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Estimation of Heterosis for Yield and Yield Contributing Traits in Bottle Gourd [*Lagenaria siceraria* (Mol.) Standl.]

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ABSTRACT

Twenty eight F^1 hybrids developed from a diallel set involving eight parents (excluding reciprocals) in bottle gourd were evaluated at Horticulture complex, Department of Horticulture JNKVV. Jabalpur (MP). The study was aimed to estimate heterosis for yield and yield contributing traits in bottle gourd. Analysis of variance revealed the presence of considerable variability among parents and hybrids for all the characters under study. Heterosis for fruit yield per vine ranged from -1.27 to 17.33 % over mid parent and 0.61 to -22.74% over better parent. For number of fruits per plant and average fruit weight was ranged from 0.25 to -25.30% and 1.37 to 46.67% over mid parent and -0.17 to -33.44% and 0.00 to 41.94% over better parent, respectively. Regarding fruit length the heterosis ranged from 0.64 to 16.50 over mid parent while heterosis over better parent ranged from -0.51 to -22.85. Heterosis for days to first fruit harvest ranged from 0.00 to -12.02 and 0.00 to -14.51 over mid parent and better parent, respectively. It was important to note that only two F^1 hybrids viz. Arka Bahar x Kashi Ganga and Arka Bahar x Pusa Naveen exhibited higher positive and significant values over better parent. While, crosses Arka Bahar x Narendra Dharidar, Kashi Ganga x Narendra Dharidar, Pusa Santushti x PSPL and Arka Bahar x Samrat showed significant negative heterosis over better parent for earliness.

Keywords *Lagenaria siceraria*, Heterosis, Bottle gourd, Heterobeltiosis, Transgressive segregants hybrids, Yield.

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INTRODUCTION

Bottle gourd (*Lagenaria siceraria* Mol. Standl.) belongs to the family Cucurbitaceae and is one of the important cucurbits commonly grown in both rainy and summer season in various parts of India and its chromosome No. is 2n=24. It belongs to the genus *Lagenaria* that is originated from the word *lagena*, meaning the bottle. The fresh fruit has light green smooth skin and white flesh. A good amount of

variability is found in fruit shape and size. The edible portion of fruit contains 96.3% moisture, 2.9% carbohydrates, 0.2% protein, 0.1% fat, 0.5 % mineral matter and 11 mg of vitamin C per 100 g fresh weight (Thamburaj and Singh 2005). Bottle gourd is one of the best vegetables and is reach in medicinal value. It cures many disorders of our body which occurs because of our bad eating habits like jaundice, inflammation of kidney and even toothaches. Its fruits are traditionally used as a nutritive agent having cardio protective, cardio tonic, general tonic, diuretic and aphrodisiac properties. In summers a glassful of fresh bottle gourd juice in the morning empty stomach can prevent you from the heat stroke and also controls all the problems related to gas. The vegetables soothe the body's nervous system and helps in relaxation. It also treats epilepsy, indigestion and ulcers.

India being the second largest producer of vegetable in the world, after China, shares about 15% of the world output of vegetables from about 3% of total cropped area in the country. The current production level of vegetables is over 169.04 million tonnes from an area of 10.10 million hectares. Bottle gourd occupies an area of 0.14 million hectares with a production of 2.45 million tonnes during 2015-16 (Anonymous 2017).

Crop improvement depends upon the magnitude of genetic variability and extent of which the desirable characters are heritable for a successful breeding program of any crop. Bottle guard, being a cross pollinated crop which ranges from 60 to 80%, exhibits high heterosis in its crosses (Maurya *et al*. 1993, Maurya *et al*. 2003) and has greater variability in genotypes as well. Heterosis has been successfully exploited in bottle guard for evolving high yielding F^1 hybrids resistant to disease and pests. The breeding objective can be addressed to satisfy the growers and the consumers and it can be considered in terms of crop improvement and products improvement. The main criteria for crop improvement are yield, earliness, disease resistance or abiotic stresses tolerance, uniformity and long fruiting period. A speedy crop and product improvement can be brought about in bottle gourd by assessing the variety and exploitation of heterosis. Because of the monoecious nature of the crop, large flower size, easy pollination, high proportion of fruit set of pollinated pistillate flowers, large number of seeds per fruit, and low seed rate required per unit area, bottle gourd is highly amenable for heterosis breeding program. Diallel design has been found suitable to select the parents from germplasm which will be employed in the present study to determine the extent of heterosis over mid parent and better parent, respectively. Keeping the above facts in view the present investigation was undertaken with the objective to evaluate the heterosis in F^1 crosses over better parents.

