ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(12): 344-350
www.agriculturaljournals.com
Received: 02-09-2025
Accepted: 05-10-2025

JJ Patel
Ph.D. (Scholar), Department of Genetics and Plant Breeding, CPCA, SDAU, Sardarkrushinagar, Gujarat, India

RN Patel
Research Scientist, Department of Seed Technology, SDAU, Sardarkrushinagar, Gujarat, India

RA Gami
Associate Research Scientist, Centre for Millets Research, SDAU, Deesa, Gujarat, India

BM Modi
Ph.D. (Scholar), Department of Genetics and Plant Breeding, CPCA, SDAU, Sardarkrushinagar, Gujarat, India

Gundlapalli Soumith
Ph.D. (Scholar), Department of Genetics and Plant Breeding, CPCA, SDAU, Sardarkrushinagar, Gujarat, India

Corresponding Author:
JJ Patel
Ph.D. (Scholar), Department of Genetics and Plant Breeding, CPCA, SDAU, Sardarkrushinagar, Gujarat, India

Study of mean performance and extent of heterosis in cucumber (*Cucumis sativus* L.)

JJ Patel, RN Patel, RA Gami, BM Modi and Gundlapalli Soumith

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i12e.1060

Abstract
The study aimed to assess mean performance and heterosis levels for fruit yield and its component traits in cucumber. Seven parental genotypes were crossed in a half-diallel mating design to generate 21 F_1 hybrids, evaluated using a randomized block design. Seeds of the hybrids were produced during summer 2022 at the Potato Research Station, SDAU, Deesa. Significant variability among genotypes was observed for all traits. Parent ACUS-19-14 and the hybrid ACUS-19-14 × ACUS-19-19 showed the highest fruit yield per plant. Wide ranges of heterobeltiosis (-36.14% to 49.89%) and standard heterosis (-32.24% to 59.06%) were recorded for yield, with ACUS-19-14 × ACUS-19-19 exhibiting maximum positive heterosis, followed by ACUS-19-14 × ACUS-20-04 and ACUS-19-18 × ACUS-19-16. Key contributing traits included number of branches, fruit size, average fruit weight, and fruit number. Overall, the hybrids ACUS-19-14 × ACUS- 19-19 and ACUS-19-14 × ACUS-20-04 were identified as the most promising for improving fruit yield in cucumber.

Keywords: *Per se* performance; fruit yield; heterobeltiosis and standard heterosis

1. Introduction
Cucumber (*Cucumis sativus* L.) is a widely cultivated member of the *Cucurbitaceae* family, which includes 118 genera and 825 species. It is unique among *Cucumis* species for having seven chromosome pairs (2n=14), making it a true diploid. India, a major centre of origin for cucurbits, provides ideal conditions for their growth even in hot summers. Cucumber is a highly cross-pollinated, monoecious, trailing or climbing vine with distinct staminate and pistillate floral structures. Hybrid vigour (heterosis) has been an effective tool to increase cucumber yield worldwide, first reported by Hayes and Jones in 1916, with Japan releasing the first commercial hybrid in 1935. Although India has reported promising heterosis, region-specific commercial hybrids remain limited. Understanding heterosis is essential for identifying superior combiners and developing suitable breeding strategies for crop improvement.

2. Material and Methods
The experimental material consisted of seven parental lines ACUS-19-08, GCU-1, ACUS-19-14, ACUS-19-18, ACUS-19-19, ACUS-20-04, and ACUS-19-16 (with GCU-1 as the check) along with 21 F_1 hybrids generated through a half-diallel mating design. The hybrids were produced during summer 2022 at the Potato Research Station, Deesa, through manual pollination, while parental seeds were maintained by selfing. Each genotype was planted in two rows within a 4 m × 5 m plot, following 2 m inter-row and 1 m intra-row spacing. Standard agronomic and plant protection practices were applied to ensure healthy crop growth. Observations were recorded on three randomly selected plants per genotype in each replication, and the mean values were used for subsequent statistical analysis.
Analysis of variance (ANOVA) was performed according to the procedures outlined by Snedecor and Cochran (1967) [3] and further reviewed by Panse and Sukhatme (1985), to determine the significance of variability among genotypes. Heterosis was estimated as the percentage increase or decrease in hybrid performance over the better parent (heterobeltiosis), following Fonseca and Patterson (1968) [4], and over the standard check GCU-1 (standard heterosis), following the method of Meredith and Bridge (1972) [5].

