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Heterosis studies for yield and yield component traits in okra (*Abelmoschus esculentus* (L.) Moench)

Mundhe SS, Pole SP, Khandebharad PR and Patil AR

Abstract
The present investigation was conducted at experimental research farm of Agriculture Botany College of Agriculture Latur, during kharif 2021 (Crossing) and summer 2022 (evaluation), with a view to study the extent of heterosis of nine parental lines and their resultant crosses through half diallel mating design in a Randomized block design with two replications. Heterosis is the superiority of F_1 over its parents. In present investigation, the cross combinations Parbhani Kranti x IC-3769-A, Arka Abhay x Varsha Uphar, and Parbhani Kranti x Arka abhay displayed the significant positive heterosis for most of the traits. The crosses Arka Abhay x Arka Anamika, EC-305672 x Phule Vimukta, Arka Abhay x Varsha Uphar exhibited significant negative heterosis for characters such as internodal length, YVMV incidence and fruit borer severity.

Keywords: Half-diallel, F_1, heterosis, better parent, standard check, okra

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) has a prominent position in vegetables due to its wider adaptability, year round export potential and high nutritive value. It is grown extensively throughout the country during summer and rainy (*kharif*) seasons. Okra is a popular vegetable crop propagated by seeds and is grown extensively in tropical and subtropical regions of the world like India, West Africa, Brazil, South-East Asia and Southern United States and other neighboring countries. Okra, also known as *Bhindi* in India, Lady's finger in England and Gumbo in USA. The immature pods are also used for making pickle (Hadiaya *et al*., 2018) [6]. It gives mucilaginous consistency after cooking. Root and stem are used for purifying the sugarcane juice while preparing Jaggery (Gopalakrishnan, 2007) [4]. The word *Abelmoschus* came from the Arabian word "abul-l-mosk" which means "source of musk" and refers to the musky fragrance of the seeds (Charrier, 1984) [3].
Okra belongs to family malvaceae, genus-*Abelmoschus*. Though, the Okra is native of Tropical Africa yet it is a praised vegetable of India. The number of chromosomes in cultivated Okra varies significantly. The genus *Abelmoschus* is a poly-species complex consisting of species of three ploidy levels *viz.*, the diploids (2x), including *Abelmoschus coccineus* (2n=38), *A. angulosus* (2n=38), *A. tuberculatus* (2n=58), *A. manihot* (2n=60-68), *A. moschatus* (2n=72), and *A. flculneus* (2n=72); the tetraploids (4x), including *A. eschulentus* (2n=121-140), *A. tetraphyllus* (130-138) and *A. pungens* (2n=138) and the hexaploids (6x), including *Abelmoschus manihot*, Guinean type (2n=185-198). Okra is an allopolyploid consisting of two genomes each of 29 and 36 chromosomes. Indian varieties belong to the group of 2n=130 chromosomes (Joshi and Hardas, 1956) [9].
Seeds are used as antispasmodic, cordial and stimulant (Lim, 2012) [11]. Leaves and root extracts are served as demulcent and emollient poultice (Babu and Srinivasan, 1995) [1]. Researchers (Griffing, 1956; Hayman, 1954; Mather and Jinks, 1971) [5, 7, 13] devised methods for analyzing genotypes in all conceivable crosses. Due to multiple parental involvements, the diallel mating system is poised to supplement traditional breeding procedures for breaking undesirable linkages as well as providing a broad genetic foundation (Sharma, 1996) [18]. The diallel cross approach (Griffing, 1956) [5] is a useful tool for identifying hybrid combinations with the greatest potential for development and identifying superior lines among progeny in early segregating generations. Diallel analysis is one of the most powerful tools for assessing plant genotype's genetic architecture and measuring the extent of heterosis.

Materials and Methods
The experiment was set up in a Randomized Block Design with two replications at the

Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur during the summer of 2022. There are nine parents, *viz.*, Parbhani Kranti, Konkan Bhendi, Arka Abhay, Varsha Uphar, Arka Anamika, IC-3769-A, EC-305672, IC-3759, Phule Vimukta, thirty-six hybrids, and one control in the experiment. Each entry was divided into two rows, each with fifteen plants. The crop was raised according to the recommended package of practices, with a spacing of 45 x 30 cm. Five plants were chosen at random from each plot to record the observations *viz.*, Plant height (cm), Internodal length (cm), Number of nodes per plant, Number of branches per plant, Fruit length (cm), Fruit diameter (mm), Number of fruits per plant, Fruit weight (gm), Fruit yield per plant (gm), YVMV incidence (%) and Fruit borer severity (%). Heterosis was calculated using following formulae

$\overline{BP} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$ over better parent and $\overline{SC} = \frac{\overline{F_1} - \overline{SC}}{\overline{SC}} \times 100$ over standard check.

