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Hybrid vigor studies over standard check for yield and quality components in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

VR Dhakne, VS Jagtap, SS Chavan, UD Pansare and AS Bade

Abstract
Observations were recorded on parent and F_1 for 12 traits *viz*. length of vine (cm), number of branches per vine, days required for first female flower, days required for 50% female flowering, yield of fruits per ha (t/ha), average weight of fruit (g), average length of fruit (cm), average diameter of fruit (cm), average rind thickness (mm), average pulp thickness (cm), total sugar (%), vitamin-C (mg/100g). Heterosis for yield of fruits per ha plant ranged from -58.68% to 47.50% over standard heterosis of parent Ahemdnagar Local x Amravati Local and Karjat Local x Amravati Local. Yield of fruits per ha, days for 50% female flowering, average weight of fruit and average length of fruit (Karjat Local x Amravati Local), For number of branches per vine, average pulp thickness and total sugar (Chandrapur Local x Karjat Local), average diameter of fruit and average rind thickness (Chandrapur Local x Kolhapur Local), length of vine (Ahemdnagar Local x Karjat Local), days for first female flower (Karjat Local x Kolhapur Local) and vitamin-C (Aurangabad Local x Karjat Local) estimates significant heterosis over standard heterosis of these best performing hybrids.

Keywords: Half diallel, heterosis, standard heterosis, yield, bottle gourd

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol) Standl.] the name "Lagenaria" and "siceraria" are derived from Latin words '*Lagena*' for bottle and "*sicera*" for drinking utensil. Bottle gourd belongs to family cucurbitaceae with a diploid chromosome number 2n=2x=22. It is grown in both rainy and summer season and its fruits available in the market throught the year.
Bottle gourd is a good source of nutrients it is very popular among a large section of people. Fruits are used as sweets, pickles (especially on hills), kofta, petha, halwa, kopoorkand, paratha, rayata, kheer, pedha and burfi. The per 100 g. of edible portion of fruits contains vitamin C (11mg), thiamine (0.044m.g), riboflavin (0.023m.g), niacin (0.33m.g), mineral matters (0.5%), carbohydrates (2.9%), fats (0.1%) protein (0.2%) and moisture (96.3%) and its different parts possess large number of medicinal properties. As a vegetable it is easily digestible, even by patients. A decotion made from the leaf is a very good medicine for curing jaundice. The fruit has a cooling effect it is a cardiatonic and diuretic.
In Maharashtra the production of bottle gourd is less. Having the wide variability, monoecious and andromonoecious nature, highly cross pollinated and large number of seeds per fruit, variation in size, shape, colour, length and weight observed in bottle gourd. It can be serve as a good source for manifestation of heterosis and its commercial exploitation, due to cross pollination this do not suffer much for inbreeding depression. Thus heterosis breeding can prove as a useful tool in bottle gourd improvement. In spite of differed characters in bottle gourd, the acreage under this cross noticed less in Maharashtra state compared to other cucurbit crops. Due to low yield, susceptibility to disease and pest. The improvement in bottle gourd not much reported in Maharashtra.

Materials and methods
The experiment was conducted at Instructional Cum-Research Farm, Department of Horticulture, College of Agriculture, Latur during summer season 2021. The study was undertaken by using diallel analysis (without reciprocal) involving 21 F_1 hybrids and seven parental lines namely (p_1) Aurangabad Local, (p_2) Ahemdnagar Local, (P_3) Chandrapur Local, (P_4) Karjat Local, (P_5) Buldhana Local, (P_6) Amravati Local, (P_7) Kolhapur Local.
Seven parental lines were sown in randomized block design with three replications. All treatments were grown in 2 meter row to row and 1 meter plant to plant spacing respectively.

Five plants were selected and tagged for recording the observations on different characters *viz*, length of vine, number of branches per vine, days required for first female flower, days required for 50% female flowering, yield of fruits per ha (t/ha), average weight of fruit (g), average length of vine (cm), average diameter of fruit (cm), average rind thickness (mm), average pulp thickness (cm), total sugar (%), vitamin- C (mg/100g).

Heterosis was calculated by using formulae.

