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RESEARCH ARTICLE

Estimates of heterosis for yield and its attributing traits in pumpkin (*Cucurbita moschata* Duch. ex Poir.)

Mahendra Kumar Yadav*# and D. P. Singh

Abstract

The investigations were carried out to evaluate the 28 F_1 hybrids of pumpkin, which were grown in a randomized complete block design with three replications during Zaid 2021 at the main experiment station, Department of Vegetable Science, Kalyanpur, CSA University of Agriculture and Technology, Kanpur (U.P.). Observations were recorded on nineteen quantitative traits *viz.*, days to first male flower appearance, days to first female flower appearance, node number to first male flower appearance, node number to first female flower appearance, vine length, internodal length, branches per plant, days to first harvest, average fruit weight, fruits/plant, equatorial circumference of fruit, polar circumference of fruit, flesh thickness, total soluble solids, dry matter content, moisture content, seeds per fruit, specific gravity and fruit yield per plant. The highest fruit yield per plant was recorded in hybrids viz. Azad Pumpkin-1 × P-40-16, Azad Pumpkin-1 × Punjab Samrat, P-40-16 × Punjab Samrat, Azad Pumpkin-1 × P-35-16, Narendra Agrim × Punjab Samrat and Azad Pumpkin-1 × DVRP-2-5 in F_1, exhibited significant and desirable heterosis in respect to standard variety with days to first male flower appearance, days to first female flower appearance, node number to first female flower appearance and days to first fruit harvest.

Keywords: Pumpkin, heterosis, quantitative, qualitative traits and fruit yield.

Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India.

#Department of Agriculture, RNB Global University, Bikaner, Rajasthan, India.

***Corresponding author;** Email: mahendra.yadav@rnbglobal.edu.in

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Introduction

Pumpkin (*Cucurbita moschata* Duch. ex Poir.) is an economically important vegetable crop. It has a high carotene content, is resilient, and has excellent keeping quality. It is an amphidiploid vegetable that is an herbaceous annual and is sexually reproduced. Its genomic structure, AABB, is identical. It consists of roughly 27 wild and domesticated species with the same 2n = 40 chromosomal number. Of these species, the five that are most frequently farmed are *Cucurbita moschata*, *Cucurbita maxima*, *Cucurbita ficifolia*, *Cucurbita pepo*, and *Cucurbita mixta*. Native areas of the cultivated species of *Cucurbita* appear to be North Mexico of Mexico City for *C. pepo*, South America for C. maxima, South America, Central America and Mexico for *C. moschata*, Mexico and South Mexico City for *C. mixata* and Central America and Mexico for *C. ficifolia* (Hurd et al., 1971). Pumpkin can be improved as a crop by evaluating its genetic diversity and taking advantage of heterosis. Pumpkin is a particularly adaptable crop for heterosis breeding because of its monoecious nature, big flower size, ease of pollination, high proportion of fruit set from pollinated female flowers, large amount of seeds per fruit, and low seed rate required per unit area. There is a lot of room for successfully utilizing hybrid vigor. To find crosses that have a high degree of exploitable heterosis, it is essential to have knowledge on

the magnitude of heterosis in various cross combinations, the degree of heterosis in various crossings, the inbreeding depression in the F_2 generation that confirms it, and its application in upcoming crop development initiatives (Jansi et al., 2018). Numerous researchers have reported studies on hybrid vigor and high levels of heterosis in pumpkins (Pandey et al., 2010; Jahan et al., 2012; Xin-Zheng et al., 2013; Nisha and Veeraragavathatham, 2014 and Tamilselvi et al., 2015). Both the public and private sectors have released a number of hybrids for its commercial production. The area planted with F_1 hybrids is expanding quickly, which has improved this crop's productivity and output.

