 percent, heterosis range over standard hybrid check-1 were -11.35 to 48.44 percent and heterosis range over standard hybrid check-2 were -23.63 to 27.88 percent during the *kharif* where as in summer season over better parents ranged from -39.48 to 49.24 percent heterosis, over top parent ranged from -46.77 to 6.54 percent, heterosis range over standard hybrid check-1 were -24.83 to 46.87 percent and heterosis range over standard hybrid check-2 were -42.04 to 16.00 percent.

In *kharif* the crosses P4 x P10 (66.88%) showed significant positive heterosis over better parent, the cross P2 x P3 showed significant positive heterosis over top parent (16.84%), standard hybrid check-1 (48.44%) and standard hybrid check-2 (27.88%). In summer the crosses P4 x P10 (49.24%) showed highest significant positive heterosis over better parent, the crosses P5 x P9 showed significant positive heterosis over top parent (6.54%), standard hybrid check-1 (46.87%) and standard hybrid check-2 (16%).

Fruit yield per plot is most important trait in cucumber crop hence the heterosis is need to be in positive direction. In current study the magnitude and direction of heterosis over better parent and standard check were in significantly positive direction, due to the presence of dominance genes in parents. Results are similar in accordance with Sawant *et al*. (2017) [6], Singh and Tiwari (2006) [7].

Conclusion

The mean performance of most of the F_1s were superior than the mean (*per se*) performance of the parents for most of the parameters which were studied. *Per se* performance recited that, the parents P_2 (Cucumber- 2), P_4 (Cucumber- 4), P_5 (Cucumber- 5), P_6 (Cucumber- 6), P_8 (Cucumber-8) and P_{10} (Cucumber- 10) were found to be most desirable for more number of characters and most general combiner. The cross combinations P_1 x P_9, P_2 x P_3, P_4 x P_8, P_4 x P_{10}, P_5 x P_7 and P_5 x P_9 displayed the significant positive heterosis for most of the traits in both *kharif* and summer season.

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