1. $\overline{BP} = \frac{\overline{F1} - \overline{SH}}{\overline{SH}} \times 100$ (over Standard Heterosis)

2. $MP = \frac{\overline{F1} - \overline{MP}}{\overline{MP}} \times 100$ (over mid parent)

3. $\overline{BP} = \frac{\overline{F1} - \overline{BP}}{\overline{BP}} \times 100$ (over better parent)

Results and discussion

The analysis of variance (Table 1) indicated that the mean square due to genotypes were highly significant for all characters under study.

In the analysis of mean square, the differences due to the treatments were significant for all the characters studied. The treatment means were further subdivided into the parents, crosses and parent versus crosses. The parents showed significant differences for all the characters. The crosses were found significantly for all the characters.

The parent versus crosses showed significant difference for most of the characters except average weight of fruit, average length of fruit, total sugar.

The analysis of variance showed highly significant differences among the genotypes studied. The mean value of seven parents and 21 F_1 hybrids and their heterosis percentage over standard heterosis are presented in table 2.

The range of F_1 hybrid was wider than that of parents for all the characters under study, where lower value shows early maturity which is a desirable trait. Similarly, the average heterosis was negative in days required for first female flower and days required for 50% female flowering. Which is also a desirable economic trait. The range of heterotic crosses in all the characters over their respective standard heterosis varied from -46.75 to 30.89 in length of vine, -48.05 to 14.72 in number of branches per vine, -10.45 to 8.39 in days for first female flower, -10.32 to 7.14 in days for 50% female flower, -58.68 to 47.50 in yield of fruits per ha (t/ha), -36.49 to 17.46 average weight of fruit (g), -20.05 to 31.67 in average length of fruit (cm), -20.83 to 17.50 in average diameter of fruit (cm), -31.89 to 21.36 in average rind thickness (mm), -26.36 to 31.52 in average pulp thickness (cm), -4.60 to 10.20 in total sugar (%), -23.83 to 25.95 in vitamin –C (mg/100g).

The result of present investigation revealed that the crosses Ahemdnagar Local x Karjat Local was exhibited positive maximum significant heterosis over standard heterosis (30.89%) for length of vine. While the cross Karjat Local x Amravati Local also recorded highest significant positive heterosis over Standard heterosis (27.72%). Similar results were reported by Ghuge *et al.* (2016) [2], Malviya *et al.* (2017) [5], Jayanth *et al*. (2019) [4] and Mishra *et al.* (2019) [6].

The result of present investigation revealed that the crosses Chandrapur Local x Karjat Local was exhibited positive maximum significant heterosis over Standard heterosis (14.72%) for number of branches per vine. While the cross Ahemdnagar Local x Karjat Local also recorded highest significant positive heterosis over standard heterosis (9.52%). Similar results were reported by Malviya (2017) [5], Jayanth *et al*. (2019) [4] and Mishra *et al.* (2019) [6].

With regards to days for first female flower, the crosses Karjat Local x Kolhapur Local (-10.45%) exhibited significant negative heterosis followed by Karjat Local x Amravati Local (-8.39%) over standard heterosis. Similar, results were reported by Singh *et al.* (2012) and Mishra *et al*. (2019) [6].

With respect to days required for 50 % female flower, the crosses Karjat Local x Amravati Local (-10.32%) exhibited significant negative heterosis followed by Karjat Local x Kolhapur Local (-7.94%) over standard heterosis. Similarly, negative heterosis reported by Jayanth *et al*. (2019) [4].

For yield of fruit per hectare the cross Karjat Local x Amravati Local (47.50 %) was recorded significantly maximum positive heterosis followed by Aurangabad Local x Karjat Local (36.96%) and Ahemdnagar Local x Kolhapur Local (35.04%) over standard heterosis. This result was similar with Kumar *et al*. (2018) and Varalakshmi *et al.* (2019) [9].

With respect to average weight of fruit, the crosses Karjat Local x Amravati Local (17.16%) exhibited significant positive heterosis followed by Karjat Local x Buldhana Local (14.39%) over standard heterosis. Similarly, positive heterosis reported by Kumar *et al*. (2018) and Varalakshmi *et al*. (2019) [9].

The result of present investigation revealed that the crosses Karjat Local x Amravati Local was exhibited positive maximum significant heterosis over standard heterosis (31.67%) for average length of fruit. While the cross Chandrapur Local x Karjat Local also recorded highest significant positive heterosis over standard heterosis (30.13%). Similar results were reported by Ghuge *et al.* (2016) [2] and Mishra *et al.* (2019) [6].

