RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 60 Issue 1: 55-61 (January 2026)

Deployment of Heterosis Potential for Improvement of Okra Genotypes

Balagoni Maruthi[1], Sibsankar Das[1], Arup Chattopadhayay[1], Umesh Thapa[1], Anirban Maji[2] 10.18805/IJARe.A-6483

ABSTRACT

Background: To surmount productivity constraints in open-pollinated okra cultivars, hybridization-centred breeding strategies should be pursued. Heterosis breeding has proven the most ideal method for enhancing yield in okra. Numerous researchers have documented an existence of heterosis in substantial amounts for fruit yield and its related attributes. The high percentage of fruit set and ease of emasculation suggest the possibility of exploiting heterosis in okra.

Methods: A field investigation was conducted at teaching farm, extended campus of BCKV, Burdwan during rainy season, 2022 and spring-summer season, 2023. A randomised complete block design with 3 replications was used to assess the heterosis for various traits in 21 cross combinations produced through a 7×7 half-diallel mating design using 7 parents.

Result: Based on mean performance, heterobeltiosis and standard heterosis manifested in them, 2 crosses namely, Punjab 8 × Ajeet 121 and Hissar unnat × AKO 107 were found most promising for various parameters among 21 cross combinations and could be commercialized after critical evaluation. This study highlights the possibility for exploitation heterosis and isolating outstanding progenies from heterotic F_1 hybrids.

Key words: *Abelmoschus esculentus*, Heterobeltiosis (HB), Relative heterosis (RH), Standard heterosis (SH).

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a prominent malvaceous vegetable cultivated in India (Maruthi *et al*., 2025). It is an indispensable vegetable that grows across the tropical, subtropical and warmer regions of the world for it edible pods (Rai and Basu, 2019; Ibrahim *et al*., 2023; Rai *et al.,* 2025). With 6 million tonnes produced from 0.5 million hectares, India accounts for more than 72% of the world's okra production (Prem *et al.,* 2024). Among various *Abelmoschus* species in India, only *A. esculentus* is cultivated, while *A. moschatus* is grown for its fragrant seeds (Keerthana *et al.,* 2025). Okra is a nutritious vegetable that significantly contributes to fulfilling the nation's vegetable demand during periods of scarcity (Chawla *et al.,* 2018). Tender okra fruits are a valuable source of vitamins and minerals (Chacko *et al.,* 2022).

Okra genetic improvement has significance due to its dietary, nutritional and economic advantages (Singh and Pandey, 2024). The larger size of okra flowers and the Monadelphous stamens make them simple to emasculate and hand pollinate, facilitating hybridization (Sandeep *et al.,* 2025). According to many studies, okra yield and yield related attributes demonstrated 38 to 71% heterosis (Abdelkader *et al*., 2024).

Okra breeders have long recognised heterosis as a useful tool for enhancing yield and other important attributes (Ayenan *et al*., 2025). Research on crop heterosis is essential for identifying the best parents and crosses to improve genetic makeup of okra. The study sought to assess heterosis for yield and its contributing traits and to identify superior hybrids.

[1]Department of Vegetable Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, West Bengal, India.
[2]Department of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, West Bengal, India.

Corresponding Author: Balagoni Maruthi, Department of Vegetable Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, West Bengal, India. Email: maruthi.horti@gmail.com

How to cite this article: Maruthi, B., Das, S., Chattopadhayay, A., Thapa, U. and Maji, A. (2026). Deployment of Heterosis Potential for Improvement of Okra Genotypes. *Indian Journal of Agricultural Research.* **60(1):** 55-61. doi: 10.18805/IJARe.A-6483.

Submitted: 19-11-2025 **Accepted:** 16-12-2025 **Online:** 30-12-2025

MATERIALS AND METHODS

The current investigation was conducted in randomized block design with 3 replications at Teaching Farm, College of Agriculture, Burdwan, BCKV with seven diverse parents (Table 1). Parents were selected for the hybridization programme based on evaluation of yield characters and disease index. By utilizing these 7 parents 21 straight crosses were developed following a 7 × 7 half-diallel mating design (Table 2) without reciprocals. In the spring and summer of 2022, the seeds were sown in the crossing block in five rows, with 60 cm between rows and 30 cm between plants. Seeds of twenty-one crosses along with 7 parents (to be selfed) was collected and stored for evaluation of F_1 and 7 parents along with check during the rainy season, 2022 and spring-summer season, 2023.