Results and Discussion

The analysis of variance of mean values was carried out to determine the significance of differences between the treatments. The results from the analysis of variance showed that there was a great level of variability in the experimental material employed in the current investigation, with the treatment variances being very significant for all the characters. The analysis of variance for characters under study has been given in Table 1.

Heterosis value is reported as a percentage increase or reduction over better parent and standard check. The heterosis in desirable direction is only considered for the characters. The estimated values for all the characters are depicted in Table 2. The range of F_1 hybrids was wider than that of parents for all the characters under study, where higher values shows increased yield which is a desirable trait. The range of crosses in all the characters over their respective better parents varied from -8.74 percent to 26.21 percent for plant height (cm), -24.29 percent to 2.82 percent for internodal length (cm), -11.46 percent to 34.52 percent for number of nodes per plant, -35.00 percent to 42.11 percent for number of branches per plant, -24.05 percent to 11.24 percent for fruit length (cm), -27.54 percent to 29.82 percent for fruit diameter (mm), -8.71 percent to 38.85 percent for number of fruits per plant, -31.04 percent to 11.12 percent for fruit weight (gm), -37.19 percent to 52.70 percent for fruit yield per plant (gm), -55.64 percent to 71.16 percent for YVMV incidence (%) and -70.96 percent to 47.31 percent for fruit borer severity (%).

Out of 36 crosses studied, the 15 cross combinations showed a significant positive heterosis over a better parent, while 23 cross combinations showed a significant positive heterosis over a standard check. The cross Arka Abhay x Varsha Uphar (26.21) and Parbhani Kranti x IC-3769-A (19.82) exhibited significantly the highest percentage of positive heterosis over better parent and standard check respectively. The result was in correspondence with Koli *et al.* (2020) [10] and Sidapara *et al.* (2021) [19].

For internodal length strong negative heterosis is preferred for this characteristic since the length of the internode is inversely proportional to the number of nodes per plant. Among the 36 crosses, 13 cross combinations displayed significant negative heterosis over better parent and 11 crosses over standard check for internodal length. The crosses IC-3769-A x IC-3759 (-23.49) and Arka Abhay x Arka Anamika (-23.77) demonstrated the most significant negative heterosis over better parent and standard check respectively. Similar results were obtained by Chavan *et al.* (2021) [2] and Sidapara *et al.* (2021) [19].

Significant and positive heterosis is preferred for number of nodes per plant since it strongly correlates with the quantity of fruits per plant. The crosses Arka Abhay x Varsha Uphar (34.52) and Parbhani Kranti x IC-3769-A (37.72) expressed significant positive heterosis over better parent and standard check respectively, for this trait. Similar results were obtained by Makdoomi *et al.* (2018) [12] and Sidapara *et al.* (2021) [19].

Among all of the hybrids under study the cross combinations Parbhani Kranti x IC-3769-A (42.11) and Parbhani Kranti x Arka Anamika (22.73) depicted significant positive heterosis over the better parent and standard check respectively, for the trait number of branches per plant. The results are in similarity with Pithiya *et al.* (2019) [17] and Sidapara *et al.* (2021) [19].

For the trait fruit length cross combinations Parbhani Kranti x IC-3769-A (11.24) and Varsha Uphar x IC-3769-A (11.56) recorded positively significant heterosis over better parent and standard check, respectively. Similar results were obtained by Pithiya *et al.* (2019) [17] and Vekariya *et al.* (2020) [21].

A cultivar with a larger fruit diameter among all the hybrids examined is extremely valuable in breeding programmes. The cross combination Konkan Bhendi x EC-305672 (29.82), out of all the crosses, demonstrated positively significant heterosis over the better parent for fruit diameter. By contrast, none of the cross combinations have shown positively significant heterosis over the standard check. The results obtained for fruit diameter were in agreement with results obtained by Patel *et al.* (2015) [16] and Patel and Patel (2016) [15].