For average diameter of fruit the cross Chandrapur Local x Kolhapur Local (17.50%) was recorded significantly maximum positive heterosis followed by Karjat Local x Amravati Local (15.83%) and Karjat Local x Kolhapur Local (15.83%) over standard heterosis. This result was similar with Quamruzzaman *et al.* (2009) [7] and Ghuge *et al.* (2016) [2].

With regards to average rind thickness, the crosses Ahemdnagar Local x Buldhana Local (21.36%) exhibited significant negative heterosis followed by Karjat Local x Buldhana Local (20.39%) over standard heterosis. Similar, results were reported by Jagtap and Musamade (2014) [3].

Average pulp thickness, the crosses Chandrapur Local x Karjat Local (63.32%) while the cross Chandrapur Local x Kolhapur Local (45.23%) exhibited significant negative heterosis over standard heterosis. Similar results were reported by Ghuge *et al.* (2016) [2], Jayanth *et al*. (2019) [4] and Mishra *et al.* (2019) [6].

The crosses Chandrapur Local x Karjat Local was exhibited positive maximum significant heterosis over standard heterosis (10.20%) for Total sugar. While the cross Aurangabad Local x Chandrapur Local also recorded highest significant positive heterosis over standard heterosis (8.80 %). Similar results were reported by Gautam *et al.* (2017) [1].

The crosses Aurangabad Local x Karjat Local was exhibited positive maximum significant heterosis over standard heterosis (25.95%) for Vitamin-C. While the cross Karjat Local x Amravati Local also recorded highest significant positive heterosis over standard heterosis (25.26 %). Similar

results were reported by Gautam *et al*. (2017) [1].

Among the parents, P4 (Karjat Local) highest for Length of vine, Number of branches per vine, Days required for 50% female flower, Yield of fruits per ha, Average weight of fruit (g), Average fruit diameter (cm), Average rind thickness (cm) and Average pulp thickness (cm), The Parent P3 (Chandrapur Local) performing best for Days required for first female flower, Total sugar (%), The parent P5 Buldhana Local performing best for Average length of fruit (cm) and Parent P1 (Aurangabad Local) Performing best for the Vitamin-C (mg/100g).

Table 1: Analysis of variance for different characters in 7 x 7 half diallel of Bottle gourd

Source	d.f.	Length of Vine (cm)	No. of Branches per Vine	Days required for first Female Flower	Days required for 50% female flowers	Yield of Fruits per ha (ton)	Average Weight of Fruit (g)
Treatment	27	48599.96**	41.83**	18.79**	16.59 **	148.05 **	5.51 **
Parent	6	39026.63**	40.61**	18.66 **	16.31 **	71.95 **	6.72 **
Crosses	20	53864.86**	42.56**	19.09 **	16.47 **	164.05 **	5.31 **
P x C	1	741.97**	34.74**	13.71 **	20.72 **	284.49**	2.10
Error	27	88.76	0.43	1.46	1.09	14.21	1.10

Table 1: Cont…

Source	d.f.	Average length of Fruit (cm)	Average diameter of fruit (cm)	Average rind thickness (mm)	Average pulp thickness (cm)	Total sugar (%)	Vitamin-C (mg/100g)
Treatment	27	85.82 **	0.93 **	1.73 **	0.10 **	0.02 **	3.85 **
Parent	6	85.60 **	0.33 **	0.42 *	0.09 *	0.04 **	3.68 **
Crosses	20	89.93 **	0.99 **	2.12 **	0.10 **	0.01 **	3.84 **
P x C	1	5.02	3.14 **	1.95 **	0.16 *	0.001	5.08 **
Error	27	2.11	0.05	0.15	0.02	0.000	0.15

Table 2: Mean value of parents, F1 hybrids and their heterosis percentage.