Observations were noticed on growth an fruit characteristics like primary branches count per plant,

nodes per plant on main stem, length of the internode (cm), plant height (cm), days to 1st blooming, days to 50% blooming, node at 1st blooming, days to 1st harvest, fruit length (cm), fruit diameter (cm), ridges per fruit, fruit weight (g), fruits per plant, seeds per fruit, 1000 seeds weight (g), yield of fruit per plant (g), BYVMV PDI (Per cent disease index) at 90 DAS and OELCV PDI at 90 DAS.

Heterosis was computed employing the mean values of hybrids. The magnitude of heterosis for all hybrids was calculated over mid, better-parent and standard check according to Hayes *et al.* (1955). The analysis was done by using Windostat 9.30 version software (created by Indostat Services, Hyderabad).

RESULTS AND DISCUSSION

In the current investigation, 21 cross combinations along with their 7 parents were studied for 18 traits to assess the heterosis. The range and magnitude of heterosis (pooled data) for various traits (Table 2 to 5) over mid-parent, better-parent and standard check (NBH-45) were discussed below.

Significant positive SH (standard heterosis) for plant height over NBH-45 (Check) was observed in the cross Hissar Unnat × AKO 107 (28.81%**) followed by the Punjab 8 × Ajeet 121 (27.06%**). For node counts on the main stem, RH, HB and SH ranged from -12.33 * to 73.46**, -22.01** to 63.65** and -43.67** to 13.35** respectively. For internodal length, RH, HB and SH range from -60.22** to 1.92, -68.74** to 0.19 and -38.35** to 60.23** respectively. A Similar finding was previously reported by Paul *et al.,* 2017. For plant height, RH, HB and SH ranges are -18.26** to 29.43**, -20.65** to 24.23** and -17.73** to 28.81** respectively.

The plant's height, branches per plant, nodes count per plant and internode length are thought to be substantial growth attributes since they significantly affect the fruit-bearing surface of the plant. Nearly every node on the main stem and primary branches of okra yields pods. Plants with more branches on the main stem produce more fruit because they can accommodate more nodes for a given internode length. Lesser distances between nodes increase the number of nodes on the main stem, leading to increased fruit output. To accommodate more nodes and increase okra fruit output, negative heterosis is preferred for internodal length (Salaria, 2021).

For days to 1st blooming, negative heterosis estimates for this attribute implies earliness which would be desirable. Significant negative heterosis over better parent shown by the cross Hissar Unnat × AKO 107 (-29.26%**). Negative heterosis over NBH-45 (check) was reported by the crosses Hissar Unnat × AKO 107 (-1.21) and Punjab 8 × Ajeet 121 (-1.21) but was not significant. Similarly for days to 50% blooming also negative heterosis estimates implies hybrid earliness which would be advantageous. Negative heterosis over NBH-45 (check) was reported by Punjab 8 × Ajeet 121 (-1.03).

For node to 1st flowering, RH, HB and SH range from -27.25** to 19.42**, -29.68** to 11.11 and 0 to 53.91** respectively. Similar outcome was earlier noted by Sidapara *et al.* (2021). For days to 1st harvest, RH, HB and SH range from -17.41** to 1.21, -23.85** to 0 and -2.5 to 20.50** respectively.

Okra's earliness is indicated by the attributes such as days to 1st blooming, days to 50% blooming, first flowering node and days to 1st harvest. In lieu of providing earlier pickings and higher yields, early blooming and fruiting extends the plant's fruiting phase. Early yields and higher fruit per plant are two benefits of flowering and fruiting at lower nodes. Hence, negative heterosis is advantageous for these earliness characteristics (Suma *et al.*, 2025).

For fruit length, RH, HB and SH range from -44.09** to 9.83, -47.71** to 4.58 and -46.40** to 5.3 respectively. For fruit diameter, RH, HB and SH range from -17.35** to 14.71**, -23.22** to 12.25* and -30.96** to 0.57 respectively. No significant heterosis was reported for number of ridge per fruit as there is no variation among parents for this trait. For fruit weight, heterosis over NBH-45 (check) was shown by the Punjab 8 × Ajeet 121 (7.66%). Similar finding was earlier reported by Shinde *et al.* (2023). The number of fruits –per plant has a positive relationship with yield per plant. For this trait, RH, HB and SH range from -24.49** to 53.00**, -33.16** to 37.75** and -42.20** to 1.9 respectively. Similar finding was earlier reported by Chaudhary *et al.* (2023).