The cross combinations Parbhani Kranti x IC-3769-A (38.85) and Parbhani Kranti x IC-3769-A (34.03) have been found with the highest significant positive heterosis over better parent and standard check. Number of fruits per plant is one of the most crucial traits that is directly associated to an increase in yield per unit area, hence a considerably favourable heterosis effect is greatly desired for this trait. Similar results were obtained by More *et al.* (2015) [14] and Patel and Patel (2016) [15].

Out of 36 crosses none of the cross combinations displayed significant positive heterosis over better parent whereas cross Arka Anamika x IC-3769-A (16.24) resulted in significantly positive heterosis for fruit weight over standard check. Fruit weight is a significant yield-contributing factor, hence heterosis in a positive direction is preferred. The weight of the fruit values were in agreement with those from Koli *et al.* (2020) [10] and Sidapara *et al.* (2021) [19].

The cross combination Parbhani Kranti x IC-3769-A (52.70) over better parent while, the cross Parbhani Kranti x IC-3769-A (43.37) showed highest significant positive heterosis over standard check for fruit yield per plant. The results are in correspondence to Singh *et al.* (2015) [20] and Koli *et al.* (2020) [10].

The resistance to the YVMV incidence is considered as highly desirable. The hybrids showing significant negative heterosis for this trait are considered as superior. The cross combination Varsha Uphar x Phule Vimukta (-55.64) and Konkan Bhendi x Phule Vimukta (-62.11) exhibited highest significant negative heterosis over better parent and standard check respectively.

The defiance to the attack of fruit borer is considered as desirable for any cultivar under study. The crosses exhibiting negative significant heterosis for fruit borer severity are considered as superior. The cross IC-3769-A x IC-3759 (-70.96) whereas, cross Arka Anamika x Phule Vimukta (-52.87) expressed highest significant negative heterosis over better parent and standard check respectively.

From the study of heterosis it can be concluded that in the present study, for traits like plant height, number of nodes per plant, number of branches per plant, fruit length, fruit diameter, fruit weight and fruit yield per plant, higher magnitudes of heterobeltiosis and standard heterosis were observed in positive directions, whereas internodal length, YVMV incidence, and fruit borer severity were observed in negative directions. The findings of this study indicate that crosses with highly significant positive heterosis can be verified and released for heterosis exploitation.

The crosses Parbhani Kranti x IC-3769-A, Arka Abhay x Varsha Uphar, Arka Anamika x EC-305672, Arka Anamika x IC-3769-A, Parbhani Kranti x Arka Abhay, and Varsha Uphar x Phule Vimukta reported a significant positive heterosis over better parent and standard check for fruit yield per plant and yield contributing characters. The standard heterosis for fruit yield per plant was reported by several workers like Youssef (2011) [22], Jagan *et al.* (2013) [8]. Due care must therefore be given to vigorous testing of the above hybrids to confirm the stability performance of these crosses for commercial use in a wide range of environmental conditions.

Table 1: Analysis of variance for different characters in okra

Sr. No.	Characters	Source of variation			S.E. (±)
		Replication MSS	Treatment MSS	Error MSS	
		d.f. (1)	d.f. (45)	d.f. (45)	
1	Plant height (cm)	4.716	50.599**	17.553	2.963
2	Internodal length (cm)	0.061	0.173**	0.084	0.205
3	Number of nodes per plant	1.726	3.771**	1.787	0.945
4	Number of branches per plant	0.000	0.165**	0.043	0.147
5	Fruit length (cm)	0.026	0.754**	0.365	0.427
6	Fruit diameter (mm)	0.767	1.721**	0.849	0.651
7	Number of fruits per plant	0.272	3.364**	1.188	0.771
8	Fruit weight (gm)	0.969	1.141**	0.496	0.498
9	Fruit yield per plant (gm)	21.505	813.008**	292.706	12.098
10	YVMV incidence (%)	8.059	25.669**	1.415	0.841
11	Fruit borer severity (%)	0.465	70.291**	2.646	1.150

*Significance at 5 percent level and **Significance at 1 percent level.

