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Avinash Rathod
Assistant Breeder, QSP Farm Khanapur A, VNMKV, Parbhani, Maharashtra, India

SB Borgaonkar
Cotton Breeder, Cotton Research Station, MB Farm, VNMKV, Parbhani, Maharashtra, India

DK Zate
Associate Professor, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

AM Misal
Assistant Professor, College of Agriculture, Latur, Maharashtra, India

KD Dadmal
Ph.D. Scholar, Department of Agril Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Avinash Rathod
Assistant Breeder, QSP Farm Khanapur A, VNMKV, Parbhani, Maharashtra, India

Combining ability studies for yield and its components in okra (*Abelmoschus esculentus* L. Moench)

Avinash Rathod[1], SB Borgaonkar[2], DK Zate[3], AM Misal[4], KD Dadmal[5]

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Abstract
The present investigation, " Combining ability studies for yield and its components in okra [*Abelmoschus esculentus* (L.) Moench], "was conducted during Summer 2026 at Quality seed production farm Khanapur A block, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Six diverse parents IC-10256A, EC-305612, EC-305672, IC-4507, IC-3769 and IC-7472 were crossed in a diallel mating design (without reciprocals) to produce 15 F_1 hybrids. The experiment consists of 24 genotypes (6 parents, 15 F_1s and 3 checks: Parbhani Kranti, Radhika and *Pusa* Sawani) were evaluated in RBD with two replications. Observations were recorded for 13 characters: days 50% to flowering, plant height, internodal length, number of nodes/plant, number of branches/plant, number of ridges/fruit, fruit length, fruit diameter, number of fruits/plant, fruit weight, fruit yield/plant and shoot borer severity. Analysis of variance revealed highly significant differences among the genotypes for all the traits, confirming ample genetic variability. Diallel analysis showed significant parent and cross differences for all characters; parent vs. cross contrast was significant except for internodal length and fruit diameter. The parents EC-305612, EC-305672, and IC-3769 were found to be good general combiners from the investigation of general combining ability because they showed significant GCA effects in the desired direction for the majority of the characters, such as plant height, number of branches per plant, fruit length, fruit diameter, fruit weight, and fruit yield per plant. The parent IC-7472 was the best general combiner for earliness (days to 50% flowering), while IC-10256A was a good general combiner for fruit length and IC-3769 for reduced fruit borer severity. For specific combining ability, the cross combinations EC-305612 × EC-305672, IC-10256A × EC-305672, EC-305612 × IC-3769, EC-305612 × IC-7472, EC-305672 × IC-4507, and IC-4507 × IC-7472 were found superior for most of the traits. These crosses deserve due consideration for their further exploitation as commercial hybrids as they produced higher fruit yield and showed significant SCA effects.

Keywords: General combining ability, Specific combining ability, Diallel mating, Non additive gene effects

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is a popular vegetable all over the world. Okra is an amphidiploids having $2n = 130$ chromosomes. It is an often cross pollinated crop. Immature fresh and green seed pods are consumed as vegetable. New cultivars of the okra have been developed by okra breeders across the country. However, they possess one or the other demerits. The improvement in okra needs attention for the characters like more plant height, early flowering, more branches, fruit length, slender fruits, more number of fruits, high yield and disease and pest resistance. Understanding the nature of gene action governing the expression of various traits could be helpful in predicting the effectiveness of selection. The efficient partitioning of the genetic variances into its components namely additive, dominance and their interactions will help in formulating an effective and sound breeding programme. The cases where hybrid seed cost is of greater importance in such cases, the use of additive gene effects of parents could be used to retain the vigour in subsequent generations. And after all, using these methods to develop variety or to exploit hybrid vigour, the breeding material should perform consistently and for that, adaptability of the material is an important factor. It is grown extensively across tropical and subtropical regions, particularly in India, West Africa, Brazil, South-East Asia, and the southern United States, where it forms an integral part of daily diets and local cuisines (Siemonsma, 1982) [1]. Okra is known by different names across the world, reflecting its cultural importance viz; “Bhindi” in India, “Lady’s finger” in England, and “Gumbo” in the United States (Lim, 2012) [2]. Immature fresh green pods are usually consumed as a cooked vegetable, prepared in stir-fries, curries, stews, and mixed dishes, where their characteristic mucilaginous texture helps thicken gravies and soups (Hadiya *et al*., 2018) [3]. The pods are also pickled, canned or dehydrated, expanding their culinary use and shelf life and creating scope for small-scale processing enterprises (Gemede *et al*., 2015) [