Seeds count per fruit has positive correlation with yield. For this trait, RH, HB and SH range from -48.75** to 19.26**, -48.95** to 16.83** and -55.46** to 5.31 respectively. Similar outcome was earlier reported by Chaudhary *et al.* (2023). 1000 seed weight also has positive correlation with yield. For this trait, RH, HB and SH range from -38.39** to 17.31**, -44.47** to 14.52* and -39.70** to 12.57* respectively. For fruit yield per plant, significant positive heterosis (69.68%**) over mid-parent was displayed by Punjab 8 × Ajeet 121. Significant positive heterosis (50.21%**) over better parent shown by Hissar Unnat × AKO 107. Heterosis over NBH-45 (check) was shown by Punjab 8 × Ajeet 121 (9.59%*). The most promising heterotic cross among all 21 crosses for this trait was Punjab 8 × Ajeet 121.

For BYVMV PDI at 90 DAS, RH and HB range from -100.00** to 2069.08** and -100.00** to 984.54** respectively. Negative heterosis estimates for this attribute are desirable. The highest, significant, positive

Table 1: 7 diverse parents along with source.

Parent (P)	Source
Punjab 8 (P_1)	PAU, Punjab
Hisar unnat (P_2)	CCSHAU, Hisar
Hoshairpur local (P_3)	Local cultivar from Punjab
Anima (P_4)	Bhairavi biosciences
Green gold (P_5)	Somani seeds
Ajeet-121 (P_6)	Ajeet seeds
AKO 107(P_7)	PDKV, Akola

Table 2: Manifestation of heterosis for various traits (Pooled).

Cross combinations	Number of primary branches			Number of nodes			Internodal length			Plant height			Days to first flowering		
	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)
Punjab-8 × Hissar unnat	46.17**	35.63**	21.74**	27.34**	22.83**	-0.35	-12.57*	-23.48**	-0.48	16.33**	15.01**	12.21*	-6.51	-7.23	3.96
Punjab-8 × Hoshiarpur local	26.49**	16.31**	4.4	11.59*	5.47	-14.43**	-6.61	-12.9	-1.77	6.64	3.98	1.45	0	-2.94	13.79
Punjab-8 × Anima	22.84**	13.02*	1.45	12.85**	7.31	-12.95**	0.98	0.19	-0.68	-10.14*	-11.69*	-13.83**	-0.31	-1.53	11.37
Punjab-8 × Green gold	-1.64	-7.97	-17.39**	17.72**	3.2	-16.27**	-11.13	-26.91**	10.62	-1.49	-2.68	-2.69	-12.99*	-18.35**	2.76
Punjab-8 × Ajeet 121	45.90**	38.91**	24.69**	62.50**	39.72**	13.35**	-8.45	-27.95**	22.49**	26.88**	23.70**	27.06**	-18.14**	-24.60**	-1.21