Table 2: Heterosis (%) over better parent (BP) and standard check (SC) in 9 x 9 half diallel set of okra

Sr. No.	Crosses	Plant Height (cm)		Internodal Length (cm)		Number of Nodes Per Plant		Number of Branches Per Plant	
		1		2		3		4	
		BP	SC	BP	SC	BP	SC	BP	SC
1	Parbhani Kranti x Konkan Bhendi	18.27**	10.94	-2.18	2.00	-11.46	-10.53	-30.43**	-27.27**
2	Parbhani Kranti x Arka Abhay	21.27**	9.2	-10.79	-6.99	18.86*	17.19	0.00	-13.64
3	Parbhani Kranti x Varsha Uphar	12.45	1.26	-14.01	-10.34	-4.85	-7.02	-21.05	-31.82**
4	Parbhani Kranti x Arka Anamika	-0.09	4.48	-7.40	-3.45	-0.86	1.23	28.57**	22.73*
5	Parbhani Kranti x IC-3769-A	12.68*	19.82**	-13.32	-9.62	27.02**	37.72**	42.11**	22.73*
6	Parbhani Kranti x EC-305672	15.12*	15.86**	-6.53	-2.54	3.1	4.91	-10.53	-22.73*
7	Parbhani Kranti x IC-3759	-8.74	-5.96	-4.09	0.00	18.75*	30**	10.00	0.00
8	Parbhani Kranti x Phule Vimukta	3.26	11.11	-9.66	-5.81	-6.23	0.35	-33.33**	-36.36**
9	Konkan Bhendi x Arka Abhay	13.73*	6.69	2.11	5.26	8.33	9.47	-13.04	-9.09
10	Konkan Bhendi x Varsha Uphar	19.17**	11.79*	-4.14	-1.18	2.08	3.16	-13.04	-9.09
11	Konkan Bhendi x Arka Anamika	8.94	13.92*	-7.48	-4.63	-3.44	-1.4	-30.43**	-27.27**
12	Konkan Bhendi x IC-3769-A	7.29	14.09*	-2.73	0.27	-0.81	7.54	-8.70	-4.55
13	Konkan Bhendi x EC-305672	15.97**	16.71**	-4.49	-1.54	12.07	14.04	-26.09**	-22.73*
14	Konkan Bhendi x IC-3759	6.22	9.45	-7.83	-4.99	8.17	18.42	-13.04	-9.09

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis.

Sr. No.	Crosses	Plant Height (cm)		Internodal Length (cm)		Number of Nodes Per Plant		Number of Branches Per Plant	
		1		2		3		4	
		BP	SH	BP	SH	BP	SH	BP	SH
15	Konkan Bhendi x Phule Vimukta	4.96	12.93*	2.82	5.99	0.66	7.72	-30.43**	-27.27**
16	Arka Abhay x Varsha Uphar	26.21**	10.62	-14.29*	-20.51**	34.52**	32.63**	0.00	-22.73*
17	Arka Abhay x Arka Anamika	11.54*	16.65**	-22.65**	-23.77**	8.08	10.35	0.00	-4.55
18	Arka Abhay x IC-3769-A	11.86*	18.95**	-24.29**	-22.78**	-2.43	5.79	0.00	-22.73*
19	Arka Abhay x EC-305672	9.99	10.70	-1.56	-2.63	6.21	8.07	0.00	-18.18
20	Arka Abhay x IC-3759	8.56	11.86*	1.43	2.9	2.56	12.28	-5.00	-13.64
21	Arka Abhay x Phule Vimukta	3.73	11.61*	-2.17	-1.63	5.08	12.46	-14.29	-18.18
22	Varsha Uphar x Arka Anamika	11.31*	16.40**	-2.85	-4.26	7.22	9.47	-4.76	-9.09

23	Varsha Uphar x IC-3769-A	9.29	16.22**	-4.27	-2.36	5.02	13.86	0.00	-22.73*
24	Varsha Uphar x EC-305672	7.13	7.82	-5.87	-6.9	7.59	9.47	0.00	-18.18
25	Varsha Uphar x IC-3759	1.49	4.58	-5.01	-3.63	0.96	10.53	-35.00**	-40.91**
26	Varsha Uphar x Phule Vimukta	5.34	13.34*	-2.71	-2.18	9.18	16.84	-14.29	-18.18
27	Arka Anamika x IC-3769-A	12.19*	19.31**	-17.79**	-16.15**	9.55	18.77	-14.29	-18.18
28	Arka Anamika x EC-305672	11.43*	16.53**	-15.78**	-16.70**	19.42*	21.93*	-9.52	-13.64