Parents and crosses	Length of vine (cm)		Number of branches per vine		Days required for first female flower		Days required for 50% female flower	
	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.
P1	537.28		16.40		62.20		66.00	
P2	420.42		12.60		63.70		68.50	
P3	692.89		17.30		55.70		62.00	
P4	853.48		25.10		57.00		60.00	
P5	609.31		21.70		59.30		63.00	
P6	609.96		13.40		63.00		66.00	
P7	510.59		15.40		59.30		64.00	
P1 x P2	495.54	-30.79 **	14.90	-35.50 **	59.30	1.54	63.00	0.00
P1 x P3	498.56	-30.37 **	16.50	-28.57 **	60.60	3.77	64.50	2.38
P1 x P4	737.44	2.99 *	22.70	-1.73	61.20	4.79 *	63.00	0.00
P1 x P5	640.27	-10.58 **	23.10	0.00	56.40	-3.42	61.50	-2.38
P1 x P6	396.20	-44.67 **	12.70	-45.02 **	58.00	-0.68	62.00	-1.59
P1 x P7	548.94	-23.33 **	17.70	-23.38 **	60.40	3.42	64.50	2.38
P2 x P3	721.45	0.76	19.80	-14.29 **	60.30	3.25	64.00	1.59
P2 x P4	937.21	30.89 **	25.30	9.52 **	63.30	8.39 **	66.00	4.76 **
P2 x P5	521.45	-27.17 **	19.70	-14.72 **	60.70	3.94	63.00	0.00
P2 x P6	398.77	-44.31 **	12.00	-48.05 **	61.50	5.31 *	65.50	3.97 *
P2 x P7	486.45	-32.06 **	13.40	-41.99 **	57.10	-2.23	61.00	-3.17
P3 x P4	876.94	22.48 **	26.50	14.72 **	55.30	-5.31 *	60.00	-4.76 **
P3 x P5	647.28	-9.60 **	21.10	-8.66 **	57.40	-1.71	61.00	-3.17
P3 x P6	471.69	-34.12 **	15.50	-32.90 **	59.40	1.71	63.50	0.79
P3 x P7	543.55	-24.09 **	16.50	-28.57 **	54.40	-6.85 **	58.50	-7.14 **
P4 x P5	712.58	-0.48	23.50	1.73	61.20	4.79 *	65.50	3.97 *
P4 x P6	914.51	27.72 **	25.10	8.66 **	53.50	-8.39 **	56.50	-10.32 **
P4 x P7	607.03	-15.22 **	19.00	-17.75 **	52.30	-10.45 **	58.00	-7.94 **
P5 x P6	685.38	-4.28 **	22.50	-2.60	61.00	4.45 *	65.50	3.97 *
P5 x P7	655.81	-8.41 **	23.70	2.60	60.00	2.74	65.00	3.17
P6 x P7	381.29	-46.75 **	12.70	-45.02 **	63.30	8.39 **	67.50	7.14 **
SE±	6.64	9.42	0.50	0.65	0.83	1.20	0.74	1.04
C.D at 5%	19.24	19.33	1.46	1.34	2.43	2.47	2.16	2.14

Table 2: Cont…

Parents and crosses	Yield of fruits per ha.		Average weight of fruit.		Average length of fruit		Average diameter of fruit	
	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.
P1	21.52		607.55		32.92		5.15	
P2	16.75		609.80		34.66		4.90	
P3	25.45		628.45		33.30		5.50	
P4	32.00		633.80		45.16		6.15	
P5	23.00		631.45		47.58		5.65	
P6	13.55		617.75		38.63		5.35	
P7	19.94		614.40		30.53		5.20	
P1 x P2	21.75	-28.10 *	680.15	-9.01	37.27	-2.05	5.85	-2.50
P1 x P3	25.45	-15.87	705.60	-5.61	31.86	-16.27 **	5.75	-4.17
P1 x P4	39.30	29.92 *	810.75	8.46	39.61	4.10	6.25	4.17
P1 x P5	31.50	4.13	715.95	-4.22	49.06	28.94 **	6.05	0.83
P1 x P6	13.05	-56.86 **	474.70	-36.49 **	40.65	6.83	4.85	-19.17 **
P1 x P7	19.20	-36.53 **	620.85	-16.94 *	33.11	-12.98 **	5.40	-10.00 *
P2 x P3	27.15	-10.25	671.25	-10.20	32.81	-13.77 **	5.90	-1.67
P2 x P4	39.20	29.59 *	843.40	12.83	48.49	27.44 **	6.75	12.50 **
P2 x P5	19.82	-34.48 *	611.05	-18.25 *	34.62	-9.01 *	4.75	-20.83 **
P2 x P6	12.50	-58.68 **	555.75	-25.65 **	37.06	-2.60	5.05	-15.83 **
P2 x P7	16.10	-46.78 **	619.60	-17.11 *	35.08	-7.81	5.40	-10.00 *
P3 x P4	40.85	35.04 **	801.85	7.27	49.51	30.13 **	6.35	5.83
P3 x P5	31.35	3.64	755.65	1.09	30.42	-20.05 **	5.95	-0.83
P3 x P6	26.70	-11.74	644.45	-13.79	31.87	-16.24 **	6.50	8.33 *
P3 x P7	32.00	2.98	820.65	9.79	32.85	-13.65 **	7.05	17.50 **
P4 x P5	31.20	3.14	855.05	14.39*	46.71	22.76 **	6.85	14.17 **
P4 x P6	44.62	47.50 **	875.75	17.16 *	50.10	31.67 **	6.95	15.83 **
P4 x P7	29.20	-3.47	835.65	11.79	32.32	-15.05 **	6.95	15.83 **
P5 x P6	23.92	-20.93	647.95	-13.32	32.47	-14.66 **	5.75	-4.17
P5 x P7	23.32	-22.89	640.35	-14.33	40.60	6.70	5.60	-6.67
P6 x P7	18.62	-38.45 **	690.75	-7.59	36.37	-4.40	5.25	-12.50 **
SE±	2.65	3.77	42.91	61.08	1.01	1.45	0.16	0.23
C.D at 5%	7.68	7.73	124.31	125.33	2.92	2.98	0.48	0.48