Materials and Methods

This investigation was carried out to evaluate 28 F_1 of pumpkin and was grown in a randomized complete block design with three replications during Zaid 2021 at the Main Experiment Station, Department of Vegetable Science, Kalyanpur, CSA University of Agriculture and Technology, Kanpur (U.P.). Observations were recorded on nineteen quantitative traits *viz.*, days to first male flower appearance, days to first female flower appearance, node number to first male flower appearance, node number to first female flower appearance, vine length, internodal length, branches per plant, days to first harvest, average fruit weight, fruits per plant, equatorial circumference of fruit, polar circumference of fruit, flesh thickness, total soluble solids, dry matter content, moisture content, seeds per fruit, specific gravity and fruit yield per plant. The data recorded from 28 F_1s on nineteen characters were subjected to estimate heterosis expressed as percent increase or decrease in the mean values of F_1's (hybrid) over standard variety (standard heterosis) was calculated according to the method suggested by Hayes et al. (1955).

Results and Discussion

The heterosis was expressed as a percentage increase or decrease in F_1 values relative to the Punjab Samrat standard variety (SV). Table 1 displays the estimations of standard heterosis for every characteristic in twenty-eight F_1 during Zaid, 2021. For all maturity traits—days to first male and female flower appearance, node number to first male and female flower appearance, internodal length, days to first fruit harvest, moisture content, and number of seeds per fruit negative estimations of heterosis were deemed desirable.

Positive estimates of heterosis were deemed desirable for the remaining characteristics. Out of 28 F_1 hybrids, five crosses showed significant and negative heterosis over standard variety for days to first male flower appearance viz. NDPK-7-24 × Kashi Harit (-20.75%) followed by Kashi Harit × DVRP-2-5 (-20.49%), Narendra Agrim × DVRP-2-5 (-19.60%), Kashi Harit × Punjab samrat (-18.57%) and Narendra Agrim × NDPK-7-24 (-16.83%) Five crosses showed significant and negative heterosis over standard variety for days to first female flower appearance namely Narendra Agrim × NDPK-7-24 (-15.78%), Narendra Agrim × DVRP-2-5 (-10.94%), Kashi Harit × DVRP-2-5 (-8.99%), Azad Pumpkin-1 × Punjab Samrat (-6.85%) and P-40-16 × DVRP-2-5 (-6.79%). Out of twenty eight F_1 hybrids, all crosses showed significant and negative heterosis over standard variety for node to first male flower appearance and for node to first female flower appearance. Seventeen crosses showed significant and positive standard heterosis for vine length.

Best five crosses for vine length P-40-16 × NDPK-7-24 (21.57%) followed by P-35-16 × Kashi Harit (21.20%), P-40-16 × Narendra Agrim (21.02%), Azad Pumpkin-1 × DVRP-2-5 (17.82%) and P-35-16 × Narendra Agrim (14.20%). About 25 crosses exhibited standard heterosis for internodal length

Table 1a: Estimates of heterosis (%) over standard variety (SV) Punjab Samrat

S. No.	*Crosses*	*Days to first male flower appearance*	*Days to first female flower appearance*	*Node No. to first male flower appearance*	*Node No. to first female flower appearance*	*Vine length (cm)*
1	Azad Pumpkin-1 × P-35-16	-5.70**	0.29	-10.27	-11.81**	-3.75
2	Azad Pumpkin-1 × P-40-16	-11.78**	11.07**	-7.98	-7.40**	4.18
3	Azad Pumpkin-1× Narendra Agrim	-8.69**	-1.57	-2.23	-14.04**	7.44
4	Azad Pumpkin-1 × NDPK-7-24	-4.51*	-0.53	-14.78**	-16.09**	-7.31
5	Azad Pumpkin-1 × Kashi Harit	-18.35**	-4.89	-9.89	-17.55**	7.56
6	Azad Pumpkin-1 × DVRP-2-5	-8.34**	1.86	-10.33	-17.81**	17.82**
7	Azad Pumpkin-1× Punjab Samrat	-12.20**	-6.85**	-7.67	-21.38**	3.2
8	P-35-16 × P-40-16	7.30**	14.11**	-12.99*	-12.81**	7.99
9	P-35-16 × Narendra Agrim	2.10	10.17**	-15.52**	-9.09**	14.20**
10	P-35-16 × NDPK-7-24	-4.48*	12.15**	-11.94*	-11.95**	-0.49
11	P-35-16 × Kashi Harit	4.02*	23.17**	-21.27**	-12.09**	21.20**