Heterobeltiosis was measured in percentage by using following formula

$$\text{Heterobeltiosis (\%)} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

The standard heterosis was measured in percentage by using following formula

$$\text{Standard heterosis (\%)} = \frac{\overline{F_1} - \overline{SC}}{\overline{SC}} \times 100$$

Where,

$\overline{BP}$ = Mean performance of better parent, SC = Mean performance of standard check *i.e*., GCU-1, and F1= Mean value of F1.

$\overline{F_1}$ = Mean value of F1.

The significance of heterosis value was tested using 't' test

$$t = \frac{\overline{F_1} - \overline{BP} \text{ or } \overline{SC}}{\text{S.E. of heterosis over } \overline{BP} \text{ and } \overline{SC}}$$

Calculated 't' value was equated with table 't' values at error degree of freedom for test of significance.

The heterosis can be classified as low, moderate and high based on estimates. The level of heterosis varies from character to character. In the present study following criteria was used to classify heterosis level, *i.e.*, low, moderate and high. (Joshi *et al.*, 2021) [6].

Lowest range = X + lowest value, Moderate range = 2X + lowest value, and

High range = 3X + lowest value (rest upper).

Where, X= Mean value obtained by total range value divided by three

Results and Discussion

The results (Table 1) showed highly significant differences among genotypes for all traits, indicating ample genetic variability in the parents and hybrids. Parent-wise comparisons revealed significant variation for all characters except moisture content, confirming substantial genetic diversity among parental lines.

Table 1: Analysis of variance (mean sum of square) for experimental design of sixteen characters in Cucumber

Source of variation	d.f.	Days to appearance of first male flower	Days to appearance of first female flower	Node at which first male flower appear	Node at which first female flower appear	Number of branch per plant
Replication	2	0.12	1.12	0.19	0.18	0.44
Genotypes	27	12.58**	18.25**	1.14**	1.19**	1.92**
Parents (P)	6	10.64**	11.19**	0.72**	0.50*	1.57**
Hybrids (H)	20	13.79**	21.26**	1.28**	1.44**	2.10**
P *vs.* H	1	0.10	0.32	0.89	0.45	0.45
Error	54	1.86	2.07	0.22	0.20	0.23

Source of variation	d.f.	Fruit length	Fruit diameter	Average fruit weight	Number of fruit per plant	Fruit yield per plant
Replication	2	0.19	0.23	1.20	0.20	0.004
Genotypes	27	10.68**	15.00**	741.44**	26.69**	1.538**
Parents (P)	6	5.82**	6.88*	375.99**	20.55**	0.727**
Hybrids (H)	20	12.44**	18.12**	883.46**	29.48**	1.856**
P *vs.* H	1	4.65*	1.43	93.84	7.86**	0.037
Error	54	1.07	2.23	49.87	1.08	0.027

Source of variation	d.f.	Chloroph yll content index	Moisture content	Total soluble solids	Chlorophyll - a	Chlorophyll - b	Total Chlorophyll
Replication	2	1.39	1.50	0.00	79.92	58.05	56.70
Genotypes	27	44.74**	3.28**	0.14**	6164.02**	2339.50**	15114.06**
Parents (P)	6	30.26**	0.93	0.05**	6705.08**	1833.05**	15176.49**
Hybrids (H)	20	50.56**	4.09**	0.16**	6249.03**	2506.33**	15530.43**
P *vs.* H	1	15.14**	1.10	0.05	1217.53**	2041.50**	6412.20**
Error	54	1.64	1.13	0.02	139.48	35.45	181.85
*** P ≤ 0.05; ** P ≤ 0.01.**							

Hybrids also differed significantly for all traits, reflecting diverse cross-combination performance. Significant parents vs. hybrids mean squares for fruit length, number of fruits per plant, chlorophyll content index, chlorophyll-a, chlorophyll-b, and total chlorophyll indicated the presence of considerable heterosis for these traits. The mean performance of parents (Table 2) showed that no single genotype excelled in all traits. Among parents, ACUS-19-16 performed best for earliness, number of branches, fruit number, total soluble solids, and chlorophyll traits. ACUS-19-08 was superior for the node of first male flower and chlorophyll content index, while ACUS-19-14 showed the highest fruit diameter, average fruit weight, and fruit yield per plant. ACUS-19-19 produced the longest fruits, and ACUS-20-04 was best for the node of first female flower appearance.