Punjab-8 × AKO 107	-30.87**	-36.98**	-43.43**	11.28*	-7.02	-24.56**	-34.05**	-50.71**	-2.8	-18.24**	-20.65**	-17.73**	-8.97	-18.52**	13.79
Hissar unnat × Hoshiarpur local	-12.29*	-13.14*	-33.29**	8.15	5.89	-20.18**	-2.32	-8.81	18.60*	7.48	5.98	1.05	-6.47	-8.53	7.23
Hissar unnat × Anima	-2.89	-3.77	-26.09**	7.47	5.88	-20.18**	1.92	-10.19	16.80*	6.33	5.68	0.77	-5.05	-5.49	6.89
Hissar unnat × Green gold	43.97**	42.68**	11.59*	22.65**	11.05*	-16.29**	-3.2	-10.01	36.20**	7.99	5.48	5.48	-6.51	-11.64	11.21
Hissar unnat × Ajeet 121	-21.16**	-23.27**	-37.73**	6.35	-5.65	-28.87**	-24.19**	-33.10**	13.74	-2.67	-6.16	-3.61	-15.46**	-21.58**	2.75
Hissar unnat × AKO 107	36.54**	33.96**	2.9	73.46**	49.37**	12.61**	-17.96**	-31.93**	34.23**	29.43**	24.23**	28.81**	-21.51**	-29.26**	-1.21
Hoshiarpur local × Anima	9.74	9.67	-17.29**	5.98	5.31	-22.96**	-23.69**	-28.30**	-19.14*	-0.24	-1.04	-6.77	-8.07	-9.69	5.87
Hoshiarpur local × Green gold	0	-1.85	-23.24**	29.44**	19.48**	-13.70**	-36.73**	-44.79**	-16.44*	-2.88	-6.43	-6.43	-13.05*	-16.03**	5.68
Hoshiarpur local × Ajeet 121	5.53	1.73	-17.44**	-12.33*	-20.74**	-42.75**	-53.83**	-61.60**	-34.72**	-9.32*	-13.74**	-11.40*	-14.16**	-18.68**	6.55
Hoshiarpur local × AKO 107	-24.25**	-24.95**	-43.48**	-11.06*	-22.01**	-43.67**	-60.22**	-68.74**	-38.35**	-5.45	-10.47*	-7.16	-16.77**	-23.45**	6.9
Anima × Green gold	7.61	5.68	-17.34**	40.70**	29.12**	-5.54	-7.8	-23.70**	15.48	0.63	-2.29	-2.29	-9.96	-14.52*	7.58
Anima × Ajeet 121	0.28	-3.27	-21.50**	25.04**	12.41*	-17.77**	-30.21**	-44.76**	-6.08	-6.11	-10	-7.55	-5.25	-11.73*	15.65*
Anima × AKO 107	26.24**	24.98**	-5.75	70.11**	48.36**	8.54*	-34.92**	-51.10**	-3.57	18.97**	13.53**	17.72**	-18.97**	-26.67**	2.4
Green gold × Ajeet 121	12.82*	10.77	-10.10*	67.40**	63.65**	0.02	-26.65**	-30.68**	17.86*	7.69	6.26	9.15	-14.63**	-16.31**	9.65
Green gold × AKO 107	-14.26*	-16.62*	-34.78**	17.95**	11.52	-31.84**	-43.78**	-50.32**	-2.03	-18.26**	-19.72**	-16.75**	-21.81**	-25.67**	3.8
Ajeet 121 × AKO 107	25.17**	19.58**	-2.95	28.05**	23.74**	-27.76**	-12.73**	-18.75**	60.23**	20.93**	20.36**	24.80**	-7.01	-9.88	25.85**