12	P-35-16 × DVRP-2-5	-0.43	13.65**	-19.11**	-11.09**	-1.54
13	P-35-16 × Punjab Samrat	6.15**	6.75**	-13.23*	-11.23**	5.84
14	P-40-16 × Narendra Agrim	-10.64**	-2.77	-20.22**	-7.23**	21.02**
15	P-40-16 × NDPK-7-24	-9.98**	-0.65	-27.77**	-10.09**	21.57**
16	P-40-16 × Kashi Harit	-8.00**	7.34**	-17.38**	-10.52**	-7.93
17	P-40-16 × DVRP-2-5	-14.62**	-6.79**	-17.93**	-6.38*	12.85*
18	P-40-16 × Punjab Samrat	-12.19**	-5.90*	-24.92**	-9.81**	-7.07
19	Narendra Agrim × NDPK-7-24	-16.83**	-15.78**	-8.53	-17.67**	0.92
20	Narendra Agrim × Kashi Harit	-13.99**	2.73	-4.08	-16.95**	-13.89**
21	Narendra Agrim × DVRP-2-5	-19.60**	-10.94**	-0.19	-23.03**	0.49
22	Narendra Agrim × Punjab Samrat	-14.02**	-0.52	-9.03	-20.67**	-16.96**
23	NDPK-7-24 × Kashi Harit	-20.75**	11.12**	-13.05*	-13.52**	-9.1
24	NDPK-7-24 × DVRP-2-5	-5.95**	5.15*	-17.01**	-14.95**	-9.53
25	NDPK-7-24 × Punjab Samrat	-12.31**	-5.44*	-19.79**	-15.81**	-15.00**
26	Kashi Harit × DVRP-2-5	-20.49**	-8.99**	-9.71	-18.10**	8.73
27	Kashi Harit × Punjab Samrat	-18.57**	-4.65	-19.79**	-21.67**	0.43
28	DVRP-2-5 × Punjab Samrat	-10.30**	1.45	-9.15	-8.02**	2.03
No. of crosses with significant positive heterosis		3	10	0	0	6
No. of crosses with significant negative heterosis		23	7	16	28	3
Range of heterosis		-20.75 to 7.30	-15.78 to 23.17	-27.77 to -0.19	-23.03 to -6.38	-16.96 to 21.57