MATERIALS AND METHODS

Experimental site and soil information

The present research work entitled "Estimation of heterosis for yield and yield contributing traits in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)" was undertaken to study the heterosis using half diallel mating design. The experiment was conducted at Horticulture complex, Department of Horticulture JNKVV Jabalpur (MP) during 2014-15 and 2015-16. The soil of the experimental field was medium black with good drainage and uniform texture with medium NPK status.

Experimental designs and treatments detail

The experimental materials for the present study comprised of eight promising and diverse genotypes of bottle gourd selected on the basis of genetic variability. The selected parental lines i.e., (P_1) Arka Bahar, (P_2) Kashi Ganga, (P_3) Narendra Dharidar, (P_4) Samrat, (P_5) Pusa Naveen, (P_6) Pusa Santushti, (P_7) Punjab Komal and (P_8) Pusa Summer Prolific Long were crossed in the all possible combinations in diallel technique, excluding reciprocals to get 28 F_1 hybrids for the study of heterosis for qualitative and quantitative traits in bottle gourd. In the first season the selected genotypes were crossed to produce F^1s in half diallel fashion and in the next season they were evaluated along with parents to study heterosis on the basis of morpho-physiological characters.

Sampling, observations and statistical analysis

Observations on various growth and yield characters

were made on five randomly selected plants in each replication. The data were recorded on thirteen quantitative characters viz., vine length, primary branches per plant, days to first staminate flower anthesis, days to first pistilate flower anthesis, sex ratio, node number of first female flower, days to first fruit harvest, days to last fruit harvest, fruit length, fruit width, average fruit weight, fruits per plant and fruit yield per vine. The magnitude of heterosis was studied using information on various quantitative characters. Heterosis expressed as per cent increase or decrease in the mean values of F_1's (hybrid) over better-parent (heterobeltiosis) and mid parent (average heterosis) was calculated according to method suggested by Hayes *et al*. (1955).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated that the mean square differences among parents were found to be highly significant for all the traits except for primary branches per plant. This indicates the presence of variability among parents. Similarly, significant differences were observed among hybrids for all the characters. The significance of mean squares due to parents vs. hybrids for all the traits proved that the differences in the performance of parents and hybrids were real and manifested the presence of heterosis for most of the characters (Verma and Naidu 2018). The estimates of heterosis were considered desirable in negative direction for all maturity traits viz., days to first staminate flower anthesis, days to first pistilate flower anthesis and days to first fruit harvest and node number of first pistilate flower. However, for other yield and yield contributing characters positive estimates of heterosis was considered favorable.

The highest significant and positive heterosis over average parent for vine length was recorded by Arka Bahar x Pusa Naveen followed by Narendra Dharidar x Pusa Naveen and Samrat x Pusa Santushti while, the highest significant and positive heterosis over better parent was exhibited by Arka Bahar x Pusa Naveen followed by Narendra Dharidar x Pusa Naveen and Samrat x Pusa Santushti (Table 2). Present results are in conformity with the findings of Yadav and Kumar (2012). Data on primary branches/ plant in Table 2 showed that the highest significant and positive heterosis was recorded by Narendra Dharidar x Pusa Santushti followed by Punjab Komal x PSPL and Narendra Dharidar x Punjab Komal. On the other hand, only one hybrid i.e. Narendra Dharidar x Pusa Santushti exihibited significant and positive heterosis over better parent. Highest significant and positive heterosis over average parent for female: male ratio was recorded for Narendra Dharidar x Samrat while, no significant and positive heterobeltiosis was observed for any cross combination. Days to anthesis of first female flower exhibited the highest significant and negative heterosis over average parent for cross combination Kashi Ganga x PSPL followed by Arka Bahar x Pusa Santushti

Table 1. Analysis of variance (Diallel cross) for fruit yield and its component characters in bottle gourd.