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4]. Traditional uses extend beyond the pods. In parts of India, the root and stem are used to clarify sugarcane juice during jaggery preparation (Gopalakrishnan, 2007) [5]. Seeds have been used as a coffee substitute and as a minor source of edible oil and protein in resource poor settings (Lim, 2012) [2]. Nutritionally, Okra is a low-calorie vegetable rich in water, dietary fibre, vitamins and minerals, therefore contributes meaningfully to balanced diets. Fresh pods typically contain around 88–90% moisture, 7–8% carbohydrates, about 2% protein and negligible fat, along with small amounts of fibre and mineral matter. Okra provides calcium, phosphorus and iron, and is a good source of vitamin C, vitamin K, thiamine, riboflavin, niacin and folate, making it particularly valuable in regions where animal-source foods are scarce or unaffordable (Sugani Devi *et al*., 2017) [6]. In Ayurveda and other traditional systems of medicine, Okra is widely recognized for its soothing, protective and diuretic properties. Pod mucilage is used as an edible infusion in conditions associated with irritation or inflammation of the gastrointestinal tract, kidneys and urinary system, including dysentery, diarrhea, ardor urinae and dysuria (Maramag, 2013; Lim, 2012) [7, 2]. The selection of parents is based on general combing ability effects and hybrids on specific combining ability effects (Griffing, 1956) [8]. The proposed research study was aimed at general combining ability of parents and specific combining ability of crosses in Okra, which will help in the identification of a superior okra hybrids.

Material and Method

The present investigation was undertaken to study "Combining ability studies for yield and yield component traits in okra (*Abelmoschus esculentus* (L.) Moench)". The experiment was carried out at Quality Seed Production Unit, Khanapur A Block, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during Summer 2026. The experimental material consisted of six diverse okra genotypes (parents) and fifteen F_1 hybrids developed from these parents in a diallel mating system (without reciprocals), along with three checks. These 24 genotypes (6 parents, 15 F_1s and 3 check) were evaluated to study combining ability for yield and its component traits in okra. The inbred lines of the six parental genotypes were raised in a crossing block at BSP Unit, College of Agriculture, Parbhani, for the purpose of diallel hybridization. Recommended doses of fertilizers and plant protection measures were applied to ensure healthy and uniform plant growth. Observations were recorded for 13 characters: days 50% to flowering, plant height, internodal length, number of nodes/plant, number of branches/plant, number of ridges/fruit, fruit length, fruit diameter, number of fruits/plant, fruit weight, fruit yield/plant, YVMV incidence and fruit and shoot borer severity. Seeds of parents, F_1 hybrids and check were sown manually on well prepared ridges and furrows, maintaining the planned spacing and plot size. Standard agronomic practices viz., irrigation, weeding, hoeing, thinning and plant protection were carried out uniformly for all treatments to raise a healthy and uniform crop stand. Five plants were randomly selected from each plot (excluding border plants) and tagged for recording observations. The experiment was laid out in a Randomized Block Design (RBD) with two replications at QSP Unit, Khanapur A Block, VNMKV, Parbhani. The ANOVA was carried out following the standard procedure described by Panse *et al.* (1985) [9]. . The combining ability analysis was carried out to isolate superior parents having good general combining ability effects and best specific crosses combinations with highly significant and desirable specific combining ability effects. The combining ability analysis was carried out according to Griffing's (1956) [8] Method II, Model I, which was found suitable for the material used in the present investigation.

Results and Discussion

The results are obtained from conducting diallel cross using six parents, fifteen F_1 hybrids and three standard checks for thirteen fruit yield and attributing characters. The characters comprised viz; Days to 50% flowering, plant height, internodal length, number of nodes per plant, number of branches per plant, number of ridges per fruit, fruit length, fruit diameter, number of fruits per plant, fruit weight, fruit yield per plant and fruit borer severity.

The mean sum of squares due to general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the characters studied. The data is presented in Table No. 1 and Table No. 2 respectively. This indicates that both additive and non-additive genetic effects contributed to trait expression, although their relative magnitudes differed among characters. The results use in accordance with the report of Verma & Sood, 2020; Singh *et al.*, 2021 [10]; Nanthakumar *et al.*, 2021 [11]; Yadav *et al.*, 2023 [12]; Adedoyin *et al.*, 2024 [13]; Pathania *et al.*, 2024 [14]; Patel *et al.*, 2025 [15]; Shweta & Sood, 2025.

1. General combining ability

The GCA effects of the six parents are presented in Table 2. The desirability of the sign was interpreted according to the breeding objective for each character, and the trait-wise results are discussed separately below.

1.1 Days to 50% flowering

The GCA effects ranged from -2.229 to 2.646. The parent IC-7472 (-2.229) was found best general combiner for earliness, followed by IC-3769 (-1.229) and IC-4507 (-1.104); these parents were found highly significant and desirable for earliness. Singh *et al.* (2021) [10] and Kumar *et al.* (2025) [16] likewise reported significant GCA effects for flowering and other yield-related characters in okra.

1.2 Plant height (cm)

The GCA effects for plant height ranged from -7.382 to 8.742. The parent EC-305612 was found best general combiner for plant height with a highly significant GCA effect of 8.742, followed by EC-305672 (3.373) and IC-3769 (2.618). Amaranatha Reddy and Sridevi (2018) [17] also found significant general combining ability affects for plant stature in diallel-derived okra material.