Among F1 hybrids, none was superior for all traits, but several showed strong performance for specific characters. The hybrid ACUS-19-14 × ACUS-19-19 was outstanding for branches per plant, fruit diameter, fruit weight, fruit number, and total yield. ACUS-19-18 × ACUS-19-16 and ACUS-19-19 × ACUS-19-16 were best for early male flowering, while ACUS-19-18 × ACUS-19-16 also excelled in fruit length and chlorophyll traits. Other crosses showed

superiority for female flowering node, chlorophyll content index, and total soluble solids.

Table 2: Mean performance of the parents and their F_1 hybrids for various traits in cucumber

Sr. No.	Genotypes	Days to appearance of first male flower	Days to appearance of first female flower	Node at which first male flower appear	Node at which first female flower appear
		Parents			
1	ACUS-19-08	41.78	53.67	3.44	6.11
2	GCU- 1	41.44	53.44	4.00	5.89
3	ACUS-19-14	42.00	54.56	3.89	6.22
4	ACUS-19-18	44.44	56.67	4.78	6.22
5	ACUS-19-19	39.11	51.44	3.78	5.89
6	ACUS-20-04	42.11	55.33	4.56	5.22
7	ACUS-19-16	39.00	51.44	4.56	5.33
Parental Mean		**41.41**	**53.79**	**4.14**	**5.84**
		F1 Hybrids			
8	ACUS-19-08 × GCU- 1	43.78	52.67	3.78	5.89
9	ACUS-19-08 × ACUS-19-14	40.44	52.56	3.56	6.78
10	ACUS-19-08 × ACUS-19-18	39.00	50.67	4.78	6.89
11	ACUS-19-08 × ACUS-19-19	42.22	53.11	3.89	6.67
12	ACUS-19-08 × ACUS-20-04	43.78	54.44	4.78	6.00
13	ACUS-19-08 × ACUS-19-16	41.78	55.78	5.11	4.78
14	GCU- 1 × ACUS-19-14	44.11	53.67	4.89	6.78
15	GCU- 1 × ACUS-19-18	42.00	56.22	3.78	6.22
16	GCU- 1 × ACUS-19-19	41.56	54.89	3.78	6.11
17	GCU- 1 × ACUS-20-04	43.67	57.78	4.89	6.56
18	GCU- 1 × ACUS-19-16	41.56	56.44	3.89	6.00
19	ACUS-19-14 × ACUS-19-18	44.11	56.11	3.89	5.89
20	ACUS-19-14 × ACUS-19-19	37.78	49.89	3.11	5.00
21	ACUS-19-14 × ACUS-20-04	38.33	50.44	3.22	5.11
22	ACUS-19-14 × ACUS-19-16	42.44	57.67	4.00	6.00
23	ACUS-19-18 × ACUS-19-19	39.22	51.00	3.22	5.11
24	ACUS-19-18 × ACUS-20-04	42.45	54.33	3.44	5.89
25	ACUS-19-18 × ACUS-19-16	38.67	49.22	3.00	4.89
26	ACUS-19-19 × ACUS-20-04	41.89	56.56	4.11	6.22
27	ACUS-19-19 × ACUS-19-16	37.44	50.67	3.00	6.33
28	ACUS-20-04 × ACUS-19-16	41.78	52.56	3.89	7.11
	Hybrid Mean	41.33	53.65	3.90	6.01
	General mean (μ)	41.35	53.69	3.96	5.97
	Overall range	37.44 to 44.11	49.22 to 57.78	3.00 to 5.11	4.78 to 7.11
	S. Em. ±	0.79	0.83	0.27	0.25
	C.D. at 5%	2.23	2.36	0.77	0.72
	C.V. %	3.30	2.68	11.92	7.39

Table 2: Conti….