Source of variation	df	Vine length (m) at 90 das	Primary branches/ plant	Female: Male ratio	Days to anthesis of first female flower	Days to anthesis of first male flower	Node number of first female flower	Days to first harvest for vegetable use	Days to last harvest for vegetable use	Fruit length (cm)	Fruit width (cm)	Fruit weight (kg)	Fruits/ plant	Fruit yield/ plant (kg)
Replicates	2.00	0.01	0.01	0.00	1.95	5.08	0.09	2.79	2.79	0.07	8.36	0.02	0.07	0.17
Treatments	35.00	0.60**	0.54	0.01**	39.81**	47.70**	2.74**	29.14**	53.06**	36.47**	24.65**	0.05**	0.69**	0.74**
Parents	7.00	0.16**	0.46	0.02**	19.33**	18.52**	5.55**	28.48**	47.24**	29.71**	3.58**	0.04**	0.53**	0.70**
Hybrids	27.00	0.73**	0.58	0.01**	40.62**	52.14**	2.10**	26.96**	52.26**	39.57**	30.72**	0.06**	0.79**	0.78**
Parent Vs Hybrids	1.00	0.32**	0.12	0.10**	161.40**	132.15**	1.27**	92.51**	115.56**	1.26**	8.39**	0.04**	0.04**	0.04**
Error	70.00	0.02	0.04	0.00	3.95	4.45	0.43	1.33	2.30	1.29	7.69	0.02	0.05	1.06

* - Significant at 5 % probability level.
** - Significant at 1 % probability level.

Table 2. Estimates of heterosis (%) over mid parent and better parent for thirteen characters in bottle gourd.

Crosses		Primary branches/ plant		Vine length (m) at 90 das		Female: male ratio		Days to anthesis of first female flower	
		AH	BP	AH	BP	AH	BP	AH	BP
1x2	Arka Bahar x Kashi Ganga	-1.05	-1.40	12.38**	8.84**	-34.15**	-34.94**	-14.47**	-20.83**
1x3	Arka Bahar x N. Dharidar	2.27	2.24	-12.33**	-14.29**	-25.00	-45.78**	-9.51**	-14.81**
1x4	Arka Bahar x Samrat	1.93	-5.65*	9.53**	5.61*	-59.54**	-61.11**	-3.61	-9.26**
1x5	Arka Bahar x Pusa Naveen	-14.79**	-19.31**	17.69**	17.11**	-57.61**	-61.39**	-1.63	-7.93**
1x6	Arka Bahar x Pusa Santushti	-9.70**	-13.46**	0.67	-0.33	-43.56**	-44.58**	-16.56**	-20.75**
1x7	Arka Bahar x Punjab Komal	-6.18*	-14.20**	3.75	1.92	-32.87**	-42.17**	-13.13**	-16.23**
1x8	Arka Bahar x PSPL	1.82	-1.50	-5.73**	-7.64**	-4.13	-30.12**	10.23**	4.38
2x3	Kashi Ganga x N. Dharidar	4.11	3.78	-1.9	-2.85	-1.69	-28.40**	-18.18**	-19.64**
2x4	Kashi Ganga x Samrat	-13.55**	-20.24**	-12.90**	-18.57**	-52.05**	-54.44**	-2.42	-4.17
2x5	Kashi Ganga x Pusa Naveen	-1.32	-6.88*	-7.17**	-10.53**	-25.27**	-32.67**	-6.02*	-7.14*
2x6	Kashi Ganga x Pusa Santushti	-5.37	-9.62**	-8.49**	-10.51**	-54.04**	-54.32**	-0.92	-3.57
2x7	Kashi Ganga x Punjab Komal	6.84**	-2.61	11.78**	6.41**	-34.75**	-43.21**	-10.56**	-14.29**
2x8	Kashi Ganga x PSPL	-5.76*	-9.15**	-3.29	-4.43	-49.58**	-62.96**	0.61	-1.79
3x4	N. Dharidar x Samrat	-7.43**	-14.35**	9.84**	3.64	14.96	-18.89	-8.64**	-8.64**
3x5	N. Dharidar x Pusa Naveen	4.99	-0.62	17.65**	14.47**	-46.38**	-63.37**	-9.20**	-9.76**
3x6	N. Dharidar x Pusa Santushti	13.75**	8.97**	10.68**	9.29**	-0.85	-27.50*	-2.80	-3.70
3x7	N. Dharidar x Punjab Komal	7.17**	-2.03	4.07	0.00	-27.84	-41.67**	-6.96*	-9.26**
3x8	N. Dharidar x PSPL	6.12*	2.61	-2.85	-3.05	1.33	0.00	-0.62	-1.23
4x5	Samrat x Pusa Naveen	-4.88	-7.14*	-12.13**	-14.87**	-24.61**	-28.71**	-6.13*	-6.71*
4x6	Samrat x Pusa Santushti	-21.60**	-24.40**	14.66**	9.50**	-34.12**	-37.78**	-12.15**	-12.96**
4x7	Samrat x Punjab Komal	-9.43**	-10.61**	1.85	-0.06	-36.00**	-46.67**	-8.86**	-11.11**
4x8	Samrat x PSPL	5.92*	1.19	5.06*	-0.68	-17.19	-41.11**	-4.35	-4.94
5x6	Pusa Naveen x Pusa Santushti	5.06	3.75	6.18**	4.61	-33.70**	-40.59**	-1.55	-3.05
5x7	Pusa Naveen x Punjab Komal	-2.56	-6.09*	5.19*	3.85	-8.07	-26.73**	3.77	0.61
5x8	Pusa Naveen x PSPL	0.32	-1.88	-0.13	-2.63	-20.86	-45.54**	-5.56*	-6.71*
6x7	Pusa Santushti x Punjab Komal	-11.11**	-15.36**	-5.11*	-7.69	-5.71	-17.50	3.51	1.89
6x8	Pusa Santushti x PSPL	6.15*	5.13	2.77	1.69	-42.37**	-57.50**	-5.33	-5.63
7x8	Punjab Komal x PSPL	7.53**	1.45	10.52**	6.41	-44.90**	-55.00**	-4.46	-6.25*