1.3 Internodal length (cm)

The GCA effects for internodal length varied from -0.274 to 0.281. The parents EC-305612 (-0.274), EC-305672 (-0.257) and IC-10256A (-0.144) recorded significant parents in the desirable negative direction. Keerthana *et al.* (2024) [18] reported that internodal length may receive both additive and non-additive genetic contributions, depending on the parental material.

1.4 Number of nodes per plant

The GCA effects number of nodes per plant ranged from -0.641 to 0.910. The parent EC-305612 was found best general combiner (0.910), followed by EC-305672 (0.329) the GCA effects were found highly significant and positive for number of nodes per plant. Yadav *et al.* (2023) [12] identified parents with favourable GCA for nodal and yield attributes, supporting selection of good general combiners.

1.5 Number of branches per plant

The GCA effects for number of branches per plant ranged from -0.345 to 0.262. The parents EC-305612 (0.262), EC-305672 (0.217) and IC-3769 (0.057) displayed significant positive GCA effects. Pathania *et al.* (2024) [14] identified significant additive parental contributions for branching and related growth traits in okra.

1.6 Number of ridges per fruit

The GCA effect for Number of ridges per fruit ranged from -0.352 to 0.181. The parent EC-305612 (0.181), IC-4507 (0.141) and IC-3769 (0.096) significant positive general combining ability effects for ridges per fruit. Shweta and Sood (2025) also detected significant parental combining-ability differences for fruit morphological characters.

1.7 Fruit length (cm)

The GCA effects for fruit length ranged from -1.070 to 0.715. The parent IC-10256A (0.715) was found best general combiner, for fruit length followed by EC-305612 (0.669), IC-3769 (0.385) and EC-

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305672 (0.333); significant and positive GCA effects for fruit length. Keerthana *et al.* (2024) [18] found significant GCA for fruit length, confirming exploitable additive parental effects.

1.8 Fruit diameter (cm)

The GCA effects fruit diameter ranged from -0.090 to 0.096. EC-305612 was found general combiner (0.096), followed by IC-10256A (0.057) and IC-3769 (0.013); these parents a significant positive GCA effect. Akotkar *et al.* (2025a) [19] identified significant GCA for fruit dimensions in their recent combining-ability investigation.

1.9 Number of fruits per plant

The GCA for effects Number of fruits per plant ranged from -1.265 to 1.081. The parents EC-305612 (1.081), EC-305672 (0.771), IC-3769 (0.135) and IC-10256A (0.047) were found to record highly significant and positive general combining effect for Number of fruits per plant. Pathania *et al.* (2024) [14] also identified parents with strong general combining ability effect for fruit number and total yield.

1.10 Fruit weight (g)

The GCA effects for fruit weight ranged from -0.730 to 0.987. The parents EC-305612 (0.987), IC-4507 (0.580) and EC-305672 (0.393) recorded significant and positive GCA effect for fruit weight. Shweta and Sood (2025) identified significant parental effects for fruit weight in line × tester material.

1.11 Fruit yield per plant (g)

The GCA effects for fruit yield ranged from -22.620 to 19.015. The parent EC-305612 was best general combiner with GCA effect of 19.015, followed by EC-305672 (12.462) and IC-3769 (8.319) these parents were good general combiners for fruit yield per plant. Yadav *et al.* (2023) [12], Keerthana *et al.* (2024) [18] and Akotkar *et al.* (2025a) [19] similarly identified good general combiners for fruit yield and its components.

1.12 Fruit and shoot borer severity (%)

The GCA effects ranged from -0.534 to 0.611. The parents IC-3769 (-0.534), EC-305612 (-0.474) and IC-4507 (-0.339) recorded highly significant and negative general combing ability effects for fruit and shoot borer in desirable selection. The parental differences agree with field-screening evidence reported by Barot *et al.* (2024) [20], who identified variation in borer susceptibility among okra genotypes.

2 Specific combining ability

The SCA effects of the fifteen F_1 Okra hybrids are presented in Table 4.10 (a) and 4.10 (b). Highly significant SCA revealed that a specific parental combination performed beyond expectation based on average parental combining ability. The specific combining ability effect of different characters is discussed below.

2.1 Days to 50% flowering

The SCA effects for Days to 50% flowering ranged from -5.964 to 5.911. Six hybrids recorded significant and negative SCA effects. The hybrid EC-305612 × IC-7472 was found best specific combination (-5.964), followed by EC-305672 × IC-3769 (-3.964) and IC-4507 × IC-3769 (-2.214). Shwetha *et al.* (2018) [21] found substantial specific combining ability for earliness, supporting the use of parental combinations rather than parental performance alone.

2.2 Plant height (cm)

SCA effect for plant height ranged from -29.444 to 29.724. Eight hybrids showed significant positive SCA effects for plant height. The hybrid IC-10256A × EC-305672 was best specific combination (29.724), followed by EC-305612 × EC-305672 (21.420) and IC-3769 × IC-7472 (13.560). Adedoyin *et al.* (2024) [13] reported significant specific combining ability effects for plant architecture and yield components, indicating important non-additive contributions.