Table 3: Manifestation of Heterosis for various traits (Pooled).

Cross combinations	Days to 50% flowering			Node to first flowering			Days to first harvest			Fruit length			Fruit diameter		
	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)
Punjab-8 × Hissar unnat	-4.7	-5.32	4.41	-1.86	-5.88	2.61	-1.23	-1.75	5.5	-17.92**	-20.71**	-24.08**	-8.89	-12.01*	-19.00**
Punjab-8 × Hoshiarpur local	0.66	-1.3	11.76	-7.16	-13.33*	0.04	1.21	0	10	-12.23*	-15.22*	-18.82**	5.47	0.38	-13.92*
Punjab-8 × Anima	-1.98	-2.18	6.88	5.02	3.75	6.41	-2.22	-2.22	5	-7.35	-7.59	-11.06	1.74	0.29	-14.00*
Punjab-8 × Green gold	-10.71*	-15.55**	3.08	-14.44**	-26.58**	2.61	-10.56	-14.85*	1.13	-11.23*	-12.78*	-13.46*	-11.59*	-14.04*	-26.29**
Punjab-8 × Ajeet 121	-15.88**	-21.75**	-1.03	-8.85	-16.19*	0	-15.45**	-20.89**	-2.5	6.62	4.58	4.12	14.71**	12.25*	0.57
Punjab-8 × AKO 107	-8.44	-17.40**	11.75	0.53	-14.39**	21.85**	-8.38	-16.35**	8.75	-8.72	-11.73*	-9.51	-10.32*	-16.36**	-17.12**
Hissar unnat × Hoshiarpur local	-5	-6.23	6.18	14.29*	11.11	28.26**	-3.12	-4.78	4.75	1.74	1.74	-9.2	3.09	-5.07	-12.61*
Hissar unnat × Anima	-2.74	-3.19	6.77	12.75*	9.41	19.28*	-1.69	-2.21	5	-6.45	-9.85	-13.24*	-7.52	-11.92*	-18.92**
Hissar unnat × Green gold	-8.44	-12.85*	6.37	3.11	-8.23	28.26**	-5.56	-10.53	6.25	8.91	3.44	2.63	4.31	-1.96	-9.75
Hissar unnat × Ajeet 121	-13.41**	-18.95**	2.5	10.09	5.34	25.69**	-10.67*	-16.83**	2.5	2.04	-3.25	-3.67	-8.48	-9.7	-16.87**
Hissar unnat × AKO 107	-18.69**	-26.20**	-0.16	-20.36**	-29.68**	0.09	-16.19**	-23.85**	-1	9.83	2.72	5.3	3.77	0.08	-0.82
Hoshiarpur local × Anima	-6.15	-7.8	4.41	16.49**	10	26.98**	-3.97	-5.11	4.38	-6.87	-10.26	-13.63*	3.92	0.29	-16.46**
Hoshiarpur local × Green gold	-10.00*	-13.25**	5.89	-19.55**	-26.55**	2.65	-8.42	-11.80*	4.75	-9.24	-13.80*	-14.47*	8.84	6.47	-13.76*
Hoshiarpur local × Ajeet 121	-10.55*	-15.23**	7.21	9.23	7.45	28.22**	-9.11	-13.99*	6	-38.95**	-42.12**	-42.37**	-17.35**	-22.94**	-30.96**
Hoshiarpur local × AKO 107	-14.79**	-21.74**	5.89	19.42**	8.14	53.91**	-12.40*	-19.13**	5.13	-44.09**	-47.71**	-46.40**	-13.82*	-23.22**	-23.91**
Anima × Green gold	-9.22*	-13.98**	5	5.86	-8.23	28.26**	-9.57	-13.90*	2.25	-10.57*	-11.92*	-12.60*	11.27	9.73	-8.6
Anima × Ajeet 121	-3.08	-9.67*	14.24*	-7.44	-13.94*	2.69	-3.31	-9.53	11.5	-6.3	-7.86	-8.26	-9.43	-12.61*	-21.70**
Anima × AKO 107	-15.57**	-23.69**	3.24	-7.86	-20.73**	12.83	-13.85**	-21.35**	2.25	-6.86	-9.7	-7.44	4	-4.3	-5.16
Green gold × Ajeet 121	-14.08**	-15.58**	6.76	-22.77**	-28.42**	0.04	-13.22**	-14.80*	5	-5.6	-5.76	-6.17	-2.64	-7.31	-16.95**
Green gold × AKO 107	-19.45**	-23.39**	3.65	-27.25**	-27.91**	2.61	-17.41**	-20.98**	2.72	-14.90**	-16.26**	-14.16*	-4.59	-13.31*	-14.09*
Ajeet 121 × AKO 107	-6.41	-9.46*	22.49**	8.82	0.03	42.37**	-4.84	-7.31	20.50**	-0.84	-2.27	0.19	-1.82	-6.53	-7.37

Table 4: Manifestation of Heterosis for various traits (Pooled).