Table 2. Continued.

Crosses		Days to anthesis of first male flower		Node at which first female flower appeared		Days to first harvest for vegetable use		Days to last harvest for vegetable use	
		AH	BP	AH	BP	AH	BP	AH	BP
1x2	Arka Bahar x Kashi Ganga	-14.46	-20.57	14.91*	9.66	-9.84**	-14.51**	-7.31**	-9.72**
1x3	Arka Bahar x N. Dharidar	-7.84	-13.02	-0.45	-5.98	-12.02**	-13.13**	-5.90**	-5.90**
1x4	Arka Bahar x Samrat	-4.08	-9.47	0.14	-15.82**	-2.58	-3.08*	-6.25**	-6.25**
1x5	Arka Bahar x Pusa Naveen	0.62	-5.29	-0.63	-11.90	-5.76**	-6.74**	-6.83**	-8.39**
1x6	Arka Bahar x Pusa Santushti	-19.24	-23.35	-7.92	-21.84**	0.78	0.00	-0.34	-1.03

Table 2. Continued.

	Crosses	Days to anthesis of first male flower		Node at which first female flower appeared		Days to first harvest for vegetable use		Days to last harvest for vegetable use	
		AH	BP	AH	BP	AH	BP	AH	BP
1x7	Arka Bahar x Punjab Komal	-11.54	-14.81	10.45	-1.36	-0.25	-2.94*	3.65**	-0.64
1x8	Arka Bahar x PSPL	10.41	4.79	16.13**	5.06	-7.82**	-13.64**	-3.96**	-5.65**
2x3	Kashi Ganga x N. Dharidar	-18.60	-20.00	25.77**	13.68	-1.52	-1.52	-1.23	-2.08
2x4	Kashi Ganga x Samrat	-2.33	-4.00	1.96	-17.46**	-5.34**	-6.06**	-3.33**	-4.17**
2x5	Kashi Ganga x Pusa Naveen	-9.57	-10.86	26.20**	7.43	-4.39**	-6.57**	-2.93*	-5.37**
2x6	Kashi Ganga x Pusa Santushti	-1.75	-4	19.48**	-2.38	-0.52	-2.53	-0.87	-2.40
2x7	Kashi Ganga x Punjab Komal	-8.01	-11.43	9.35	-6.27	-1.49	-2.94*	1.51	-3.50**
2x8	Kashi Ganga x PSPL	5.26	2.86	24.89**	8.37	-6.20**	-12.12**	-5.88**	-8.33**
3x4	N. Dharidar x Samrat	-8.88	-8.88	5.69	-6.65	-0.54	-6.15**	-3.03*	-5.56**
3x5	N. Dharidar x Pusa Naveen	-3.83	-4.12	6.56	-0.37	4.97**	0.53	0.88	-3.36**
3x6	N. Dharidar x Pusa Santushti	0.00	-0.59	4.87	-6.41	5.79**	1.05	3.36**	0.00
3x7	N. Dharidar x Punjab Komal	-5.74	-7.69	-8.14	-13.45*	2.92*	-4.90**	3.24**	-3.50**
3x8	N. Dharidar x PSPL	1.19	0.59	-4.28	-8.56	-3.82**	-4.55**	-5.21**	-5.21**