Sr. No.	Genotypes	Number of branch per plant	Fruit length (cm)	Fruit diameter (mm)	Average fruit weight (g)
		Parents			
1	ACUS-19-08	4.67	21.80	38.53	132.90
2	GCU- 1	5.33	21.94	39.67	153.99
3	ACUS-19-14	6.00	22.90	42.68	167.55
4	ACUS-19-18	5.11	21.17	39.27	156.74
5	ACUS-19-19	4.67	23.20	39.75	151.10
6	ACUS-20-04	5.33	21.91	41.77	160.37
7	ACUS-19-16	6.67	18.96	41.37	144.95
Parental Mean		**5.40**	**21.70**	**40.44**	**152.52**
		F1 Hybrids			
8	ACUS-19-08 × GCU- 1	5.56	23.15	40.23	153.81
9	ACUS-19-08 × ACUS-19-14	5.22	21.77	40.01	146.59
10	ACUS-19-08 × ACUS-19-18	5.11	19.66	36.61	136.46
11	ACUS-19-08 × ACUS-19-19	6.45	18.77	35.81	131.63
12	ACUS-19-08 × ACUS-20-04	6.33	24.01	39.17	162.47
13	ACUS-19-08 × ACUS-19-16	4.78	22.09	40.87	148.37
14	GCU- 1 × ACUS-19-14	5.33	20.22	40.94	145.18
15	GCU- 1 × ACUS-19-18	5.56	23.18	40.38	158.17
16	GCU- 1 × ACUS-19-19	5.67	22.99	41.78	162.43
17	GCU- 1 × ACUS-20-04	6.22	25.09	42.67	170.04
18	GCU- 1 × ACUS-19-16	4.33	22.44	40.50	153.33
19	ACUS-19-14 × ACUS-19-18	5.33	21.29	37.71	138.63

20	ACUS-19-14 × ACUS-19-19	7.22	25.47	44.32	195.29
21	ACUS-19-14 × ACUS-20-04	6.56	24.02	43.60	186.24
22	ACUS-19-14 × ACUS-19-16	5.78	19.69	37.14	136.55
23	ACUS-19-18 × ACUS-19-19	4.22	22.56	41.64	163.30
24	ACUS-19-18 × ACUS-20-04	5.33	22.14	40.91	150.22
25	ACUS-19-18 × ACUS-19-16	6.89	26.28	43.77	181.83
26	ACUS-19-19 × ACUS-20-04	5.22	20.54	37.71	139.24
27	ACUS-19-19 × ACUS-19-16	5.67	21.93	40.36	152.00
28	ACUS-20-04 × ACUS-19-16	4.11	19.79	36.71	142.31
	Hybrid Mean	5.57	22.24	40.13	154.96
	General mean (µ)	5.52	22.10	40.21	154.35
	Overall range	4.11 to 7.22	18.77 to 26.28	35.81 to 44.32	131.63 to 195.29
	S. Em. ±	0.28	0.60	0.86	4.08
	C.D. at 5%	0.79	1.69	2.44	11.56
	C.V. %	8.77	4.68	3.71	4.58

