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RESEARCH ARTICLE

Evaluation of partial diallel derived okra hybrids in Bundelkhand region

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Abstract

An experiment was conducted at Vegetable Research Farm, Department of Vegetable Science, Banda University of Agriculture and Technology, Banda, Uttar Pradesh during the spring summer and rainy seasons of 2020 using 10 diverse parental lines viz., Arka Anamika (P_1), Kashi Pragati (P_2), Hisar Naveen (P_3), Hisar Unnat (P_4), Punjab-8 (P_5), Pusa A-4 (P_6), Varsha Uphar (P_7), Akola Bahar (P_8), Phule Vimukta (P_9) and Punjab Suhavani (P_{10}) and its 45 F_1 (Hybrids) developed through half-diallel mating design with an objective to estimate the magnitude of heterosis for the yield and its component traits in okra. The extent of heterosis was found best for three crosses over better parent i.e., $P_2 \times P_{10}$ (21.42%), $P_2 \times P_8$ (18.47%) and $P_6 \times P_7$ (15.91%) percent, respectively. for fruit yield per plant and yield per hectare suggested the great scope of realizing higher yield in okra through heterosis breeding. Other economic traits were also recorded as moderate to high level of heterosis over the better parents. The highest magnitude of heterobeltiosis and standard heterosis for almost all of the desired growth characteristics as well as yield-attributing features that may be applied to further breeding programs, were eventually achieved by this particular cross combination, especially in Bundelkhand parts of Uttar Pradesh.

Keywords: Heterobeltiosis, Heterosis, Okra, Yield, Hybrid, Bundelkhand

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Introduction

Okra [*Abelmoschus esculentus* (L.) Moench], commonly known as Lady's finger, is an important and single vegetable crop that belongs to the family Malvaceae and is cultivated in subtropical and tropical parts of the world. Its tender fruits are used as vegetables, stems and roots for clarification of sugar cane juice to make jaggery and crude fiber of mature fruits and stems are used in the paper industry (Makur et al., 2019). Okra seeds are an alternative source of edible oils with high unsaturated fats like oleic acid and linolic acid (Zerihun et al., 2020). It is a potential source of numerous minerals like potassium, phosphorus, sulfur, iron, sodium, calcium, manganese, etc. and vitamins A, B, C and K, as well as folates (Badrie, 2016). Considering the potentiality of this crop there is a prime need for its improvement and to develop higher-yielding hybrid varieties with superior marketable fruit quality and resistance/tolerance to biotic and abiotic stresses that are suitable for specific agro-climatic zones. Moreover, the widespread adoption of hybrids by farmers also necessitates the development of new higher-yielding hybrids, which can express a high degree of economic heterosis (Mishra et al., 2021). The ease in emasculation and a very high percentage of fruit setting indicates the possibilities of exploitation of hybrid vigor in okra. The public has released several hybrids as well as private sectors for commercial cultivation and F_1 hybrids are growing fast, which helped to enhance production and productivity.

Heterosis breeding depends mainly on the choice of superior parents for hybridization. Okra, several workers have used this design for estimating the high levels of heterosis in desirable directions have been reported in several major economic traits of okra, including yield by (Akhtar et al., 2010; Das et al., 2013; Bhatt et al., 2016; Sood, 2015 & Devi et al., 2020) indicating thereby ample scope of exploitation of hybrid vigor in okra. The present investigation aims primarily to study the direction and extent of relative heterosis and heterobeltiosis for yield and its associated traits in 10 × 10 half-diallel crosses for utilization of existing genetic diversity to develop heterotic F1 hybrids in okra.