4x5	Samrat x Pusa Naveen	-10.32	-10.59	-32.44**	-36.46**	-8.53**	-10.61**	-1.71	-3.36**
4x6	Samrat x Pusa Santushti	-12.50	-13.02	-9.84*	-10.91*	0.00	-2.02	-1.72	-2.40
4x7	Samrat x Punjab Komal	-0.30	-2.37	-3.49	-9.92	-10.45**	-11.76**	-6.31**	-10.19**
4x8	Samrat x PSPL	-7.14	-7.69	-13.21**	-20.08**	1.56	0.00	-2.05	-3.69**
5x6	Pusa Naveen x Pusa Santushti	2.08	1.18	-15.71**	-19.83	-3.38**	-4.62**	-2.76*	-3.42**
5x7	Pusa Naveen x Punjab Komal	3.01	0.59	3.45	2.60	-9.77**	-11.76**	-4.32**	-8.28**
5x8	Pusa Naveen x PSPL	-5.04	-5.88	12.55*	10.04	2.90*	2.63	3.73**	2.68*
6x7	Pusa Santushti x Punjab Komal	5.17	3.59	-1.55	-7.08	-9.92**	-13.24**	-8.17**	-10.51**
6x8	Pusa Santushti x PSPL	-5.99	-5.99	-5.96	-12.45*	-8.63**	-11.76**	-7.59**	-10.83**
7x8	Punjab Komal x PSPL	-5.17	-6.59	-12.58*	-13.83*	-1.79	-3.03*	-0.53	-1.39

Table 2. Continued.

	Crosses	Fruit length (cm)		Fruit width (cm)		Fruit weight (g)		Fruits per plant		Fruit yield/ plant (kg)	
		AH	BP	AH	BP	AH	BP	AH	BP	AH	BP
1x2	Arka Bahar x Kashi Ganga	4.97*	-1.86	20.35*	18.8	1.37	-5.13	-9.09*	-12.00**	14.56**	9.94**
1x3	Arka Bahar x N. Dharidar	0.79	-4.95*	-1.60	-1.75	-14.67	-17.95*	17.41**	2.38	-1.27	-12.16**
1x4	Arka Bahar x Samrat	16.50**	15.70**	63.80**	60.88**	12.68	2.56	9.01**	-3.23	7.22*	1.70
1x5	Arka Bahar x Pusa Naveen	12.26**	8.42**	2.35	1.09	-16.67*	-23.08**	17.92**	-0.17	17.33**	6.63*
1x6	Arka Bahar x Pusa Santushti	-9.22**	-11.00**	3.04	0.86	-23.68**	-25.64**	2.86	-7.10	-5.49	-13.89**
1x7	Arka Bahar x Punjab Komal	4.07	-0.74	7.63	5.01	-5.71	-15.38	-11.83**	-20.13**	-15.34**	-22.47**
1x8	Arka Bahar x PSPL	-9.14**	-12.34**	-16.26	-21.04*	-11.76	-23.08**	-3.01	-8.51*	3.29	0.64
2x3	Kashi Ganga x N. Dharidar	7.35**	-4.95*	3.58	2.09	-8.57	-11.11	-1.05	-16.07**	-3.68	-11.01**
2x4	Kashi Ganga x Samrat	-14.06**	-20.17**	-3.63	-4.11	-6.06	-8.82	-12.29**	-24.32**	-14.11**	-15.15**
2x5	Kashi Ganga x Pusa Naveen	4.19	-5.69*	2.06	1.99	-7.46	-8.82	15.04**	-5.16	7.60*	1.66

Table 2. Continued.