2.3 Internodal length (cm)

The SCA effects for internodal length ranged from -1.078 to 1.199. Nine crosses had exhibited significant negative SCA effects. For Internodal length the hybrid EC-305612 × IC-3769 was found best specific combiner for internodal lenght (-1.078), followed by IC-10256A × IC-7472 (-0.781) and IC-10256A × EC-305672 (-0.473). Patel *et al.* (2025) [15] demonstrated that specific combining ability for architectural traits can vary across environments, indicating the need for further stability testing.

2.4 Number of nodes per plant

The SCA effects for Number of nodes per plant varied from -1.289 to 2.341, Nine crosses recorded significant positive SCA effects. The hybrid IC-10256A × EC-305672 was best specific combination (2.341), followed by EC-305612 × EC-305672 (1.731) and IC-10256A × EC-305612 (1.149). Nanthakumar *et al.* (2021) [11] similarly observed significant positive SCA effects for nodes and associated yield characters.

2.5 Number of branches per plant

The SCA effects Number of branches per plant ranged from -0.873 to 0.640. Nine hybrids showed significant positive effects for Number of branches per plant. The hybrid IC-10256A × EC-305672 was best specific combination (0.640), followed by IC-3769 × IC-7472 (0.577) and EC-305612 × EC-305672 (0.535). Ranga *et al.* (2024) [22] also recorded highly significant SCA effects for branching and other yield components.

2.6 Number of ridges per fruit

The SCA effects for Number of ridges per fruit ranged from -0.700 to 1.137, with eight hybrids showing significant positive effects. EC-305612 × IC-7472 ranked first (1.137), followed by IC-4507 × IC-3769 (0.851) and EC-305672 × IC-7472 (0.750). Adedoyin *et al.* (2024) [13] attributed strong cross-specific responses in fruit traits to the importance of non-additive gene effects.

2.7 Fruit length (cm)

The SCA effects for fruit length ranged from -3.767 to 2.729. Ten hybrids showed significant positive SCA effects. The hybrid EC-305672 × IC-4507 was the best specific combiner (2.729), followed by IC-10256A × IC-7472 (2.679) and IC-10256A × IC-3769 (2.156) Kumar *et al.* (2025) [16] likewise reported strong SCA effects for fruit dimensions and yield components.

2.8 Fruit diameter (cm)

The SCA effects for fruit diameter ranged from -0.240 to 0.157. Seven hybrids exhibited significant positive SCA effect for fruit diameter. The hybrid EC-305612 × EC-305672 ranked first (0.157) for SCA effect for fruit diameter highly significant and positive, followed by IC-3769 × IC-7472 (0.148) and IC-10256A × EC-305672 (0.147). Singh *et al.* (2021) [10] similarly observed cross-specific effects for fruit diameter and other marketable-yield components.

2.9 Number of fruits per plant

The SCA effects for Number of fruits per plant varied from -4.259 to 3.173. Ten hybrids recorded significant positive SCA effects. The hybrid IC-10256A × EC-305672 recorded highly significant and positive SCA effects for Number of fruits per plant (3.173), followed by the hybrids EC-305612 × EC-305672 (2.739) and IC-3769 × IC-7472 (2.386). Ranga *et al.* (2024) [22] similarly reported important non-additive effects and high SCA for number of fruits per plant.

2.10 Fruit weight (g)

The SCA effects for fruit weight ranged from -2.085 to 4.802. Six hybrids recorded significant positive effect for fruit weight. The hybrid IC-4507 × IC-7472 was found best specific combination (4.802) for fruit weight, followed by IC-4507 × IC-3769 (2.974) and IC-10256A × EC-305672 (2.723). Adedoyin *et al.* (2024) [13] similarly reported strong SCA for fruit weight and related yield components.

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2.11 Fruit yield per plant (g)

The SCA effects for Fruit yield per plant ranged from -58.774 to 47.901. Six crosses had significant and positive SCA effect for Fruit yield per plant. The hybrid IC-10256A × EC-305672 was the best specific combination for Fruit yield per plant (47.901), followed by the hybrids EC-305612 × EC-305672 (43.494) and IC-3769 × IC-7472 (24.978) Patel *et al.* (2025) [15] and Kumar *et al.* (2025) [16] reported strong cross-specific effects for fruit yield, reinforcing the value of testing particular hybrid combinations across environments.

2.12 Fruit and shoot borer severity (%)

The SCA effects for Fruit and shoot borer severity ranged from -4.889 to 4.886. Nine crosses recorded significant and negative values. The hybrid IC-10256A × EC-305672 was the best specific combiner (-4.889), followed by IC-4507 × IC-7472 (-4.406) and EC-305612 × EC-305672 (-3.169). These cross-specific reductions support genetic exploitation of borer tolerance, although Nagre *et al.* (2025) [23] showed that crop protection remains necessary under substantial pest pressure.