Materials and Methods

The present investigation was carried out at the Vegetable Research Farm, Department of Vegetable Science, Banda University of Agriculture and Technology, Banda, Uttar Pradesh, during *rabi* season by providing good agronomic practices to keep the crop in good condition. The material for experimentation comprised ten distinct genotypes, i.e., Arka Anamika (P_1), Kashi Pragati (P_2), Hisar Naveen (P_3), Hisar Unnat (P_4), Punjab-8 (P_5), Pusa A-4 (P_6), Varsha Uphar (P_7), Akola Bahar (P_8), Phule Vimukta (P_9) and Punjab Suhavani (P_{10}) collected from Indian Institute of Vegetable Science (IIVR) Varanasi and maintained in the department of vegetable science. These ten lines were crossed in all the possible combinations in the diallel technique, excluding reciprocal crosses to derive all possible 45 F_1 hybrids and seeds were collected for study purposes. The parents were also maintained through selfing. All the 45 F_1s seeds, along with ten parents, were sown in randomized block design (RBD) with three replications during the *kharif* season. Each treatment or genotype in each replication was represented by one row, each accommodating ten plants at a row-to-row spacing of 60cm and 30cm from plant to plant. The observations were recorded on randomly selected five plants in each replication of parents and their F_1s. The selected plants were tagged and properly labeled before flowering for taking observations, *viz.,* days to first flowering, days to 50% flowering, plant height (cm), number of branches per plant, node at which first flower appears, internodal length (cm), number of nodes per plant, number of fruits per plant, fruit yield per plant (g), fruit yield (q ha^{-1}), fruit length (cm), fruit diameter (cm), fruit weight (g) and 100-seed weight. The magnitude of heterosis was studied using information on various quantitative characters. Heterosis expressed as a percent increase or decrease in the mean values of F_1's (hybrid) over better-parent (heterobeltiosis) was calculated according to the method suggested by Hayes et al. (1955).

Results and Discussion

The attainment of maximum crop yield is an important objective in most breeding programs and the major emphasis in vegetable breeding is on the development of improved varieties. The utilization of the effect of heterosis is very rightly considered to be one of the most outstanding achievements of vegetable breeders in the 20th century. Vegetable breeders have widely exploited and used heterosis in boosting up yield of many crops. The goal of okra hybrid breeding is to identify and then reliably reproduce superior hybrid genotypes. Virtually all commercial okra hybrids are made from crosses of inbred lines. Knowledge of heterotic groups from which to draw parental germplasm for hybrid combinations is limited. Improvement of complex characters, such as pod yield, may be accomplished through the component approach of breeding. This method, in general, assumes strong associations of yield with several characters, making up yield and simpler inheritance for these component characters.

Analysis of Variance

The mean square of parents, hybrids and parents *vs.* hybrids showed highly significant differences for all the eighteen characters. The variance due to parents exhibited significance for all the eighteen characters except for days to edible fruit maturity, fruit length (cm) and seed yield per plant (g). Similarly, the variance due to parents *vs.* hybrids was found significant for all eighteen characters except for node at first flower appears, days to edible fruit maturity, number of nodes per plant, internodal length (cm), number of branches per plant and seed yield per plant (g) indicating therefore, significant differences among these sources of variations concerning the traits studies.

Mean Performance

The mean sum of squares due to genotypes and hybrids showed highly significant differences for all the eighteen characters studied except for node at first flower appears, days to edible fruit maturity, number of nodes per plant, Internodal length (cm), number of branches per plant, fruit length (cm) and Seed yield per plant (g). The variance due to parents exhibited significance for all the eighteen characters except for days to edible fruit maturity, fruit length (cm) and seed yield per plant (g). Similarly, the variance due to parents *vs.* hybrids was found to be significant for all eighteen characters except for node at first flower appears, days to edible fruit maturity, number of nodes per plant, Internodal length (cm), number of branches per plant and seed yield per plant (g). This suggested great variability in the source of variations for almost all the characters under study.