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis

Sr. No.	Crosses	Plant Height (cm)		Internodal Length (cm)		Number of Nodes Per Plant		Number of Branches Per Plant	
		1		2		3		4	
		BP	SH	BP	SH	BP	SH	BP	SH
29	Arka Anamika x IC-3759	13.19*	18.38**	-20.84**	-19.69**	4.97	14.91	-14.29	-18.18
30	Arka Anamika x Phule Vimukta	9.78	18.12**	-20.76**	-20.33**	4.59	11.93	-14.29	-18.18
31	IC-3769-A x EC-305672	9.49	16.43**	-4.09	-2.18	4.21	12.98	-11.11	-27.27**
32	IC-3769-A x IC-3759	8.53	15.41**	-23.49**	-21.96**	2.88	12.63	-10.00	-18.18
33	IC-3769-A x Phule Vimukta	9.76	18.09**	-2.58	-0.64	5.83	14.74	-19.05	-22.73*
34	EC-305672 x IC-3759	15.31**	18.82**	-18.34**	-17.15**	7.37	17.54	-5.00	-13.64
35	EC-305672 x Phule Vimukta	9.24	17.54**	-21.48**	-21.05**	7.54	15.09	-9.52	-13.64
36	IC-3759 x Phule Vimukta	-0.56	7.00	-1.97	-0.54	6.73	16.84	0.00	-4.55
	S.E. D ±	3.34	3.34	0.28	0.28	1.35	1.35	0.21	0.21
	C.D. @ 5%	6.72	6.72	0.56	0.56	2.71	2.71	0.41	0.41
	C.D. @ 1%	8.98	8.98	0.75	0.75	3.62	3.62	0.55	0.55

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis

Sr. No.	Crosses	Fruit Length (cm)		Fruit Diameter (mm)		Number of Fruits Per Plant		Fruit Weight (gm)	
		5		6		7		8	
		BP	SH	BP	SH	BP	SH	BP	SH
1	Parbhani Kranti x Konkan Bhendi	-0.43	2.31	-7.29	-5.58	-7.74	-0.69	1.13	6.24
2	Parbhani Kranti x Arka Abhay	1.46	-1.24	-3.02	2.45	24.45**	18.40*	2.72	4.65
3	Parbhani Kranti x Varsha Uphar	-8.24	0.00	-9.04	-7.36	7.69	2.08	4.86	6.83
4	Parbhani Kranti x Arka Anamika	-3.55	-1.07	2.40	4.91	5.43	1.04	-0.28	6.24
5	Parbhani Kranti x IC-3769-A	11.24*	10.84*	-11.77	-5.28	38.85**	34.03**	11.12	15.74*
6	Parbhani Kranti x EC-305672	0.36	-0.36	6.63	8.59	4.76	-0.69	-0.92	6.83
7	Parbhani Kranti x IC-3759	1.11	-2.84	0.12	1.96	26.99**	27.43**	-3.44	-0.10
8	Parbhani Kranti x Phule Vimukta	-4.00	-6.22	-13.74	-3.68	-0.68	1.04	-4.05	0.99
9	Konkan Bhendi x Arka Abhay	-2.34	0.36	3.37	9.20	1.61	9.38	-3.49	1.39
10	Konkan Bhendi x Varsha Uphar	-7.01	1.33	-12.12	-11.04	-3.55	3.82	-0.38	4.65
11	Konkan Bhendi x Arka Anamika	-24.05**	-21.96**	-20.18*	-18.22	-8.71	-1.74	-31.04**	-26.53**
12	Konkan Bhendi x IC-3769-A	-5.62	-3.02	-16.00	-9.82	4.19	12.15	-2.45	2.48
13	Konkan Bhendi x EC-305672	-2.25	0.44	29.82**	13.50	2.26	10.07	-5.88	1.49
14	Konkan Bhendi x IC-3759	-0.78	1.96	10.56	9.82	8.71	17.01*	0.85	5.94

*Significance at 5% level and ** Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis.