Table 2: Cont…

Parents and crosses	Average rind thickness.		Average pulp thickness.		Total sugar		Vitamin- C	
	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.	Mean	Heterosis % over S.H.
P1	4.15		0.94		2.61		10.47	
P2	3.95		0.84		2.58		8.62	
P3	4.20		1.26		2.76		7.74	
P4	5.15		1.31		2.60		9.82	
P5	4.75		1.04		2.46		9.40	
P6	4.25		0.92		2.26		8.71	
P7	3.85		0.73		2.60		6.40	
P1 x P2	4.15	-19.42 *	1.09	9.55	2.56	2.40 *	9.87	22.84 **
P1 x P3	4.45	-13.59	1.10	10.55	2.72	8.80 **	6.13	-23.71 **
P1 x P4	4.65	-9.71	1.13	13.57	2.49	-0.40	10.12	25.95 **
P1 x P5	4.55	-11.65	1.02	3.02	2.56	2.60 **	8.68	8.03
P1 x P6	3.10	-39.81 **	0.95	-4.52	2.49	-0.20	7.12	-11.39 *
P1 x P7	3.60	-30.10 **	1.00	0.50	2.64	5.80 **	8.10	0.81
P2 x P3	4.35	-15.53	1.22	23.12	2.65	6.20 **	6.80	-15.31 **
P2 x P4	5.70	10.68	1.44	44.72 *	2.54	1.60	8.19	1.93
P2 x P5	4.65	-9.71	0.96	-3.52	2.38	-4.60 **	7.21	-10.21 *
P2 x P6	3.15	-38.83 **	1.21	21.61	2.52	1.00	9.47	17.86 **
P2 x P7	3.25	-36.89 **	1.03	4.02	2.44	-2.40 *	6.30	-21.59 **
P3 x P4	5.30	2.91	1.62	63.32 **	2.75	10.20 **	9.90	23.27 **
P3 x P5	5.90	14.56	1.15	15.58	2.59	3.60 **	8.42	4.79
P3 x P6	4.95	-3.88	1.28	28.64	2.51	0.40	7.80	-2.92
P3 x P7	6.25	21.36 *	1.44	45.23 *	2.46	-1.60	6.12	-23.83 **
P4 x P5	6.20	20.39 *	1.33	34.17 *	2.67	7.00 **	9.12	13.50 **
P4 x P6	6.05	17.48 *	1.39	40.20 *	2.64	5.80 **	10.06	25.26 **
P4 x P7	5.55	7.77	1.03	4.02	2.65	6.00 **	6.91	-14.00 **
P5 x P6	5.25	1.94	0.82	-17.59	2.52	0.80	8.90	10.77 *
P5 x P7	5.45	5.83	0.86	-13.57	2.56	2.40 *	6.15	-23.46 **
P6 x P7	3.45	-33.01 **	0.73	-26.63	2.47	-1.20	7.50	-6.66
SE±	0.27	0.39	0.11	0.16	0.01	0.02	0.27	0.3
C.D at 5%	0.80	0.81	0.33	0.33	0.04	0.04	0.78	0.8

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