Conclusion

The five best hybrids with significant SCA effects is positive selection for different characters are presented. The hybrids IC-10256A × EC-305672 was found best for six characters, EC-305612 × EC-305672 was consistently favorable for yield and yield components, EC-305612 × IC-3769 was the best for shorter internodes, EC-305612 × IC-7472 was best for earliness and ridges, IC-4507 × IC-7472 was best for fruit weight and lower YVMV incidence and EC-305672 × IC-4507 was best for fruit length. The crosses with good specific combining ability effects had parents with Medium X High, High x Low, Low x High and medium x Low general combining ability effects. These combinations should therefore be prioritized for fruit yield improvement according to objective of breeding progression: Direct hybrid evaluation of non-additive traits whereas selection from segregating generations where favorable additive similar trends was reported in Okra by Singh *et al.*, 2021 [10]; Yadav *et al.*, 2023 [12]; Ranga *et al.*, 2024 [22]; Pathania *et al.*, 2024 [14]; Kumar *et al.*, 2025 [16]. Across characters, the hybrid IC-10256A × EC-305672 was the best specific combination for plant height, number of nodes, number of branches, number of fruits, fruit yield and fruit borer severity. The hybrid EC-305612 × IC-7472 was found best for earliness and number of ridges, EC-305612 × IC-3769 for shorter internodes, EC-305672 × IC-4507 for fruit length, EC-305612 × EC-305672 for fruit diameter, IC-4507 × IC-7472 for fruit weight and reduced YVMV incidence. Verma and Sood (2020), Nanthakumar *et al.* (2021) [11] and Pathania *et al.* (2024) [14] also found similar results where the best specific combination changed with the character under selection.

Table 1. Analysis of variance for different characters in the diallel set of okra

Source	d.f.	DF	PH	IL	NON	NBPP	NOR
Treatment	20	32.595**	608.498**	0.979**	3.403**	0.624**	0.741**
Parent	5	32.133**	453.667**	1.121**	2.388**	0.528**	0.208**
Crosses	14	32.800**	704.502**	0.998**	3.702**	0.692**	0.771**
P × C	1	32.038**	38.602**	0.001	4.296**	0.138**	2.992**
Error	20	0.395	4.561	0.001	0.002	0.001	0.001
Source	**d.f.**	**FD**	**NFPP**	**FWT**	**FYPP**	**FL**	**FSB**
Treatment	20	0.048**	11.112**	9.925**	2335.171**	9.649**	17.091**
Parent	5	0.041**	6.437**	5.220**	2944.725**	6.419**	11.210**
Crosses	14	0.054**	13.496**	9.236**	2127.246**	9.935**	18.054**
P × C	1	0.002	1.098**	43.104**	2198.356**	21.801**	33.005**
Error	20	0.001	0.001	0.124	20.421	0.017	0.023

*,** Significant at 5% and 1% respectively

Table 2. Analysis of variance for combining ability in the diallel set of okra

Source	d.f.	DF	PH	IL	NON	NBPP	NOR	FL
GCA	5	27.970**	297.523**	0.510**	2.471**	0.410**	0.008**	5.487**
SCA	15	12.406**	306.490**	0.482**	1.445**	0.279**	0.009**	4.603**
Error	20	0.197	2.280	0.001	0.001	0.001	0.028	0.008

*,** Significant at 5% and 1% respectively

DF- Days to 50% Flowering, PH- Plant height (cm), IL- Internodal length (cm), NON- Number of nodes per plant, NBPP- Number of branches per plant, NOR- Number of ridges per fruit, FL- Fruit length (cm), FD- Fruit diameter, NFPP- Number of fruits per plant, FWT- Fruit weight (g), FYPP- Fruit yield per plant (g), YMV- Yellow Mosaic Virus, FSB- Fruit and Shoot borer severity.

Table 3. Analysis of variance for combining ability in the diallel set of okra

Source	d.f.	FD	NFPP	FWT	FYPP	YMV	FSB
GCA	5	0.044**	6.356**	4.433**	2003.258**	13.283**	26.692**
SCA	15	0.017**	5.289**	5.139**	889.028**	5.213**	12.421**
Error	20	0.001	0.001	0.062	10.210	9.336	7.336

*,** Significant at 5% and 1% respectively

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Table 4. General combining ability effects of parents for different characters in okra

Sr. No.	Parents	DF	PH	IL	NON	NBPP	NOR	FL
1	IC-10256A	0.271	-1.462 **	-0.144 **	-0.250 **	-0.078 **	0.058	0.715 **
2	EC-305612	2.646 **	8.742 **	-0.274 **	0.910 **	0.262 **	-0.017	0.669 **
3	EC-305672	1.646 **	3.373 **	-0.257 **	0.329 **	0.217 **	-0.017	0.333 **
4	IC-4507	-1.104 **	-5.888 **	0.199 **	-0.367 **	-0.113 **	-0.029	-1.070 **
5	IC-3769	-1.229 **	2.618 **	0.281 **	0.019	0.057 **	0.021	0.385 **
6	IC-7472	-2.229 **	-7.382 **	0.195 **	-0.641 **	-0.345 **	-0.017	-1.032 **
	S.E. (gi) ±	0.145	0.487	0.008	0.010	0.008	0.010	0.030
	C.D. at 5%	0.369	1.253	0.020	0.027	0.021	0.025	0.077