A perusal of *per se* performance of the parental lines and F_1 hybrids (Table 1a-c) for all the traits studied revealed a wide range of mean values, which indicated that the parental lines involved in this study were genetically diverse and had good breeding value, which confirmed the predictions of analysis of variance. Among the parental lines, P_7 was the earliest concerning days to first flowering

Table 1a: Range of Mean Value of parents, F_1 hybrids and heterosis percentage Over Mid Parents (MP) and Better Parents (BP) for eighteen different quantitative traits

Parameters	*Days to first flowering*	*Days to 50% flowering*	*Node at first flower appear*	*Days to edible fruit maturity*	*Number of node per plant*	*Internodal length (cm)*
Range of mean values						
Parents	38.67 to 46.67	44.00 to 53.00	3.77 to 6.29	50.64 to 59.22	20.44 to 25.25	4.65 to 6.13
F_1	38.00 to 47.33	44.67 to 50.67	3.95 to 6.39	50.97 to 65.19	16.66 to 25.70	3.18 to 6.80
Range of Heterosis (%)						
MP	-10.94 to 14.06	-9.76 to 11.58	-34.43 to 50.62	-9.09 to 21.8	-32.25 to 13.80	-36.42 to 21.06
BP	-15.71 to 10.40	-15.72 to 11.28	-37.25 to 45.01	-13.81 to 20.83	-34.00 to 1.90	-40.65 to 16.99
Number of Heterotic crosses over						
MP	10	16	26	4	22	11
BP	4	12	23	5	16	10
Top three parents						
	P_7 (38.67)	P_5 (44.33)	P_9 (3.52)	P_8 (50.64)	P_5 (25.25)	P_2 (4.65)
	P_8 (39.00)	P_7 (46.00)	P_{10} (4.07)	P_4 (51.83)	P_7 (25.22)	P_4 (5.19)
	P_9 (41.33)	P_8 (46.33)	P_4 (4.38)	P_6 (52.14)	P_6 (23.94)	P_6 (5.28)
Top three F_1's with heterosis percentage						
MP	P5×P6 (-10.94)	P5×P7 (-9.76)	P1×P5 (-34.43)	P5×P7 (-9.09)	P3×P10 (13.80)	P1×P4 (-36.42)
	P1×P8 (8.80)	P3×P5 (-7.74)	P1×P10 (-23.83)	P3×P8 (9.84)	P2×P7 (12.57)	P1×P9 (-35.23)
	P3×P8 (9.02)	P9×P10 (-7.69)	P2×P5 (-23.59)	P2×P4 (15.10)	P1×P10 (12.39)	P5×P9 (-25.21)
BP	P5×P6 (-15.71)	P5×P7 (-15.72)	P1×P10 (-37.25)	P5×P7 (-13.81)	P8×P10 (2.23)	P2×P5 (-40.65)
	P5×P7 (-10.00)	P3×P5 (-13.84)	P1×P5 (-35.45)	P5×P3 (-12.15)	P2×P7 (1.90)	P1×P9 (-39.39)
	P3×P5 (-8.22)	P5×P6 (-13.21)	P1×P4 (-35.03)	P5×P6 (-12.32)	P4×P8 (1.29)	P5×P9 (-29.87)
Best F_1 hybrid						
	P5×P6	P5×P7	P1×P10	P5×P7	P8×P10	P2×P5

Table 1b: Range of Mean Value of parents, F_1 hybrids and heterosis percentage Over Mid Parents (MP) and Better Parents (BP) for eighteen different quantitative traits

Parameters	Number of branches per plant	Plant height (cm) at harvesting	No. of fruit per plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)
Range of mean values						
Parents	2.48 to 3.67	95.2 to 135.63	14.92 to 20.66	9.37 to 15.9	9.27 to 11.74	1.42 to 1.80
F_1	2.54 to 3.97	86.82 to 140.84	12.21 to 26.56	8.99 to 25.06	9.59 to 13.02	1.23 to 1.79
Range of Heterosis (%)						
MP	-22.09 to 29.23	-26.47 to 31.92	-32.28 to 46.84	-34.23 to 129.69	-0.48 to 30.13	-28.85 to 15.46
BP	-30 to 24.62	-33.14 to 28.77	-37.85 to 42.68	-39.19 to 123.78	-0.63 to 23.00	-30.06 to 9.73
Number of Heterotic crosses over						
MP	20	35	19	27	19	19
BP	21	27	13	21	7	13
Top three parents						
	P_1 (3.67)	P_5 (135.63)	P_7 (20.66)	P_8 (15.90)	P_3 (11.74)	P_6 (1.80)
	P_{10} (3.49)	P_{10} (135.23)	P_2 (20.61)	P_2 (15.53)	P_7 (11.16)	P_7 (1.76)
	P_3 (3.45)	P_9 (135.03)	P_1 (19.65)	P_2 (15.38)	P_1 (10.42)	P_9 (1.70)