Table 1b: Estimates of heterosis (%) over standard variety (SV) Punjab Samrat

S. No.	*Crosses*	*Internodal length (cm)*	*No. of primary branches/ plant*	*Days to first harvest*	*Average fruit weight (kg)*	*Number of fruits/ plant*
1	Azad Pumpkin-1 × P-35-16	-11.73**	6.67	-4.40**	23.16**	26.71**
2	Azad Pumpkin-1 × P-40-16	-7.82**	13.38**	-6.39**	2.22	17.87**
3	Azad Pumpkin-1× Narendra Agrim	-18.89**	14.23**	-14.56**	-1.53	12.41**
4	Azad Pumpkin-1 × NDPK-7-24	-6.84*	4.53	-8.04**	-1.25	16.29**
5	Azad Pumpkin-1 × Kashi Harit	-15.64**	20.00**	-21.37**	-13.59**	8.54
6	Azad Pumpkin-1 × DVRP-2-5	-2.93	22.35**	-13.60**	25.38**	17.78**
7	Azad Pumpkin-1× Punjab Samrat	-8.47**	20.73**	-12.64**	1.53	13.41**
8	P-35-16 × P-40-16	-14.01**	21.97**	3.14*	-4.99	51.34**
9	P-35-16 × Narendra Agrim	-8.14**	-6.28	-4.76**	5.69	4.67
10	P-35-16 × NDPK-7-24	-16.29**	13.55**	-3.69*	-6.1	-6.06
11	P-35-16 × Kashi Harit	-12.38**	-0.85	2.02	-7.35	22.24**
12	P-35-16 × DVRP-2-5	-10.10**	5.73	-8.90**	30.24**	8.84
13	P-35-16 × Punjab Samrat	-20.20**	13.21**	-6.07**	2.08	15.39**
14	P-40-16 × Narendra Agrim	-12.05**	-0.13	-20.26**	-8.6	6.55
15	P-40-16 × NDPK-7-24	-10.75**	13.68**	-13.35**	0.14	-16.68**
16	P-40-16 × Kashi Harit	-16.61**	23.72**	-8.80**	-2.64	23.14**
17	P-40-16 × DVRP-2-5	-23.13**	14.23**	-18.34**	1.11	11.22*
18	P-40-16 × Punjab Samrat	-16.29**	-3.33	-15.17**	7.21	19.46**

19	Narendra Agrim × NDPK-7-24	-15.31**	9.96*	-16.94**	-2.91	15.69**
20	Narendra Agrim × Kashi Harit	-9.77**	7.48	-13.14**	-3.05	-6.85
21	Narendra Agrim × DVRP-2-5	-4.89	13.76**	-20.24**	5.41	17.08**
22	Narendra Agrim × Punjab Samrat	-0.33	-2.78	0.13	27.46**	25.92**
23	NDPK-7-24 × Kashi Harit	-8.14**	9.62	-21.06**	-5.41	11.72*
24	NDPK-7-24 × DVRP-2-5	-20.20**	-4.57	-10.52**	25.66**	-9.93*
25	NDPK-7-24 × Punjab Samrat	-15.31**	-1.75	-14.16**	-2.77	14.40**
26	Kashi Harit × DVRP-2-5	-15.31**	15.09**	-11.79**	-1.11	23.34**
27	Kashi Harit × Punjab Samrat	-9.12**	19.49**	-20.22**	-6.24	16.88**
28	DVRP-2-5 × Punjab Samrat	-9.45**	13.72**	-9.45**	-10.68*	10.72*
No. of crosses with significant positive heterosis		0	16	1	5	20
No. of crosses with significant negative heterosis		25	0	25	2	2
Range of heterosis		-23.13 to -0.33	-0.13 to 23.72	-21.37 to 3.14	-13.59 to 30.24	-16.68 to 51.34