Cross combinations	No. of ridges per fruit			Fruit weight			No. of fruits per plant			No. of seeds per fruit			1000 seed weight		
	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	SH (%)
Punjab-8 × Hissar unnat	-0.99	-1.96	0	-2.51	-3.6	-15.88**	13.11*	9.21	-5.56	1.25	-5.36	-8.91	12.70**	11.37*	4.37
Punjab-8 × Hoshiarpur local	-1.02	-1.99	-0.03	2.15	-0.51	-8.41	3.55	-3.13	-16.24**	-5.9	-10.62*	-13.98**	17.31**	14.52*	4.79
Punjab-8 × Anima	-0.03	-0.03	-0.03	4.91	-1.18	-13.77**	-11.00*	-15.69**	-27.10**	-16.99**	-25.74**	-28.53**	-0.75	-3.87	-12.04*
Punjab-8 × Green gold	-0.02	-0.03	0	-14.77**	-20.77**	-19.54**	-24.49**	-32.55**	-41.68**	-37.16**	-39.90**	-42.16**	-24.38**	-29.21**	-25.73**
Punjab-8 × Ajeet 121	-1.01	-1.99	0	13.38**	4.88	7.66	46.83**	17.83**	1.9	11.60*	9.42	5.31	14.57**	7.2	12.57*
Punjab-8 × AKO 107	0	0	0	5.42	-4.1	2.13	-17.97**	-33.16**	-42.20**	-20.48**	-24.20**	-27.05**	-12.05**	-18.97**	-12.01*
Hissar unnat × Hoshiarpur local	-1.93	-1.93	0.03	0.14	-3.53	-11.19*	1.54	-1.74	-20.90**	0.48	-1.2	-14.46**	2.96	-0.65	-6.89
Hissar unnat × Anima	0.99	0	2	10.34	5.05	-10.38*	-13.90*	-15.59*	-32.04**	1.72	-2.97	-18.81**	2.5	-1.85	-8.01
Hissar unnat × Green gold	-0.97	-1.93	0.03	4.43	-3.92	-2.42	1.89	-6.02	-24.34**	8.66	6.07	-6.82	5.57	-0.06	4.85
Hissar unnat × Ajeet 121	-1.98	-1.99	0	11.87*	2.43	5.14	-9.15	-25.05**	-39.66**	-9.3	-13.63*	-20.11**	-13.01**	-17.69**	-13.56**
Hissar unnat × AKO 107	-0.99	-1.96	0	10.43*	-0.55	5.91	45.24**	21.73**	-2	19.26**	16.83**	1.91	9.38*	1.9	10.65*
Hoshiarpur local × Anima	-0.99	-1.96	0	6.16	-2.44	-10.19*	-7.25	-8.48	-29.21**	0.71	-5.47	-18.16**	1.63	0.82	-12.13*
Hoshiarpur local × Green gold	-0.97	-1.93	0.03	-4.97	-9.41	-8	19.38**	13.60*	-14.46**	4.43	3.67	-8.93	3.24	-5.5	-0.85
Hoshiarpur local × Ajeet 121	-1.94	-1.96	0.03	-29.83**	-33.45**	-31.69**	-5.56	-19.97**	-39.74**	-41.15**	-43.03**	-47.31**	-25.73**	-32.04**	-28.64**
Hoshiarpur local × AKO 107	-0.99	-1.96	0	-39.61**	-43.71**	-40.05**	-3.67	-17.01*	-37.51**	-48.75**	-48.95**	-55.46**	-38.39**	-44.47**	-39.70**
Anima × Green gold	-0.02	-0.03	0	-14.61**	-24.88**	-23.71**	15.24*	8.28	-16.24**	0.03	-6.74	-18.07**	-3.73	-12.52*	-8.22
Anima × Ajeet 121	0.97	-0.03	2	7.63	-5.74	-3.25	25.93**	5.56	-18.35**	12.65*	2.58	-5.13	8.29	-1.63	3.3
Anima × AKO 107	0.03	0.03	0.03	-12.91**	-24.92**	-20.04**	33.73**	13.93*	-11.87*	5.81	-1.03	-13.66**	-2.77	-12.99**	-5.52
Green gold × Ajeet 121	-1.02	-1.99	0	-12.06**	-12.52*	-10.21*	53.00**	35.36**	-7.95	3.35	0.76	-6.81	-5.6	-5.64	-0.91
Green gold × AKO 107	3.98	3.97	4	-8	-10.13*	-4.29	3.72	-6.62	-36.50**	-12.26*	-12.56*	-23.19**	-19.44**	-20.80**	-14.01**
Ajeet 121 × AKO 107	2.99	1.96	4.03	-2.18	-3.95	2.29	40.49**	37.75**	-25.00**	4.95	1.97	-5.69	-7.4	-8.93	-1.11

Table 5: Manifestation of heterosis for various traits (Pooled).