Top three F_1's with heterosis percentage						
	P2×P7 (29.23)	P1×P6 (31.92)	P9×P10 (46.84)	P5×P7 (129.69)	P4×P6 (30.13)	P7×P9 (-28.85)
MP	P4×P9 (25.44)	P2×P8 (28.85)	P6×P8 (46.10)	P3×P7 (94.65)	P4×P9 (24.35)	P5×P7 (-23.46)
	P6×P7 (22.13)	P2×P6 (26.70)	P4×P7 (42.93)	P7×P10 (92.80)	P4×P5 (23.53)	P8×P10 (-21.73)
	P2×P7 (24.62)	P1×P6 (28.77)	P6×P8 (42.68)	P5×P7 (123.78)	P4×P6 (23.00)	P7×P9 (-30.06)
BP	P4×P9 (22.59)	P2×P6 (21.77)	P9×P10 (39.49)	P7×P10 (90.78)	P4×P5 (22.55)	P5×P7 (-27.22)
	P3×P4 (13.53)	P2×P8 (18.91)	P5×P6 (39.40)	P3×P6 (76.47)	P4×P9 (18.56)	P6×P8 (-24.07)
Best F_1 hybrid						
	P2×P7	P1×P6	P6×P8	P5×P7	P4×P6	P7×P9

Table 1c: Range of Mean Value of parents, F_1 hybrids and heterosis percentage Over Mid Parents (MP) and Better Parents (BP) for eighteen different quantitative traits

Parameters	*No. of seeds per fruit*	*Seed weight per fruit*	*100-Seed weight*	*Seed yield per plant (g)*	*Fruit yield per plant (g)*	*Fruit Yield quintal per hectare*
Range of mean values						
Parents	46.34 to 53.83	2.51 to 3.62	4.66 to 6.09	35.87 to 53.80	183.03 to 257.72	101.68 to 129.71
F_1	35.51 to 55.96	1.67 to 4.17	3.66 to 7.58	19.79 to 56.78	101.49 to 271.83	56.38 to 151.01
Range of Heterosis (%)						
MP	-32.21 to 12.54	-47.45 to 35.75	-29.35 to 59.29	-55.85 to 42.65	-49.64 to 23.35	-49.64 to 23.35
BP	-33.35 to 11.68	-50.93 to 34.14	-29.82 to 56.11	-63.21 to 29.51	-46.36 to 18.47	-53.49 to 21.00
Number of Heterotic crosses over						
MP	21	20	27	12	32	31
BP	17	21	23	11	30	27
Top three parents						
	P_7 (53.83)	P_5 (3.62)	P_7 (6.09)	P_7 (53.80)	P_8 (257.72)	P_8 (143.18)
	P_9 (53.28)	P_1 (3.60)	P_5 (5.40)	P_9 (53.17)	P_3 (247.08)	P_3 (137.27)
	P_5 (53.00)	P_9 (3.57)	P_8 (5.39)	P_9 (51.37)	P_9 (233.48)	P_9 (129.71)
Top three F_1's with heterosis percentage						
MP	P3×P10 (12.54)	P2×P7 (35.75)	P3×P6 (59.29)	P4×P6 (42.65)	P2×P8 (23.35)	P2×P8 (23.35)
	P6×P10 (12.29)	P3×P6 (35.63)	P6×P10 (48.20)	P4×P7 (37.78)	P2×P3 (16.07)	P2×P10 (10.60)
	P2×P9 (6.97)	P6×P10 (30.14)	P6×P9 (46.33)	P4×P5 (30.06)	P7×P8 (10.74)	P6×P7 (6.21)
BP	P6×P10 (11.68)	P3×P6 (34.14)	P3×P6 (56.11)	P4×P10 (29.51)	P2×P8 (18.47)	P2×P10 (21.00)
	P3×P10 (8.87)	P7×P8 (24.63)	P6×P9 (45.24)	P6×P10 (21.40)	P6×P7 (15.91)	P6×P7 (15.73)
	P6×P7 (8.32)	P6×P10 (23.76)	P6×P10 (45.10)	P6×P7 (19.03)	P2×P3 (1.02)	P5×P8 (4.52)
Best F_1 hybrid						
	P6×P10	P3×P6	P3×P6		P2×P8	P2×P10