Sr. No.	Crosses	Fruit Length (cm)		Fruit Diameter (mm)		Number of Fruits Per Plant		Fruit Weight (gm)	
		5		6		7		8	
		BP	SH	BP	SH	BP	SH	BP	SH
15	Konkan Bhendi x Phule Vimukta	-6.06	-3.47	-11.54	-1.23	-1.94	5.56	-1.32	3.86
16	Arka Abhay x Varsha Uphar	-5.87	2.58	-2.44	3.07	29.20**	22.92**	4.45	4.65
17	Arka Abhay x Arka Anamika	-6.76	-4.36	-10.98	-5.95	18.84*	13.89	-5.67	0.5
18	Arka Abhay x IC-3769-A	0.98	0.62	2.29	9.82	8.27	4.51	2.47	6.73
19	Arka Abhay x EC-305672	6.80	6.04	-1.28	4.29	11.68	6.25	-17.54**	-11.09
20	Arka Abhay x IC-3759	2.65	-0.09	12.66	19.02	19.38*	19.79*	-1.15	2.28
21	Arka Abhay x Phule Vimukta	4.19	1.78	-14.29	-4.29	3.75	5.56	-0.94	4.26
22	Varsha Uphar x Arka Anamika	2.04	11.20*	-7.19	-4.91	8.33	3.82	-13.38*	-7.72
23	Varsha Uphar x IC-3769-A	2.37	11.56*	-13.09	-6.69	6.47	2.78	2.85	7.13
24	Varsha Uphar x EC-305672	-7.99	0.27	-12.73	-11.66	5.54	-0.69	-4.32	3.17
25	Varsha Uphar x IC-3759	-12.56*	-4.71	-15.15	-14.11	2.08	2.43	-18.47**	-15.64*
26	Varsha Uphar x Phule Vimukta	1.75	10.89*	-3.30	7.98	11.60	13.54	7.71	13.37
27	Arka Anamika x IC-3769-A	4.16	6.84	-22.29*	-16.56	20.14*	15.97*	9.11	16.24*
28	Arka Anamika x EC-305672	5.63	8.36	-14.19	-12.09	23.55**	18.40*	7.81	16.24*

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis.

Sr. No.	Crosses	Fruit Length (cm)		Fruit Diameter (mm)		Number of Fruits Per Plant		Fruit Weight (gm)	
		5		6		7		8	
		BP	SH	BP	SH	BP	SH	BP	SH
29	Arka Anamika x IC-3759	0.00	2.58	-27.54**	-25.77*	14.19	14.58	0.28	6.83
30	Arka Anamika x Phule Vimukta	-3.12	-0.62	3.85	15.95	0.34	2.08	-3.72	2.57
31	IC-3769-A x EC-305672	1.34	0.98	4.00	11.66	4.68	1.04	-3.31	4.26
32	IC-3769-A x IC-3759	2.77	2.40	-10.86	-4.29	9.00	9.38	3.52	7.82
33	IC-3769-A x Phule Vimukta	5.08	4.71	1.10	12.88	9.56	11.46	6.49	12.08
34	EC-305672 x IC-3759	-5.55	-6.22	-12.54	-13.13	9.00	9.38	-6.24	1.09
35	EC-305672 x Phule Vimukta	-0.27	-0.98	-18.96*	-9.51	-0.34	1.39	-1.29	6.44
36	IC-3759 x Phule Vimukta	-1.27	-3.56	-12.64	-2.45	7.17	9.03	-1.88	3.27
	SE ±	0.60	0.60	1.60	1.60	1.12	1.12	0.71	0.71
	CD @ 5%	1.22	1.22	3.22	3.22	2.27	3.03	1.42	1.42
	CD @ 1%	1.63	1.63	4.30	4.30	2.27	3.03	1.90	1.90

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis

Sr. No.	Crosses	Fruit Yield Per Plant (gm)		YVMV Incidence (%)		Fruit Borer Severity (%)	
		9		10		11	
		BP	SH	BP	SH	BP	SH
1	Parbhani Kranti x Konkan Bhendi	-7.19	-1.29	-32.59**	-38.62**	22.52**	69.22**
2	Parbhani Kranti x Arka Abhay	29.46*	17.46	-23.06*	-12.11	-23.24**	-4.51
3	Parbhani Kranti x Varsha Uphar	12.56	2.13	-19.99**	10.49	47.31**	78.24**
4	Parbhani Kranti x Arka Anamika	4.92	0.48	57.14**	43.09**	6.01	28.27*
5	Parbhani Kranti x IC-3769-A	52.70**	43.37**	-29.20*	-35.53**	-66.98**	-33.35**
6	Parbhani Kranti x EC-305672	5.75	0.28	35.80**	23.66*	-8.67	10.50
7	Parbhani Kranti x IC-3759	23.91*	21.10	-3.48	-12.11	-26.72**	-11.33
8	Parbhani Kranti x Phule Vimukta	-3.90	-3.65	-16.34	-23.82*	-3.10	28.85**
9	Konkan Bhendi x Arka Abhay	-1.36	4.91	-14.95	-2.85	23.29**	70.28**
10	Konkan Bhendi x Varsha Uphar	-3.40	2.74	-49.31**	-30.00**	-38.51**	-15.07
11	Konkan Bhendi x Arka Anamika	-37.19**	-33.20**	-12.89	-34.92**	-47.79**	-27.88**
12	Konkan Bhendi x IC-3769-A	1.38	7.82	42.54**	20.41*	-57.18**	-13.59
13	Konkan Bhendi x EC-305672	-0.92	5.38	-31.26*	-47.97**	-20.51*	9.79
14	Konkan Bhendi x IC-3759	9.24	16.18	4.07	-33.50**	-45.73**	-25.05*