Sr. No.	Parents	FD	NFPP	FWT	FYPP	YMV	FSB
1	IC-10256A	0.057 **	0.047 **	-0.529 **	-10.427 **	0.896	0.729
2	EC-305612	0.096 **	1.081 **	0.987 **	19.015 **	-0.667	-2.708**
3	EC-305672	0.009	0.771 **	0.393 **	12.462 **	-1.292	-0.208
4	IC-4507	-0.090 **	-0.769 **	0.580 **	-6.749 **	-0.229	1.042
5	IC-3769	0.013 *	0.135 **	-0.702 **	8.319 **	-0.854	-1.302
6	IC-7472	-0.084 **	-1.265 **	-0.730 **	-22.620 **	2.146*	2.448**
	S.E. (gi) ±	0.006	0.009	0.081	1.031	0.011	0.035
	C.D. at 5%	0.014	0.024	0.207	2.651	0.029	0.089

*,** Significant at 5% and 1% respectively

DF- Days to 50% Flowering, PH- Plant height (cm), IL- Internodal length (cm), NON- Number of nodes per plant, NBPP- Number of branches per plant, NOR- Number of ridges per fruit, FL- Fruit length (cm), FD- Fruit diameter, NFPP- Number of fruits per plant, FWT- Fruit weight (g), FYPP- Fruit yield per plant (g), YMV- Yellow Mosaic Virus, FSB- Fruit and Shoot borer severity.

Table 5. Specific combining ability effects of hybrids for different characters in the diallel set of okra

Cross	DF	PH	IL	NON	NBPP	NOR	FL
IC-10256A × EC-305612	-1.464 **	4.231 **	-0.097 **	1.149 **	0.321 **	0.096	-0.337 **
IC-10256A × EC-305672	4.536 **	29.724 **	-0.473 **	2.341 **	0.640 **	0.096	0.328 **
IC-10256A × IC-4507	3.286 **	10.865 **	0.380 **	0.086 **	0.420 **	0.009	2.062 **
IC-10256A × IC-3769	-1.589 **	-14.700 **	0.343 **	-0.800 **	-0.839 **	0.059	2.156 **
IC-10256A × IC-7472	3.411 **	2.490	-0.781 **	0.086 **	0.187 **	-0.104	2.679 **
EC-305612 × EC-305672	3.161 **	21.420 **	-0.184 **	1.731 **	0.535 **	-0.029	1.439 **
EC-305612 × IC-4507	0.911 *	8.441 **	1.064 **	0.476 **	0.195 **	-0.016	1.113 **
EC-305612 × IC-3769	3.036 **	9.651 **	-1.078 **	0.280 **	0.311 **	-0.066	0.702 **
EC-305612 × IC-7472	-5.964 **	-29.444 **	1.199 **	-0.844 **	-0.873 **	0.071	-0.995 **
EC-305672 × IC-4507	1.411 **	-10.486 **	0.553 **	0.482 **	0.039	-0.016	2.729 **
EC-305672 × IC-3769	-3.964 **	-24.426 **	-0.049 *	-1.289 **	-0.610 **	0.2339*	-3.767 **
EC-305672 × IC-7472	-1.464 **	0.499	-0.448 **	-0.328 **	0.106 **	-0.029	1.111 **
IC-4507 × IC-3769	-2.214 **	-16.765 **	0.274 **	-0.768 **	-0.500 **	-0.054	-1.008 **
IC-4507 × IC-7472	-0.714	4.035 **	-0.424 **	0.017	0.036	0.084	-2.641 **
IC-3769 × IC-7472	5.911 **	13.560 **	-0.276 **	0.416 **	0.577 **	0.034	1.264 **
S.E. (sij) ±	0.39405	1.33871	0.02127	0.02882	0.02273	0.02630	0.08178
C.D. at 5%	0.84514	2.87124	0.04563	0.06182	0.04875	0.05642	0.17540

*,** Significant at 5% and 1% respectively

Table 6. Specific combining ability effects of hybrids for different characters in the diallel set of okra

Cross	FD	NFPP	FWT	FYPP	YMV	FSB
IC-10256A × EC-305612	0.009	1.403 **	0.939 **	5.733	-1.170	0.313
IC-10256A × EC-305672	0.147 **	3.173 **	2.723 **	47.901 **	-3.045	-4.6875*
IC-10256A × IC-4507	0.120 **	1.512 **	0.236	23.448 **	-2.857	-3.438
IC-10256A × IC-3769	-0.148 **	-2.041 **	0.118	-23.801 **	2.768	1.406
IC-10256A × IC-7472	0.054 **	0.059 *	0.361	16.269 **	-0.232	0.156
EC-305612 × EC-305672	0.157 **	2.739 **	2.472 **	43.494 **	-2.732	-1.250