anthesis (38.67 days); days to 50% flowering P_8 (44.00 days); node at first flower appear P_9 (3.77 nodes); days to edible fruit maturity P_8(50.64 days); Number of node per plant P_2 (20.44 nodes); internodal length P_2 (4.65 cm); number of branches per plant P_1 (3.67); plant height (cm) at harvesting P_5 (135.63 cm); number of fruit per plant P_7 (20.66 fruits) and fruit weight in (g) P_7 (15.9 g); fruit length (cm) P_3 (11.74 cm); fruit diameter (cm) P_6 (1.8 cm), number of seed per fruit P_7 (53.83 seeds) , P_5 had maximum seed weight per fruit (3.62 g), highest 100-seed weight P_7(6.09 g), seed yield/plant P_2(53.8 g); fruit yield/plant (g) P_8 (257.72 g) and P_8 maximum fruit yield quintal/hectare (143.18 quintal). Out of 45 F_1 hybrids eighteen hybrids *viz.,* $P_2 \times P_8$, $P_2 \times P_3$, $P_5 \times P_8$, $P_6 \times P_8$, $P_1 \times P_8$, $P_6 \times P_7$, $P_4 \times P_6$, $P_3 \times P_5$, $P_3 \times P_5$, $P_3 \times P_4$, $P_3 \times P_7$, $P_1 \times P_3$, $P_7 \times P_8$, $P_2 \times P_9$, $P_3 \times P_{10}$, $P_1 \times P_2$, $P_8 \times P_9$, $P_1 \times P_9$ and $P_3 \times P_9$ produced significantly higher yield (Table 1). Among the significant crosses for fruit yield per plant, crosses P_2 x P_8 and P_2 x P_3, which were the top two crosses, also showed superiority for fruit diameter and number of nodes per plant along with perfect fruit shape with medium and small fruit length, respectively.

Heterosis

Exploitation of heterosis in cultivated plants is one of the most important accomplishments of the science of genetics in agricultural practices. The exploitation of heterosis requires an intensive evaluation of germplasm to find diverse donors with high nicking of genes and further identification of heterotic crosses. The results of heterosis obtained (Table 1) and the range of mean values of parents, F_1 hybrids and range of heterosis indicating the three best F_1 hybrids and the three most heterotic crosses concerning of the 18 economic characters (Table 1) have been discussed.

The nature and magnitude of heterosis differed for different traits in various hybrid combinations. A close examination of heterosis values of the five maturity traits viz., days to first and 50% flowering, node at which first flower appears and days to edible fruit maturity and number of branches per plant (Table 1), revealed that only a few F_1 hybrids exhibited a significant but very low level of heterosis in desirable direction for all these characters. For maturity traits, negative heterosis is usually desirable, because this causes the hybrids to produce first fruits earlier as compared to parents, thereby increasing the productivity per day per unit area. The best performing F_1 hybrid regarding earliness based on performance over the better parent was $P_5 \times P_6$ (-15.71) for days to first flowering and $P_5 \times P_7$ (-15.72) for days to 50% flowering, $P_1 \times P_{10}$ (-13.02) for node at first flower appear, $P_5 \times P_7$ (3.47) for days to edible fruit maturity and Kashi Pragati × Varsha Upahar (24.62) for number of branches per plant (Table1). However, significant heterobeltiosis was estimated for all the maturity traits in a desirable direction and had also been reported by previous workers (Bhatt et al., 2016; Tiwari et al., 2015; Jagan et al., 2013; Ashwini et al., 2013; Reddy et al., 2013; Medagam et al., 2012 & Patel et al., 2010). Our study further revealed that either of the three early parents P_7, P_8 and P_9 or any two of them, were invariably involved as parents in the three ranking F_1 hybrids over the better parents for all the five maturity traits. This is because the maturity traits approach to that of earlier parents. It may, therefore, safely be concluded that either of the three best parents (Varsha Upahar (P_7) or Akola Bahar (P_8) and Phule Vimukta (P_9) or any two of them may be a better choice in any heterosis breeding program intended to breed early hybrids. The present results confirm the findings of Rani & Veeragavatham (2013).