Cross combinations	Fruit yield per plant			BYVMV PDI at 90 DAS		OELCV PDI at 90 DAS	
	MP (%)	BP (%)	SH (%)	MP (%)	BP (%)	MP (%)	BP (%)
Punjab-8 × Hissar unnat	9.78*	5.24	-20.62**	-86.12**	-86.84**	-100.00**	-100.00**
Punjab-8 × Hoshiarpur local	5.91	1.59	-23.37**	-100.00**	-100.00**	26.51*	-0.18
Punjab-8 × Anima	-6.87	-16.64**	-37.13**	423.80**	211.81**	8.48	-6.56
Punjab-8 × Green gold	-34.83**	-37.81**	-53.09**	-100.00**	-100.00**	354.28**	309.02**
Punjab-8 × Ajeet 121	69.68**	45.29**	9.59*	-100.00**	-100.00**	-100.00**	-100.00**
Punjab-8 × AKO 107	-11.46*	-21.64**	-40.90**	-100.00**	-100.00**	648.73**	274.37**
Hissar unnat × Hoshiarpur local	1.82	1.75	-29.50**	170.16**	96.00**	40.64**	18.04
Hissar unnat × Anima	-5.45	-12.00*	-39.11**	242.76**	100.68**	-0.16	-19.34*
Hissar unnat × Green gold	7	6.48	-26.32**	-100.00**	-100.00**	20.12	16.51
Hissar unnat × Ajeet 121	3.19	-8.33	-36.57**	-100.00**	-100.00**	613.31**	256.65**
Hissar unnat × AKO 107	63.33**	50.21**	3.93	-100.00**	-100.00**	-100.00**	-100.00**
Hoshiarpur local × Anima	-1.35	-8.24	-36.43**	-100.00**	-100.00**	212.99**	121.88**
Hoshiarpur local × Green gold	14.11**	13.49*	-21.38**	196.57**	116.25**	-35.58**	-44.54**
Hoshiarpur local × Ajeet 121	-33.05**	-40.56**	-58.82**	2069.08**	984.54**	-100.00**	-100.00**
Hoshiarpur local × AKO 107	-41.02**	-45.79**	-62.44**	-100.00**	-100.00**	1877.16**	888.58**
Anima × Green gold	-0.35	-6.83	-36.16**	596.64**	536.40**	-29.92**	-44.68**
Anima × Ajeet 121	39.26**	32.41**	-21.08**	1241.26**	570.63**	8.11	-45.95**
Anima × AKO 107	19.70**	18.17**	-29.57**	1413.50**	656.75**	21.76	-39.12**-
Green gold × Ajeet 121	35.12**	20.54**	-17.40**	-100	-100.00*	113.09**	6.54
Green gold × AKO 107	-3.71	-11.05	-39.05**	-100	-100.00*	776.87**	338.43**
Ajeet 121 × AKO 107	37.27**	32.15**	-23.26**	-	-	-	-

MP heterosis (2069.08%**) and BP heterosis (984.54%**) were noticed in the cross Hoshiarpur local × Ajeet 121. For BYVMV OELCV at 90 DAS, RH and HB range from -100.00** to 1877.16** and -100.00** to 888.58** respectively. The most promising heterotic cross among all 21 crosses for this trait was Punjab 8 × Hissar Unnat, Punjab 8 × Ajeet 121 and Hissar Unnat × AKO 107. Positive heterosis is preferred for attributes like total number of fruits produced by a plant, length and weight of the fruits which are thought to be closely related to the overall yield per plant in okra (Abdelkader *et al*., 2024; Ranga *et al*., 2024).

CONCLUSION

Okra exhibits heterosis in terms of yield and yield related characteristics. Hybrids differ significantly in their individual heterosis levels for each feature. Yield components must be evaluated to enhance yield by selective breeding. In the current study 2 crosses namely, Punjab 8 × Ajeet 121 and Hissar Unnat × AKO 107 were found most promising and could be commercialized after critical evaluation.

ACKNOWLEDGEMENT

The present study was supported by department of vegetable science, BCKV.

Disclaimers

We are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

Not applicable.

Conflict of interest

The authors have no conflict of interest.

REFERENCES

Abdelkader, M.F., Mahmoud, M.H., Diyasty, M.Z., Sukar, N.A., Farag, M.I., Mohamed, N.N. and Abdein, M.A. (2024). Genetic components derived parameters and heterosis in okra under Saudi Arabia conditions. *Genetics Research.* **1(23):** 6432560.

Ayenan, M.A., Vihou, F., Ambali, M., Opoku, J.A., Ibitoye, D.O. and Schafleitner, R. (2025). Tapping into the potential of okra (*Abelmoschus* spp.) in Africa: integrating value-added traits into breeding. *Frontiers in Plant Science*. **16:** 1631221.

Chacko, R.S., Raj, K., Sheeja, P.S.P., Jacob, D., Lakshmi, G.P.R., Radhakrishnan, N.V. and Krishnasree, R.K. (2022). Nutrient availability and nutrient uptake by crop and weed as influenced by stale seedbed, mulching and mechanical weeding in okra. *Agricultural Science Digest.* **42(5):** 568-573. doi: 10.18805/ag.D-5529.

Chaudhary, P.L., Kumar, B. and Kumar, R. (2023). Analysis of heterosis and heterobeltiosis for earliness, yield and its contributing traits in okra [*Abelmoschus esculentus* (L.) Moench]. *International Journal of Plant and Soil Science*. **35(11):** 84-98.