Crosses		Fruit length (cm)		Fruit width (cm)		Fruit weight (g)		Fruits per plant		Fruit yield/ plant (kg)	
		AH	BP	AH	BP	AH	BP	AH	BP	AH	BP
2x6	Kashi Ganga x Pusa Santushti	-13.83**	-20.91**	0.70	-0.15	-9.86	-13.51	8.09*	-5.16	6.74*	1.11
2x7	Kashi Ganga x Punjab Komal	3.21	1.07	2.42	-1.33	-21.54*	-25.00*	-7.01	-18.18**	-11.50**	-15.73**
2x8	Kashi Ganga x PSPL	-4.19	-7.27*	-3.27	-7.65	1.59	-5.88	-2.33	-10.64**	-3.47	-4.97
3x4	N. Dharidar x Samrat	9.26**	3.71	-10.66	-12.39	-8.82	-13.89	-12.52**	-14.29**	-3.63	-9.95**
3x5	N. Dharidar x Pusa Naveen	4.64*	2.09	18.13	16.49	-4.35	-8.33	9.10**	5.38	-5.10	-7.32*
3x6	N. Dharidar x Pusa Santushti	-4.29*	-8.00**	-6.98	-9.09	-26.03**	-27.03**	0.43	-3.45	-9.16**	-11.53**
3x7	N. Dharidar x Punjab Komal	-13.29**	-21.78**	7.48	5.03	-4.48	-11.11	-5.59	-9.52**	-8.13**	-11.01**
3x8	N. Dharidar x PSPL	-15.40**	-22.85**	-20.02	-24.69*	-4.62	-13.89	-8.74**	-16.07**	-8.07**	-16.27**
4x5	Samrat x Pusa Naveen	-5.69*	-8.30**	-3.12	-3.66	-4.62	-6.06	9.52**	3.72	2.31	-2.21
4x6	Samrat x Pusa Santushti	-4.40	-5.64**	-3.67	-4.01	-13.04	-18.92*	-1.33	-3.23	4.35	0.00
4x7	Samrat x Punjab Komal	7.68**	2.02	-3.32	-7.31	4.76	3.12	0.25	-1.99	1.46	-2.25
4x8	Samrat x PSPL	4.92*	0.55	4.28	0.04	4.92	0.00	-9.33**	-15.01**	3.43	0.61
5x6	Pusa Naveen x Pusa Santushti	-4.18	-5.63*	14.83	13.78	20.00*	13.51	11.54**	3.72	3.60	3.31
5x7	Pusa Naveen x Punjab Komal	7.64**	-0.69	13.47	9.38	12.50	9.09	15.47**	7.04*	5.85*	4.97
5x8	Pusa Naveen x PSPL	6.63**	-0.51	5.88	1.03	-3.23	-9.09	-25.30**	-33.44**	-10.98**	-17.13**
6x7	Pusa Santushti x Punjab Komal	1.69	-4.83	3.89	-0.73	-2.94	-10.81	-2.91	-3.23	-17.32**	-17.78**
6x8	Pusa Santushti x PSPL	0.64	-4.74	-3.13	-6.76	-9.09	-18.92*	5.41	0.65	12.50**	5.00
7x8	Punjab Komal x PSPL	10.80**	9.48**	-9.62	-16.72	46.67**	41.94**	11.86**	7.14	8.98**	2.25

* - Significant at 5 % probability level.
** - Significant at 1 %probability level.

and Arka Bahar x Kashi Ganga. While, maximum significant and negative heterosis over better parent was exhibited by Arka Bahar x Kashi Ganga followed by Arka Bahar x Pusa Santushti and Kashi Ganga x Narendra Dharidar. On the other hand, no significant positive or negative heterosis over average parent or better parent was observed for days to anthesis of first male flower. Heterosis in 36 hybrids was reported and ranged from -8.23% to 32.47% over standard variety and -25.43% to 36.66% over better parents (Yadav and Kumar 2012).

The earliness characters are considered important for adaptation and acceptance of the hybrids in different ecological conditions (Doloi *et al*. 2018). Days to first harvest for vegetable use exhibited highest significant and negative heterosis over average parent for cross combination Arka Bahar x Samart followed by Samart x PSPL and Pusa Santushti x PSPL (Table 2). While, maximum significant and negative heterosis over better parent was exhibited by Arka Bahar x Narendra Dharidar followed by Kashi Ganga x Narendra Dharidar and Pusa Santushti x PSPL. These hybrid combinations may be exploited in future breeding program for development of early maturing varieties as the negative value of heterosis for days to first harvest is considered as an index of earliness. For days to first harvest the range was -3.57% to 16.13% over better parent as suggested by Singh *et al*. (2012a). Negative heterosis for this trait was also reported by Parmar (2016). Highest significant and positive heterosis over average parent for days to last harvest for vegetable use was recorded for Pusa Santushti x Punjab Komal followed by Arka Bahar x PSPL and Narendra Dharidar x Punjab Komal while significant and positive heterosis over better parent was exhibited by Pusa Santushti x Punjab Komal (Table 2). Node at which first female flower exhibited highest significant and negative heterosis over average parent for cross combination Samrat x Pusa