Heterobeltiosis over rest of the economic traits was also observed, i.e., number of fruits per plant, fruit weight (g), fruit length, fruit diameter, number of seeds per fruit, seed weight per fruit, 100-seed weight, seed yield per plant, fruit yield per plant and fruit yield quintal per hectare. High heterosis compared to early maturity traits for these characters has also been reported by (Naphade, 2016; Dabhi et al., 2015 & Joshi & Murugan 2012). Considering the heterosis over better parent, the top ranking F_1 hybrids were Punjab-8 x P_6 for days to first flowering (-15.71), $P_5 \times P_7$ (-15.72) for days to 50% flowering, P_1 x P_{10} (-37.25) for the node at first flower appear, P_5 x P_7 (-13.81) for days to edible fruit maturity, P_8 x P_{10} (2.34) for number of node per plant, $P_2 \times P_5$ (-40.65) for internodal length, $P_2 \times P_7$ (24.62) for number of branches per plant, $P_2 \times P_9$ (-33.14) for plant height, $P_6 \times P_8$ (45.68) for number of fruit per plant, $P_5 \times P_7$ (123.78) for fruit weight, $P_4 \times P_6$ (23.00) for fruit length, $P_7 \times P_9$ (-30.06) fruit diameter, $P_1 \times P_{10}$ (10.74) for number of seed per plant, $P_3 \times P_6$ (34.14) seed weigh per fruit, $P_3 \times P_6$ (56.11) for 100-Seed weight, $P_4 \times P_{10}$ (29.51) for seed yield per plant, $P_2 \times P_{10}$ (21.42) for fruit yield per plant and $P_2 \times P_{10}$ (21.00) for fruit yield quintal per hectare (Table 2.3). The number of fruits per plant is one of the most important components of fruit yield, with respect of which hybrids with positive heterosis are desirable. The findings of the present study revealed that the nine crosses $P_6 \times P_8$, $P_9 \times P_{10}$, $P_5 \times P_6$, $P_6 \times P_{10}$, $P_8 \times P_{10}$, $P_3 \times P_8$, $P_4 \times P_7$, $P_2 \times P_7$ and $P_2 \times P_5$ expressed significant heterosis in desirable direction over better parent (Table 1). The highest heterosis for the number of fruits per plant was recorded by the cross $P_6 \times P_8$ followed by $P_9 \times P_{10}$ and $P_5 \times P_6$ over better parent (Table 1). In general, the hybrids with significant heterosis for yield also expressed significant heterosis either for fruit weight or for fruits per plant. The work of (Patel et al., 2010; Wammanda et al., 2010; Dhabi et al., 2010; Bhatt et al., 2016 & Tiwari et al., 2015) are also in close agreement with this finding.

Fruit yield per plant is a complex trait and is a multiplicative product of several basic component traits of yield. The improvement in heterosis for yield components may not necessarily be reflected in increased yield. Contrarily the increased fruit yield will definitely be because of an increase in one or more component traits. In the present study, the top-performing F_1 hybrids for yield also showed significant heterosis either for fruit weight or fruits per plant, along with some other yield component traits. Likewise, crosses showing heterosis for other yield components did not necessarily show heterosis for fruit yield. This showed that heterosis depends upon nicking for genes. Similar results have also been reported by (Chowdhury & Kumar 2019 & Tiwari et al., 2015).