Sr. No.	Genotypes	Number of fruit per plant	Fruit yield per plant (kg)	Chlorophyll content index	Mositure content (%)
		Parents			
1	ACUS-19-08	12.10	1.57	27.34	94.50
2	GCU- 1	18.77	2.83	25.57	93.41
3	ACUS-19-14	18.03	3.01	25.99	93.57
4	ACUS-19-18	16.43	2.70	25.29	94.01
5	ACUS-19-19	18.30	2.78	23.69	94.12
6	ACUS-20-04	17.83	2.66	17.79	94.28
7	ACUS-19-16	20.37	2.96	26.17	95.05
Parental Mean		**17.40**	**2.65**	**24.55**	**94.14**
		F1 Hybrids			
8	ACUS-19-08 × GCU- 1	15.63	2.53	16.88	92.07
9	ACUS-19-08 × ACUS-19-14	13.50	1.92	28.60	91.83
10	ACUS-19-08 × ACUS-19-18	16.60	2.37	26.18	94.76
11	ACUS-19-08 × ACUS-19-19	20.17	3.07	29.72	95.84
12	ACUS-19-08 × ACUS-20-04	20.57	3.32	23.86	94.38
13	ACUS-19-08 × ACUS-19-16	14.17	2.34	28.72	95.12
14	GCU- 1 × ACUS-19-14	14.43	2.09	30.34	94.71
15	GCU- 1 × ACUS-19-18	14.97	2.52	21.68	94.82
16	GCU- 1 × ACUS-19-19	15.50	2.55	26.02	94.35
17	GCU- 1 × ACUS-20-04	20.03	3.52	27.54	94.70
18	GCU- 1 × ACUS-19-16	15.63	2.44	31.50	94.60
19	ACUS-19-14 × ACUS-19-18	14.23	1.94	19.68	93.93
20	ACUS-19-14 × ACUS-19-19	23.40	4.51	27.43	96.29
21	ACUS-19-14 × ACUS-20-04	21.67	4.26	31.59	95.43
22	ACUS-19-14 × ACUS-19-16	13.80	2.03	23.89	94.21
23	ACUS-19-18 × ACUS-19-19	14.10	2.18	26.81	94.38
24	ACUS-19-18 × ACUS-20-04	14.73	2.17	23.29	94.69
25	ACUS-19-18 × ACUS-19-16	21.33	4.02	27.99	95.53
26	ACUS-19-19 × ACUS-20-04	17.63	2.59	20.57	93.95
27	ACUS-19-19 × ACUS-19-16	15.07	2.26	23.10	92.05
28	ACUS-20-04 × ACUS-19-16	13.50	1.94	20.70	94.73
	Hybrid Mean	16.70	2.69	25.53	94.40
	General mean (µ)	16.88	2.68	25.28	94.33
	Overall range	13.50 to 23.40	1.92 to 4.51	16.88 to 31.59	91.83 to 96.29
	S. Em. ±	0.60	0.09	0.74	0.61
	C.D. at 5%	1.70	0.27	2.09	1.74
	C.V. %	6.17	6.07	5.06	1.13

Gfj

Sr. No.	Genotypes	Total soluble solids (˚Brix)	Chlorophyll- a (µg/g F.W.)	Chlorophyll- b (µg/g F.W.)	Total chlorophyll (µg/g F.W.)
			Parents		
1	ACUS-19-08	3.98	712.12	111.59	823.71
2	GCU- 1	4.07	748.78	118.71	867.48
3	ACUS-19-14	4.32	738.01	125.24	863.25
4	ACUS-19-18	4.04	723.00	129.80	852.79
5	ACUS-19-19	4.16	751.13	142.38	893.51
6	ACUS-20-04	4.14	730.81	123.35	854.16
7	ACUS-19-16	4.32	853.63	185.50	1039.13
Parental Mean		**4.15**	**751.07**	**133.79**	**884.86**

F1 Hybrids					
8	ACUS-19-08 × GCU- 1	4.34	736.06	138.64	874.70
9	ACUS-19-08 × ACUS-19-14	3.78	720.30	120.30	840.61
10	ACUS-19-08 × ACUS-19-18	3.88	714.45	126.16	839.98
11	ACUS-19-08 × ACUS-19-19	4.31	772.31	145.85	918.16
12	ACUS-19-08 × ACUS-20-04	3.92	740.41	108.40	848.82
13	ACUS-19-08 × ACUS-19-16	4.44	802.15	158.99	961.14
14	GCU- 1 × ACUS-19-14	4.33	758.59	136.40	894.99
15	GCU- 1 × ACUS-19-18	4.39	730.78	152.27	883.05
16	GCU- 1 × ACUS-19-19	4.26	766.16	144.80	910.96
17	GCU- 1 × ACUS-20-04	3.92	762.69	117.38	880.07
18	GCU- 1 × ACUS-19-16	4.22	771.36	150.72	922.08
19	ACUS-19-14 × ACUS-19-18	4.18	774.30	162.58	936.88
20	ACUS-19-14 × ACUS-19-19	4.20	775.63	139.01	914.64
21	ACUS-19-14 × ACUS-20-04	3.63	717.82	137.24	855.06
22	ACUS-19-14 × ACUS-19-16	4.32	744.34	160.41	904.75
23	ACUS-19-18 × ACUS-19-19	4.16	718.09	132.29	850.38
24	ACUS-19-18 × ACUS-20-04	4.02	743.77	117.13	860.90
25	ACUS-19-18 × ACUS-19-16	3.91	925.86	249.57	1175.43
26	ACUS-19-19 × ACUS-20-04	3.94	725.24	130.74	855.98
27	ACUS-19-19 × ACUS-19-16	4.00	768.13	166.31	934.43
28	ACUS-20-04 × ACUS-19-16	3.76	788.60	153.58	942.18
	Hybrid Mean	4.09	759.86	145.18	905.04
	General mean (μ)	4.11	746.95	142.33	899.99
	Overall range	3.63 to 4.44	714.45 to 925.86	108.40 to 249.57	839.98 to 1175.43
	S. Em. ±	0.08	6.82	3.44	7.79
	C.D. at 5%	0.21	19.33	9.75	22.08
	C.V. %	3.17	1.56	4.18	1.50