Naveen followed by Pusa Naveen x Pusa Santushti and Samrat x PSPL. On the other hand maximum significant and negative heterosis over better parent was exhibited by Samrat x Pusa Naveen followed by Arka Bahar x Pusa Santushti and Samrat x PSPL. The work of Yadav and Kumar (2012) were also in close agreement with this finding. In case of fruit length, the highest significant and positive heterosis over average parent was recorded cross combination Arka Bahar x Samrat followed by Arka Bahar x Pusa Naveen and Punjab Komal x PSPL while, maximum heterosis over better parent was exhibited by Arka Bahar x Samrat followed by Punjab Komal x PSPL and Arka Bahar x Pusa Naveen. Significant heterosis for this trait was also reported by Yadav and Kumar (2012). The highest heterosis over average parent for fruit width was shown by crosses Arka bahar x Samrat and Arka Bahar x Kashi Ganga while, maximum heterobeltiosis for these trait was exhibited by only cross combination Arka Bahar x Samrat. High heterosis for this character has also been reported by Singh *et al*. (2011). For fruit weight the highest significant and positive heterosis over average parent was recorded by Punjab Komal x PSPL and Pusa Naveen x Pusa Santushti. On the other hand, heterosis over better parent was significant and positive for cross combination Punjab Komal x PSPL only. Significant heterosis for this trait was also reported by Singh *et al*. (2012b).

Data on fruits/plant (Table 2) showed that, the highest significant and positive heterosis over mid parent was recorded for Arka Bahar x Pusa Naveen followed by Arka Bahar x Narendra Dharidar and Pusa Naveen x Punjab Komal, while two hybrids *viz*. Punjab Komal x PSPL and Pusa Naveen x Punjab Komal exhibited higher values of heterobeltiosis. Significant standard heterosis for this trait was found and top three best hybrids were Arka Bahar x Punjab Komal (67.25), Pusa Naveen x NDBG-613-4 (60.03) and Punjab Long x Narendra Rashmi (55.50) (Shaikh *et al*. 2011). Significant heterosis for this trait was also reported by Singh *et al*. (2012a). Similar findings have also been obtained by Yadav and Kumar (2012) for days to first male flower anthesis, primary branches/plant, fruit length and fruit weight as well as Singh *et al*. (2011) for vine length, days to first female flower anthesis, days of first male flower anthesis, number of fruits/plant and days to first harvesting. For fruit yield/plant, the highest significant and positive heterosis over average parent was recorded by Arka Bahar x Pusa Naveen followed by Arka Bahar x Kashi Ganga and Pusa Santushti x PSPL while, higher heterobeltiosis was recorded for fruit yield/plant by cross combination Arka Bahar x Kashi Ganga and Arka Bahar x Pusa Naveen. It is very important in heterosis breeding to identify and utilize the most heterotic and useful crosses to make the commercial cultivation of hybrid beneficial. Similar results have also been reported by Yadav and Kumar (2012), Sharma *et al*. (2012). Heterosis for fruit yield was also reported earlier by Kumar *et al*. (2012). The results discussed above are quite indicative of the fact that hybrid in bottle gourd has great potentialities for maximizing yield.

CONCLUSION

In the present study the top performing hybrids for yield also showed significant heterosis for average fruit weight along with some other yield component traits. Likewise, improvement in heterosis for other yield components did not necessarily show heterosis for fruit yield. This proved that heterosis depends upon nicking for genes (Ghuge *et al*. 2016). Significant mid parent (average heterosis) and better parent heterosis (heterobeltiosis) were found for all the traits except for primary branches per plant. For fruit yield per plant, cross combinations *viz*. Arka Bahar x Kashi Ganga and Arka bahar x Pusa Naveen were found as best heterotic F^1 s over better parent. These crosses also showed high significant and positive heterosis for other yield contributing characters. In bottle gourd, these hybrids can be utilized for selecting superior desirable segregants in later generations and developing commercial hybrids after their stability test.

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