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Cross	FD	NFPP	FWT	FYPP	YMV	FSB
EC-305612 × IC-4507	0.061 **	0.099 **	-0.695 **	3.156	-1.295	1.250
EC-305612 × IC-3769	0.083 **	1.296 **	1.122 **	5.823	-1.920	-1.406
EC-305612 × IC-7472	-0.070 **	-3.675 **	-2.085 **	-27.318 **	1.330	3.594
EC-305672 × IC-4507	-0.036 *	0.689 **	-0.841 **	-4.066	1.830	1.250
EC-305672 × IC-3769	-0.240 **	-4.259 **	-1.874 **	-58.774 **	1.205	7.3438**
EC-305672 × IC-7472	0.002	0.150 **	0.039	-8.720 **	1.955	-0.156
IC-4507 × IC-3769	-0.166 **	-1.435 **	2.974 **	23.567 **	-1.357	-6.4062**
IC-4507 × IC-7472	-0.054 **	-0.561 **	4.802 **	-3.054	2.143	2.344
IC-3769 × IC-7472	0.148 **	2.386 **	-0.681 **	24.978 **	-2.232	-2.813
S.E. (sij) ±	0.01517	0.02580	0.22157	2.83247	0.03088	0.09508
C.D. at 5%	0.03253	0.05533	0.47522	6.07502	0.06623	0.20393

*,** Significant at 5% and 1% respectively

DF- Days to 50% Flowering, PH- Plant height (cm), IL- Internodal length (cm), NON- Number of nodes per plant, NBPP- Number of branches per plant, NOR- Number of ridges per fruit, FL- Fruit length (cm), FD- Fruit diameter, NFPP- Number of fruits per plant, FWT- Fruit weight (g), FYPP- Fruit yield per plant (g), YMV- Yellow Mosaic Virus, FSB- Fruit and Shoot borer severity.

Table 7. Five best crosses with specific combining ability effects for different characters in okra

Sr. No.	Character	Best crosses	SCA effect
1	Days to 50% flowering	EC-305612 × IC-7472	-5.964 **
		EC-305672 × IC-3769	-3.964 **
		IC-4507 × IC-3769	-2.214 **
		IC-10256A × IC-3769	-1.589 **
		IC-10256A × EC-305612	-1.464 **
2	Plant height (cm)	IC-10256A × EC-305672	29.724 **
		EC-305612 × EC-305672	21.420 **
		IC-3769 × IC-7472	13.560 **
		IC-10256A × IC-4507	10.865 **
		EC-305612 × IC-3769	9.651 **
3	Internodal length (cm)	EC-305612 × IC-3769	-1.078 **
		IC-10256A × IC-7472	-0.781 **
		IC-10256A × EC-305672	-0.473 **
		EC-305672 × IC-7472	-0.448 **
		IC-4507 × IC-7472	-0.424 **
4	Number of nodes per plant	IC-10256A × EC-305672	2.341 **
		EC-305612 × EC-305672	1.731 **
		IC-10256A × EC-305612	1.149 **
		EC-305672 × IC-4507	0.482 **
		EC-305612 × IC-4507	0.476 **
5	Number of branches per plant	IC-10256A × EC-305672	0.640 **
		IC-3769 × IC-7472	0.577 **
		EC-305612 × EC-305672	0.535 **
		IC-10256A × IC-4507	0.420 **
		IC-10256A × EC-305612	0.321 **
6	Fruit length (cm)	EC-305672 × IC-4507	2.729 **
		IC-10256A × IC-7472	2.679 **
		IC-10256A × IC-3769	2.156 **
		IC-10256A × IC-4507	2.062 **
		EC-305612 × EC-305672	1.439 **
7	Fruit diameter (cm)	EC-305612 × EC-305672	0.157 **
		IC-3769 × IC-7472	0.148 **
		IC-10256A × EC-305672	0.147 **
		IC-10256A × IC-4507	0.120 **
		EC-305612 × IC-3769	0.083 **