In this study, heterosis was assessed over the better parent and the standard check GCU-1, providing results of practical breeding value. Among the 21 F_1 hybrids, six exhibited significant positive heterobeltiosis and five showed significant standard heterosis. Fruit yield per plant showed a wide heterotic range, from -36.14% (ACUS-19-08 × ACUS-19-14) to 49.89% (ACUS-19-14 × ACUS-19-19) for heterobeltiosis, and -32.24% to 59.06% over GCU-1. The hybrids ACUS-19-14 × ACUS-19-19 (49.89% & 59.06%), ACUS-19-14 × ACUS-20-04 (41.80% & 50.47%), and ACUS-19-18 × ACUS-19-16 (35.51% & 41.88%) showed the highest positive heterosis over both comparisons. Similar findings were reported by Pandey *et al*. (2005) [7], Kushwaha & Ram (2011) [8], Singh *et al*. (2012) [9], Airina *et al*. (2013) [10], and Devi *et al*. (2017) [11].

Table 3: Number of (F_1) hybrids depicted significant heterotic effect in cucumber

Characters		Over better parent			Over standard check (GCU-1)			
	+ve	-ve	Total	Range	+ve	-ve	Total	Range
Days to appearance of first male flower	9	2	11	-8.73 to 8.83	4	5	9	-9.65 to 6.43
Days to appearance of first female flower	7	2	9	-7.54 to 12.10	7	6	13	-7.90 to 8.10
Node at which first male flower appear	5	3	8	-34.16 to 48.45	5	5	10	-25.00 to 27.83
Node at which first female flower appear	8	2	10	-15.09 to 36.16	5	5	10	-18.90 to 20.77
Number of branch per plant	4	6	10	-38.30 to 38.14	6	3	9	-22.88 to 35.44
Fruit length	4	6	10	-19.12 to 24.12	5	5	10	-14.45 to 19.78
Fruit diameter	0	8	8	-12.99 to 5.79	4	4	8	-9.72 to 11.73
Average fruit weight	3	8	11	-18.50 to 16.55	4	6	10	-14.52 to 26.82
Number of fruit per plant	4	13	17	-33.72 to 27.87	4	14	18	-28.06 to 24.69
Fruit yield per plant	6	14	20	-36.14 to 49.89	5	14	19	-32.24 to 59.06
Chlorophyll content index	4	8	12	-38.28 to 21.55	7	7	14	-33.99 to 23.56
Mositure content	2	1	3	-2.20 to 2.91	2	0	2	-1.70 to 3.08
Total soluble solids	2	8	10	-15.90 to 7.87	6	3	9	-10.66 to 9.26
Chlorophyll- a	5	8	13	-12.80 to 8.46	8	6	14	-4.58 to 23.65
Chlorophyll- b	6	9	15	-18.75 to 34.54	16	1	17	-8.68 to 110.24
Total chlorophyll	5	8	13	-12.93 to 13.12	12	2	14	-3.10 to 35.50

A comparative study of the best heterotic hybrid, revealed that the crosses ACUS-19-14 × ACUS-19-19 and ACUS-19-14 × ACUS-20-04 were found best for fruit yield per plant with also various component traits *viz.*, days to appearance of first male flower, days to appearance of first female flower, node at which first male flower appear, node at which first female flower appear, number of branch per plant, fruit length, fruit diameter, average fruit weight, number of fruit per plant, chlorophyll- a, chlorophyll- b and total chlorophyll (Table 4).