Table 1c: Estimates of heterosis (%) over standard variety (SV) Punjab Samrat

S. No.	*Crosses*	*Equatorial circumference of fruit (cm)*	*Polar circumference of fruit (cm)*	*Flesh thickness (cm)*	*Total soluble solids (^{0}Brix)*	*Dry matter content (%)*
1	Azad Pumpkin-1 × P-35-16	20.24**	27.31**	9.24*	13.29**	12.31
2	Azad Pumpkin-1 × P-40-16	12.48**	22.17**	21.57**	24.51**	22.99**
3	Azad Pumpkin-1× Narendra Agrim	7.58**	18.92**	5.46	23.15**	6.30
4	Azad Pumpkin-1 × NDPK-7-24	3.20	9.96**	9.24*	12.76**	5.10
5	Azad Pumpkin-1 × Kashi Harit	24.82**	22.02**	5.60	10.21**	3.08
6	Azad Pumpkin-1 × DVRP-2-5	5.03**	10.59**	20.17**	13.12**	5.05
7	Azad Pumpkin-1× Punjab Samrat	22.55**	21.55**	5.32	24.21**	12.75
8	P-35-16 × P-40-16	10.57**	14.71**	10.36**	27.06**	17.99**
9	P-35-16 × Narendra Agrim	5.81**	7.24**	4.34	16.91**	6.88
10	P-35-16 × NDPK-7-24	3.14	5.62*	8.82*	13.77**	-17.32**
11	P-35-16 × Kashi Harit	-1.57	1.34	5.04	9.85**	1.25
12	P-35-16 × DVRP-2-5	8.36**	13.46**	6.72	15.37**	-19.29**
13	P-35-16 × Punjab Samrat	5.48**	6.25*	20.45**	10.74**	3.51
14	P-40-16 × Narendra Agrim	10.85**	13.48**	4.2	16.56**	3.51
15	P-40-16 × NDPK-7-24	22.53**	22.14**	4.48	20.36**	4.71
16	P-40-16 × Kashi Harit	3.92*	2.88	4.34	16.56**	-3.99
17	P-40-16 × DVRP-2-5	5.35**	4.75	10.08*	16.38**	1.01
18	P-40-16 × Punjab Samrat	8.67**	15.25**	10.22**	12.23**	6.73
19	Narendra Agrim × NDPK-7-24	0.12	0.62	10.36**	12.64**	-18.28**
20	Narendra Agrim × Kashi Harit	-4.50**	-5.36*	8.40*	12.46**	1.54
21	Narendra Agrim × DVRP-2-5	5.61**	4.53	5.18	15.13**	-17.80**
22	Narendra Agrim × Punjab Samrat	-1.63	10.97**	9.80*	14.84**	3.17
23	NDPK-7-24 × Kashi Harit	-6.79**	-6.99**	9.52*	11.28**	-22.85**
24	NDPK-7-24 × DVRP-2-5	-0.06	21.17**	11.90**	12.70**	-0.19

25	NDPK-7-24 × Punjab Samrat	8.81**	7.39**	13.03**	25.58**	-21.79**
26	Kashi Harit × DVRP-2-5	-14.10**	-9.86**	22.97**	10.62**	-12.7
27	Kashi Harit × Punjab Samrat	-13.91**	-12.06**	12.18**	11.10**	-11.83
28	DVRP-2-5 × Punjab Samrat	8.75**	9.72**	4.20	14.48**	-5.34
No. of crosses with significant positive heterosis		18	19	17	28	2
No. of crosses with significant negative heterosis		4	4	0	0	6
Range of heterosis		-14.10 to 24.82	-12.06 to 27.31	4.20 to 22.97	9.85 to 27.06	-22.85 to 22.99