Chawla, S., Narolia, R.K. and Pipliwal, S.K. (2018). Effect of dates of sowing and nitrogen levels on growth and yield of okra. *Agricultural Science Digest*. **38(3):** 231-235. doi: 10.18805/ag.D-4715.

Hayes, H.K., Immer, F.R. and Smith, D.C. (1955). Methods of Plant Breeding. McGraw Hill, New York.

Ibrahim, M.A., Abbas, R.A., Aldabbagh, J.E. and Mohammed, A. (2023). Factors affecting callus induction from anther and ovary of Okra (*Abelmoschus esculentus* L.). *Indian Journal of Agricultural Research*. **57(5):** 658-664. doi: 10.18805/IJARe.AF-754.

Keerthana, S., Dubey, N., Delvadiya, I.R., Patel, D.D. and Ginoya, A.V. (2025). Combining ability and gene action studies for fruit yield and its component traits in okra [*Abelmoschus esculentus* (L.) Moench]. *Indian Journal of Agricultural Research*. **59(4):** 621-627. doi: 10.18805/IJARe.A-6246.

Maruthi, B., Das, S., Chattopadhayay, A., Thapa U., Maji, A. and Hazra, P. (2025). Morphological characterization and shannon-weaver diversity index (H') of okra [*Abelmoschus esculentus* (L.) Moench] germplasm. *Agricultural Science Digest.* **45(2):** 272-281. doi: 10.18805/ag.D-6232.

Paul, T., Desai, R.T. and Choudhary, R. (2017). Genetic architecture, combining ability and gene action study in okra [*Abelmoschus esculentus* (L.) Moench]. *International Journal of Current Microbiology and Applied Sciences*. **6(4):** 851-858.

Prem, S.P., Dushyanthakumar, B.M., Kalleshwaraswamy, C.M., Satish, K.M., Diwan, J.R., Raghavendra, V.C. and Channabasava. (2024). Diallel approach for estimating hybrid superiority and combining ability of indigenous advanced breeding lines in okra [*Abelmoschus esculentus* (L.)]. *Genetic Resources and Crop Evolution*. **71(6):** 2987-2999.

Rai, A.K. and Basu, K.A. (2019). Post-fertilization development of seed in okra genotypes: Changes in seed quality. *Agricultural Science Digest.* **39(3):** 205-209. doi: 10.18805/ag.D-4953.

Rai, M., Singh, R.K., Sharma, V., Mishra, A.C. and Dwivedi, S.V. (2025). Studies on interrelationship and path coefficient analysis in okra [*Abelmoschus esculentus* (L.) Moench]. *Indian Journal of Agricultural Research.* **59(3):** 435-441. doi: 10.18805/IJARe.A-5963.

Ranga, A.D., Vikram, A., Kumar, R., Dogra, R.K., Sharma, R. and Sharma, H.R. (2024). Exploitation of heterosis and combining ability potential for improvement in okra (*Abelmoschus esculentus* L.). *Scientific Reports.* **14(1):** 24539.

Salaria, S. (2021). Character Association Studies in Okra. Doctoral Dissertation, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu.

Shinde, S.L., Zate, D.K., Rathod, A.H. and Cheke, S.A. (2023). Heterosis studies by using L × T design for yield and yield contributing traits in okra (*Abelmoschus esculentus* (L.) Moench). *The Pharma Innovation Journal*. **12(1):** 228-237.

Sandeep, N., Kumar, B.M. and Chavan, A.L. (2025). Microsatellite marker-driven genetic diversity and breeding potential assessment in okra [*Abelmoschus esculentus* (L.) Moench]: A multi-parent approach. *Plant Molecular Biology Reporter.* pp 1-16.

Sidapara, M.P., Gohil, D.P., Patel, P.U. and Sharma, D.D. (2021). Heterosis studies for yield and yield components in okra [*Abelmoschus esculentus* (L.) Moench]. *Journal of Pharmacognosy and Phytochemistry.* **10(1):** 1268-1275.

Singh, A. and Pandey, M.K. (2024). Advances in okra (*Abelmoschus esculentus* L.) breeding: Integrating genomics for enhanced crop improvement. *Journal of Advanced Biology and Biotechnology.* **27(5):** 397-407.

Suma, A., John, K.J., Latha, M., Thirumalaisamy, P.P., Venkatesan, K., Neeraja, P. and Singh, G.P. (2025). Exploring the genetic potential of cultivated gene pool of okra from National Gene bank, India. *Genetic Resources and Crop Evolution.* pp 1-17.