The results (Table 5a & 5b) showed that heterosis varied widely among crosses for all traits, with certain hybrids expressing high heterosis for specific characters but lower for others. This indicates that parent selection strongly influences hybrid performance. Superior hybrid performance over the better parent suggests strong potential

for transgressive segregation, making these crosses useful for future breeding (Fonseca & Patterson, 1968) [4]. Analysis of variance (Table 1) revealed significant genotype differences, confirming ample genetic variability among parents and hybrids. Among parents, ACUS-19-14 performed best for fruit diameter, average fruit weight, and fruit yield per plant. ACUS-19-16 showed superior per se performance for early flowering, branching, fruit number, TSS, and chlorophyll traits, while ACUS-19-08 was best for node of first male flower appearance and chlorophyll content index. ACUS-19-19 excelled in fruit length, and ACUS-20- 04 was superior for node of first female flower appearance.

Table 4: Comparative study of heterotic crosses in cucumber for fruit yield per plant with other Components

Sr. No.	Hybrids (F1's)	Heterosis over		Desired and significant heterobeltiosis/standard heterosis for attributes
		Better Parent (BP)	Standard Check (SC)	
Fruit yield per plant with attributes				
1	ACUS-19-14 × ACUS-19-19	49.89**	59.06**	DAM, DAF, NMA, NFA, NBP, FL, FD, AFW, NFP, CA, CB, TC.
2	ACUS-19-14 × ACUS-20-04	41.80**	50.47**	DAM, DAF, NMA, NFA, NBP, FL, FD, AFW, NFP, CCI, CB.
3	ACUS-19-18 × ACUS-19-16	35.51**	41.88**	DAM, DAF, NMA, NFA, NBP, FL, FD, AFW, NFP, CCI, CA, CB, TC.
4	GCU- 1 × ACUS-20-04	24.24**	24.24**	NMA, NFA, NBP, FL, FD, AFW.
5	ACUS-19-08 × ACUS-20-04	24.66**	17.18**	NBP, FL, NFP.

* P ≤ 0.05; ** P ≤ 0.01.

Table 5a: The overall picture of heterosis level in promising heterotic crosses of cucumber for fruit yield and its attributes with better parent

Sr. No.	Hybrids	DAM	DAF	NMA	NFA	NBP	FL	FD	AFW
1	ACUS-19-14 × ACUS-19-19	High	High	High	High	High	Moderate	High	High
2	ACUS-19-14 × ACUS-20-04	High	High	High	High	Moderate	Moderate	High	High
3	ACUS-19-18 × ACUS-19-16	Moderate	High	High	High	Moderate	High	High	High
4	GCU- 1 × ACUS-20-04	Low	Low	Low	Low	High	Moderate	High	Moderate
5	ACUS-19-08 × ACUS-20-04	Low	Moderate	Low	Moderate	High	Moderate	Moderate	Moderate
Sr. No.	**Hybrids**	**NFP**	**FYP**	**CCI**	**MC**	**TSS**	**CA**	**CB**	**TC**
1	ACUS-19-14 × ACUS-19-19	High	High	High	Low	Moderate	High	Low	Moderate
2	ACUS-19-14 × ACUS-20-04	High	High	High	Low	Low	Moderate	Moderate	Moderate
3	ACUS-19-18 × ACUS-19-16	Moderate	High	High	Low	Low	High	High	High
4	GCU- 1 × ACUS-20-04	Moderate	High	High	Moderate	Moderate	High	Low	Moderate
5	ACUS-19-08 × ACUS-20-04	High	High	Moderate	Moderate	Moderate	Moderate	Low	Moderate

Table 5b: The overall picture of heterosis level in promising heterotic crosses of cucumber for fruit yield and its attributes with standard check (GCU-1)

Sr. No.	Hybrids	DAM	DAF	NMA	NFA	NBP	FL	FD	AFW
1	ACUS-19-14 × ACUS-19-19	High	High	High	High	High	High	High	High
2	ACUS-19-14 × ACUS-20-04	High	High	High	High	High	High	High	High
3	ACUS-19-18 × ACUS-19-16	High	High	High	High	High	High	High	High
4	GCU- 1 × ACUS-20-04	Low	Low	Low	Low	High	High	High	Moderate
5	ACUS-19-08 × ACUS-20-04	Low	Moderate	Low	Moderate	High	High	Moderate	Moderate
Sr. No.	**Hybrids**	**NFP**	**FYP**	**CCI**	**MC**	**TSS**	**CA**	**CB**	**TC**
1	ACUS-19-14 × ACUS-19-19	High	High	High	Low	High	Low	Low	Low
2	ACUS-19-14 × ACUS-20-04	High	High	High	Low	Low	Low	Low	Low
3	ACUS-19-18 × ACUS-19-16	High	High	High	Low	Moderate	High	High	High
4	GCU- 1 × ACUS-20-04	Moderate	Moderate	High	Moderate	Moderate	Low	Low	Low
5	ACUS-19-08 × ACUS-20-04	High	Moderate	Moderate	Moderate	Moderate	Low	Low	Low