Table 1d: Estimates of heterosis (%) over standard variety (SV) Punjab Samrat

S. No.	*Crosses*	*Moisture content (%)*	*Number of seeds per fruit*	*Specific gravity (g/cm^3)*	*Fruit yield per plant (kg)*
1	Azad Pumpkin-1 × P-35-16	-0.92	46.79**	14.13*	56.14**
2	Azad Pumpkin-1 × P-40-16	-1.71**	24.77**	1.77	20.38**
3	Azad Pumpkin-1× Narendra Agrim	-0.47	63.53**	12.72*	10.71
4	Azad Pumpkin-1 × NDPK-7-24	-0.38	4.59	11.66*	15.13*
5	Azad Pumpkin-1 × Kashi Harit	-0.23	-0.92	4.24	-6.20
6	Azad Pumpkin-1 × DVRP-2-5	-0.38	17.43**	1.77	47.95**
7	Azad Pumpkin-1× Punjab Samrat	-0.95	44.50**	10.60	15.17*
8	P-35-16 × P-40-16	-1.34**	50.69**	-0.35	43.74**
9	P-35-16 × Narendra Agrim	-0.51	17.89**	2.47	10.58
10	P-35-16 × NDPK-7-24	1.29**	15.14*	13.78*	-12.07
11	P-35-16 × Kashi Harit	-0.09	-6.88	0.35	13.27
12	P-35-16 × DVRP-2-5	1.44**	-1.15	0.35	41.75**
13	P-35-16 × Punjab Samrat	-0.26	34.86**	-2.12	18.02**
14	P-40-16 × Narendra Agrim	-0.26	12.84	0.71	-2.94
15	P-40-16 × NDPK-7-24	-0.35	-6.65	6.71	-16.49*
16	P-40-16 × Kashi Harit	0.30	10.32	0.71	19.88**
17	P-40-16 × DVRP-2-5	-0.08	-0.23	0.35	12.57
18	P-40-16 × Punjab Samrat	-0.5	18.12**	-3.89	28.28**
19	Narendra Agrim × NDPK-7-24	1.36**	-0.69	0.35	12.24
20	Narendra Agrim × Kashi Harit	-0.11	-4.36	0.01	-9.47
21	Narendra Agrim × DVRP-2-5	1.33**	13.53*	4.59	23.40**
22	Narendra Agrim × Punjab Samrat	-0.24	-5.50	24.03**	60.73**
23	NDPK-7-24 × Kashi Harit	1.70**	-8.72	1.06	5.83
24	NDPK-7-24 × DVRP-2-5	0.01	12.16	2.12	13.48
25	NDPK-7-24 × Punjab Samrat	1.62**	19.27**	10.25	11.20
26	Kashi Harit × DVRP-2-5	0.95	-11.47	4.95	21.87**
27	Kashi Harit × Punjab Samrat	0.88	-0.23	1.41	9.55
28	DVRP-2-5 × Punjab Samrat	0.40	13.53*	2.83	-1.03
No. of crosses with significant positive heterosis		6	13	5	13
No. of crosses with significant negative heterosis		2	0	0	1
Range of heterosis		-1.71 to 1.70	-11.47 to 63.53	-3.89 to 24.03	-16.49 to 60.73

*, **Significant at 5 per cent and 1 per cent probability levels, respectively

and the best five crosses, P-40-16 × DVRP-2-5 (-23.13%) followed by P-35-16 × Punjab Samrat and NDPK-7-24 × DVRP-2-5 (-20.20%), Azad Pumpkin-1 x Narendra Agrim (-18.89%) and P-40-16 × Kashi Harit (-16.61%). Sixteen crosses showed significant positive standard heterosis for number of primary branches per plant and best five crosses P-40-16 × Kashi Harit (23.72%) followed by Azad Pumpkin-1 × DVRP-2-5 (22.35%), P-35-16 × P-40-16 (21.97%), Azad Pumpkin-1 × Punjab Samrat (20.73%) and Azad Pumpkin-1 × Kashi Harit (20.00%). About 25 crosses showed significant and negative standard heterosis for days to first fruit harvest and the best five crosses Azad Pumpkin-1 × Kashi Harit (-21.37%) followed by NDPK-7-24 × Kashi Harit (-21.06%), P-40-16 × Narendra Agrim (-20.26%), Narendra Agrim × DVRP-2-5 (-20.24%) and Kashi Harit × Punjab Samrat (-20.22%). Similar results were also proposed in many studies (Xin-zheng et al., 2013; El-Tahawey et al., 2015; Begum et al., 2016; Jansi et al., 2018; Hatwal et al., 2018; Kumar et al., 2018).