*Significance at 5% level and **Significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis

Sr. No.	Crosses	Fruit Yield Per Plant (gm)		YVMV Incidence (%)		Fruit Borer Severity (%)	
		9		10		11	
		BP	SH	BP	SH	BP	SH
15	Konkan Bhendi x Phule Vimukta	-3.44	2.70	-29.71	-62.11**	-61.86**	-47.33**
16	Arka Abhay x Varsha Uphar	39.22**	21.99	-48.19**	-28.46**	-19.51*	0.13
17	Arka Abhay x Arka Anamika	8.22	3.65	11.00	26.79*	-53.78**	-42.50**
18	Arka Abhay x IC-3769-A	7.49	0.92	10.89	26.67*	-8.42	84.80**
19	Arka Abhay x EC-305672	-9.35	-14.04	28.15**	46.38**	-51.66**	-39.86**
20	Arka Abhay x IC-3759	11.47	8.94	-23.06*	-12.11	1.60	26.40*
21	Arka Abhay x Phule Vimukta	3.19	3.46	-15.27	-3.21	-5.23	26.01*
22	Varsha Uphar x Arka Anamika	-5.68	-9.66	-39.27**	-16.14	-4.53	-7.73
23	Varsha Uphar x IC-3769-A	10.63	3.87	0.74	39.11**	-51.24**	-1.61
24	Varsha Uphar x EC-305672	1.69	-3.57	-2.27	34.96	52.56**	47.46**
25	Varsha Uphar x IC-3759	-19.63	-21.45	-33.56**	-8.25	-47.57**	-42.95**
26	Varsha Uphar x Phule Vimukta	21.28	21.59	-55.64**	-38.74**	-43.63**	-25.05*
27	Arka Anamika x IC-3769-A	33.33**	27.69*	-26.32*	-37.76**	-63.85**	-27.04*
28	Arka Anamika x EC-305672	35.15**	29.44*	-21.32	-40.45**	-32.61**	-36.38**

*Significance at 5% level and **significance at 1% level. HB=Heterobeltiosis, SH=Standard Heterosis

Sr. No.	Crosses	Fruit Yield Per Plant (gm)		YVMV Incidence (%)		Fruit Borer Severity (%)	
		9		10		11	
		BP	SH	BP	SH	BP	SH
29	Arka Anamika x IC-3759	5.60	3.20	32.10*	-1.30	5.27	14.55
30	Arka Anamika x Phule Vimukta	-1.66	-1.4	71.16**	27.89**	-64.55**	-52.87**
31	IC-3769-A x EC-305672	4.63	-0.78	49.47**	26.26*	-39.76**	21.57*
32	IC-3769-A x IC-3759	2.55	0.23	17.61	-0.65	-70.96**	-41.40**
33	IC-3769-A x Phule Vimukta	16.34	16.64	-17.52	-30.33**	-47.35**	6.25
34	EC-305672 x IC-3759	2.16	-0.16	68.64**	27.64**	-42.57**	-37.51**
35	EC-305672 x Phule Vimukta	1.48	1.74	32.01*	-0.08	-63.78**	-51.84**
36	IC-3759 x Phule Vimukta	3.54	3.81	55.34**	-0.73	-2.28	29.94**
	SE ±	17.29	17.29	1.06	1.06	1.64	1.64
	CD @ 5%	34.85	34.85	2.42	2.42	3.31	3.31

	CD @ 1%	46.56	46.56	3.24	3.24	4.42	4.42

*Significance at 5% level and **Significance at 1% level, HB=Heterobeltiosis, SH=Standard Heterosis

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