Where,

DAM	**:**	Days to appearance of first male flower	**NFP**	**:**	Number of fruit per plant
DAF	**:**	Days to appearance of first female flower	**FYP**	**:**	Fruit yield per plant
NMA	**:**	Node at which first male flower appear	**CCI**	**:**	Chlorophyll content index
NFA	**:**	Node at which first female flower appear	**MC**	**:**	Moisture content
NBP	**:**	Number of branch per plant	**TSS**	**:**	Total soluble solids
FL	**:**	Fruit length	**CA**	**:**	Chlorophyll- a
FD	**:**	Fruit diameter	**CB**	**:**	Chlorophyll- b
AFW	**:**	Average fruit weight	**TC**	**:**	Total Chlorophyll

4. Conclusion

The analysis of variance revealed significant differences due to genotypes for all the characters studied. This indicated that the studied parents and their hybrids had sufficient amount of genetic variability. The parental genotype ACUS-19-14 was found superior for fruit diameter (mm), average fruit weight (g) and fruit yield per plant (kg). A comparative study of the best heterotic hybrid, revealed that the crosses

ACUS-19-14 × ACUS-19-19 and ACUS-19-14 × ACUS-20-04 were found best for fruit yield per plant with also various component traits over both better parent and standard check GCU-1.

Acknowledgements
I am very thankful to my major guide, Dr. R. N. Patel, who provided all the facilities and precious guidance needed to complete my experiment. I am also thankful to Dr. R. A. Gami and Shri. D. M. zapadiya for helping me during my research.

References

1. Jeffrey C. Systematics of the Cucurbitaceae: an overview. In: Bates DM, Robinson RW, Jeffrey C, editors. Biology and utilization of the Cucurbitaceae. Ithaca (NY): Cornell University Press; 1990. p. 3-9.
2. Hayes HK, Jones DF. First generation crosses in cucumber. Collaborative Action for the Natural Network Newsletter. 1916;3:34-35.
3. Snedecor GW, Cochran WG. Statistical methods. 6th ed. Ames (IA): The Iowa State University Press; 1967.
4. Fonseca S, Patterson FL. Hybrid vigour in seven parental diallel crosses in common wheat (*Triticum aestivum* L.). Crop Science. 1968;8:85-88. doi:10.2135/cropsci1968.0011183X000800010025x.
5. Meredith WR, Bridge RR. Heterosis and gene action in cotton (*Gossypium hirsutum* L.). Crop Science. 1972;12(3):304-310. doi:10.2135/cropsci1972.0011183X001200030015x.
6. Joshi AH, Gami RA, Patel RN, Arvinth S. Interpretation of mean value and extent of heterosis in fodder and grain yield with associated traits of sorghum (*Sorghum bicolor* (L.) Moench). Journal of Crop and Weed. 2021;17(3):206-213. doi:10.22271/09746315.2021.v17.i3.1511.
7. Pandey S, Singh B, Singh M, Rai M. Heterosis in cucumber (*Cucumis sativus* L.). Vegetable Science. 2005;32(2):143-145.
8. Kushwaha ML, Ram HH. Heterosis studies in cucumber (*Cucumis sativus* L.). Vegetable Science. 2011;38(1):55-59.
9. Singh R, Singh AK, Kumar S, Singh BK. Heterosis and inbreeding depression for fruit characters in cucumber (*Cucumis sativus* L.). Indian Journal of Horticulture. 2012;69(2):200-204.
10. Airina KK, Pradeepkumar T, George TE, Sadhankumara PG, Krishna S. Heterosis breeding exploiting gynoecy in cucumber (*Cucumis sativus* L.). Journal of Tropical Agriculture. 2013;51(1-2):144-148.
11. Devi ND, Mariappan S, Arumugam T, Anandakumar CR. Estimating combining ability for yield and yield contributing traits in snake gourd (*Trichosanthes cucumerina* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(2):795-800.