Five crosses showed significant and positive standard heterosis for average fruit weight and the best five crosses P-35-16 × DVRP-2-5 (30.24%) followed by Narendra Agrim × Punjab Samrat (27.46%), NDPK-7-24 × DVRP-2-5 (25.66%), Azad Pumpkin-1 × DVRP-2-5 (25.38%) and Azad Pumpkin-1 × P-35-16 (23.16%). About 20 crosses showed significant and positive standard heterosis for number of fruits per plant namely P-35-16 × P-40-16 (51.34%), Azad Pumpkin-1 × P-35-16 (26.71%), Narendra Agrim × Punjab Samrat (25.92%), Kashi Harit × DVRP-2-5 (23.34%) and P-40-16 × Kashi Harit (23.14%). Two crosses showed significant and positive standard heterosis for dry matter content, viz. Azad Pumpkin-1 × P-40-16 (22.99%) and P-35-16 × P-40-16 (17.99%) and two crosses showed significant and negative standard heterosis for moisture content, namely Azad Pumpkin-1 x P-40-16 (-1.71%) and P-35-16 × P-40-16 (-1.34%). About 13 crosses showed significant and positive standard heterosis for fruit yield per plant and the best five crosses Narendra Agrim × Punjab Samrat (60.73%) followed by Azad Pumpkin-1 × P-35-16 (56.14%), Azad Pumpkin-1 × DVRP-2-5 (47.95%), P-35-16 × P-40-16 (43.74%) and P-35-16 × DVRP-2-5 (41.75%). Similar results were earlier reported studies (Sirohi et al., 2002; Xin-zheng et al., 2013; El-Tahawey et al., 2015; Begum et al., 2016; Jansi et al., 2018; Hatwal et al., 2018; Kumar et al., 2018).

Conclusion

Based on the above findings, it may be concluded that for fruit yield per plant, cross Azad Pumpkin-1 × P-35-16, Azad Pumpkin-1 × DVRP-2-5, Narendra Agrim × Punjab Samrat showed high heterosis over standard variety and may be exploited as a commercial hybrid in future. Thus, there exists scope for the development of desirable F_1/segregates as per consumer's choice to meet the ever-increasing demand of pumpkin in the future.

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सारांश

कद्दू के 28 जीनोटाइप (28 एफ 1) का मूल्यांकन करने के लिए जांच की गई थी, जो मुख्य प्रयोग स्टेशन सब्जी विज्ञान विभाग, कल्याणपुर सीएसए कृषि और प्रौद्योगिकी विश्वविद्यालय, कानपुर (यूपी) में जायद 2021 के दौरान तीन प्रतिकृति के साथ एक यादृच्छिक पूर्ण ब्लॉक डिजाइन में उगाए गए थे। उन्नीस मात्रात्मक लक्षणों पर अवलोकन दर्ज किए गए, जैसे कि पहले नर फूल की उपस्थिति के दिन, पहली मादा फूल की उपस्थिति के दिन, पहले नर फूल की उपस्थिति के लिए दिन, पहले नर फूल की उपस्थिति के लिए नोड संख्या, पहली मादा फूल की उपस्थिति के लिए नोड संख्या, बेल की लंबाई, इंटरनोडल लंबाई, प्रति पौधे शाखाएं। पहली कटाई के दिन, औसत फल का वजन, प्रति पौधा फल, फल की भूमध्यरेखीय परिधि, फल की ध्रुवीय परिधि, गूदे की मोटाई, कुल घुलनशील ठोस पदार्थ, शुष्क पदार्थ की मात्रा, नमी की मात्रा, प्रति फल बीज, विशिष्ट गुरुत्व और प्रति पौधा फल की उपज। सर्वोत्तम संकर किस्मों में प्रति पौधा सबसे अधिक फल उपज दर्ज की गई। आजाद कद्दू-1 × पी-40-16, आजाद कद्दू-1 × पंजाब सम्राट, पी-40-16 × पंजाब सम्राट आजाद कद्दू-1 × पी-35-16, नरेंद्र एग्रीम × पंजाब सम्राट और आजाद कद्दू-1 × डीवीआरपी -2-5 एफ1 में मानक किस्म के संबंध में महत्वपूर्ण और वांछनीय हेटेरोसिस प्रदर्शित किया, जिसमें पहले नर फूल आने के दिन, पहली मादा फूल दिखने के दिन, पहली मादा फूल दिखने के लिए नोड संख्या और पहले फल की कटाई के दिन शामिल थे।