The above finding indicated that some inbred has strong heterotic capability compared to other ones during the hybridization process. This may be due to diverse parents and favourable cross combination. As the performance of hybrids developed upon the heterotic capability of the parents involved, from an economic point of view it will be useful to select and utilize the parental inbreds with strong heterotic capability for important traits associated with yield to achieve higher fruit yield in F_1 hybrids through the exploitation of heterosis. Since earliness and desirable fruit diameter are the important considerations for the choice of elite high-yielding F_1 hybrids, the decision for final selection of a hybrid for commercial cultivation should also consider the earlier two factors i.e. earliness and fruit diameter trait, along with the latter i.e. high fruit yield. Out of the forty-five ranking hybrids based on fruit yield per plant, the three best hybrids were $P_2 \times P_{10}$, $P_2 \times P_8$ and $P_6 \times P_7$ which exhibited high heterobeltiosis of 21.42, 18.47 and 15.91%, respectively (Table 1). The two top hybrids ($P_2 \times P_{10}$ and $P_2 \times P_8$) also possessed good fruit length and were suitable for market demand. Thus, for high fruit yield and high number of fruits cross P_2 x P_8, medium fruit length was considered the best based on market demand.

Conclusion

It is concluded that the cross $P_2 \times P_{10}$ (21.42%) was found to be the most promising for fruit yield and other desirable traits. The crosses also showed high heterosis over better parents for fruit yield $P_2 \times P_8$ (18.47%) and number of fruits per plant $P_6 \times P_8$ (42.68), respectively. It is also indicated that the high degree of non-additive gene action for all the component traits observed in this study favors hybrid breeding in okra. So, it can be identified as the potential okra hybrid combination for commercial exploitation and after further evaluation, it can come under cultivation in the Bundelkhand area for the *Kharif* season.

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सारांश

सब्जी अनुसंधान फार्म, सब्जी विज्ञान विभाग, बांदा कृशि एवं प्रौद्योगिकी विष्वविद्यालय, बांदा, उत्तर प्रदेष में 2020 के गर्मी और बरसात के मौसम के दौरान 10 विविध पैतृक किस्मों अर्थात अर्का अनामिका (पी1), काशी प्रगति (पी2), हिसार नवीन (पी3), हिसार उन्नत (पी4), पंजाब-8 (पी5), पूसा-ए-4 (पी6) और वर्शा उपहार (पी7), अकोला बहार (पी8), फुले विमुक्त (पी9) और पंजाब सुहावनी (पी10) और इसके पैतालिस (संकर) को अर्ध-डायएलिल मेटिंग डिजाइन के माध्यम से विकसित किया गया, जिसका उद्देष्य भिंडी में उपज और इसके घटक लक्षणों के लिए हेटेरोसिस की क्षमता का अनुमान लगाना है। बेहतर माता-पिता की तुलना में तीन क्रॉस के लिए हेटेरोसिस की सीमा सबसे अच्छी पाई गई, जो कि क्रमषः पी2 × पी10 (21.42 प्रतिशत), पी2 × पी8 (18.47 प्रतिशत) और पी6 × पी7 (15.91 प्रतिशत) थी। इस शोध के माध्यम से प्रति पौधा फल का उपज और प्रति हेक्टेयर उपज के लिए हेटेरोसिस प्रजनन के माध्यम से भिंडी में उच्च उपज प्राप्त करने की बड़ी गुंजाइष का सुझाव दिया गया। अन्य आर्थिक लक्षणों में भी बेहतर माता-पिता की तुलना में मध्यम से उच्च स्तर की विशमता दर्ज की गई। लगभग सभी वांछित विकास विषेशताओं के साथ-साथ उपज-विषेशता विषेशताओं के लिए हेटेरोबेल्टिओसिस और मानक हेटेरोसिस की उच्चतम परिमाण, जिसे आगे प्रजनन कार्यक्रमों पर लागू किया जा सकता है, अंततः इस विषेश क्रॉस संयोजन द्वारा विषेश रूप से उत्तर प्रदेश के बुंदेलखण्ड भागों में भिन्डीं की संकर प्रजाति प्राप्त करने के लिए किया गया था।