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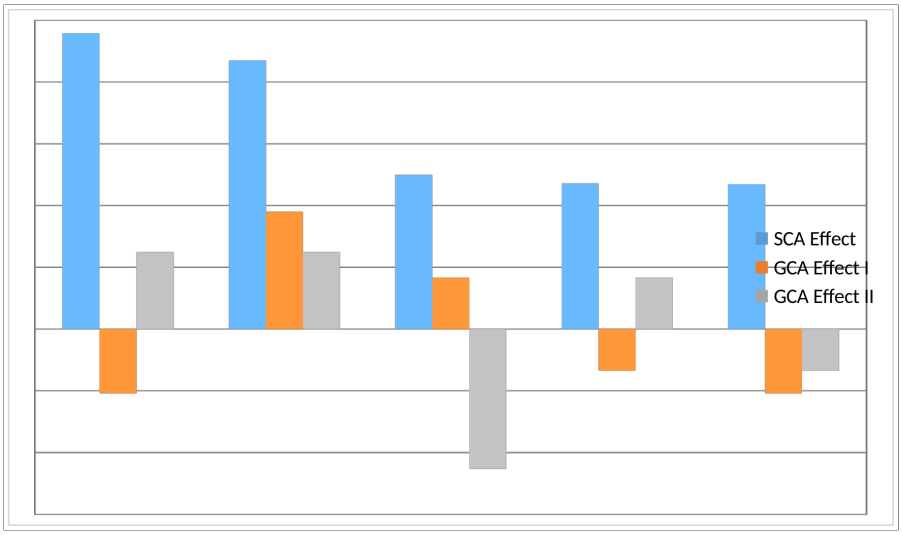
8	**Number of fruits per plant**	**IC-10256A × EC-305672**	**3.173 ****
		EC-305612 × EC-305672	2.739 **
		IC-3769 × IC-7472	2.386 **
		IC-10256A × IC-4507	1.512 **
		IC-10256A × EC-305612	1.403 **
9	Fruit weight (g)	IC-4507 × IC-7472	4.802 **
		IC-4507 × IC-3769	2.974 **
		IC-10256A × EC-305672	2.723 **
		EC-305612 × EC-305672	2.472 **
		EC-305612 × IC-3769	1.122 **
10	Fruit yield per plant (g)	IC-10256A × EC-305672	47.901 **
		EC-305612 × EC-305672	43.494 **
		IC-3769 × IC-7472	24.978 **
		IC-4507 × IC-3769	23.567 **
		IC-10256A × IC-4507	23.448 **
11	Fruit and shoot borer severity (%)	EC-305672 x IC-3769	7.344**
		EC-305612 x IC-7472	3.594
		IC-4507 x IC-7472	2.344
		IC-10256A x IC-3769	1.407
		EC-305672 x IC-4507	1.25

*,** Significant at 5% and 1% respectively

Table 8. Promising crosses for different characters with SCA effects, mean performance and GCA status of parents in okra

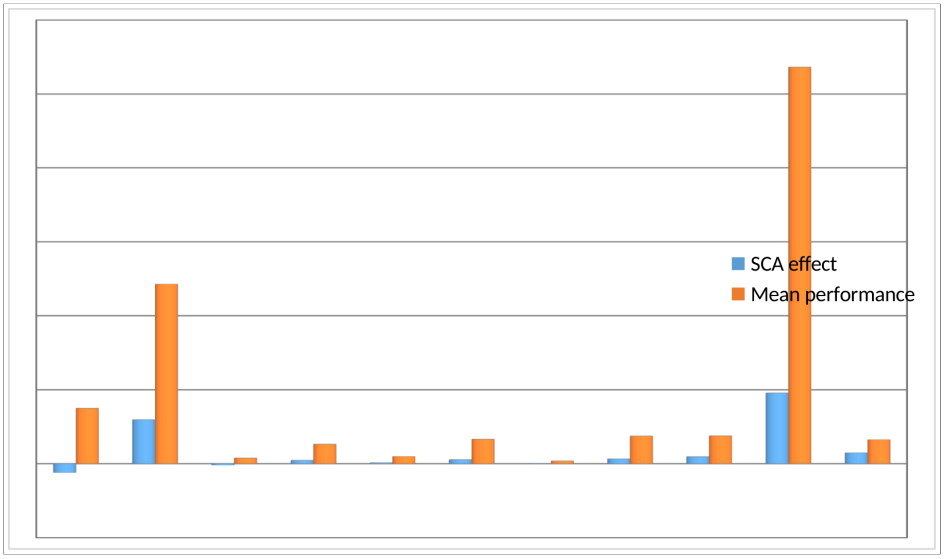
Character	Best specific combiner	SCA effect	Mean performance	GCA status of parents
Days to 50% flowering	EC-305612 × IC-7472	-5.96 **	37.50	Low × High
Plant height (cm)	IC-10256A × EC-305672	29.72 **	121.45	Medium × High
Internodal length (cm)	EC-305612 × IC-3769	-1.07 **	3.77	High × Low
Number of nodes per plant	IC-10256A × EC-305672	2.34 **	13.28	Medium × High
Number of branches per plant	IC-10256A × EC-305672	0.64 **	4.83	Medium × High
Fruit length (cm)	EC-305672 × IC-4507	2.73 **	16.56	Medium × Low
Fruit diameter (cm)	EC-305612 × EC-305672	0.15 **	1.93	High × Medium
Number of fruits per plant	IC-10256A × EC-305672	3.17 **	18.68	Medium × High
Fruit weight (g)	IC-4507 × IC-7472	4.80 **	18.81	High × Low
Fruit yield per plant (g)	IC-10256A × EC-305672	47.90 **	268.21	Low × High
Fruit and shoot borer severity (%)	EC-305672 x IC-3769	7.344**	16.25	Medium × High

*,** Significant at 5% and 1% respectively



Top five hybrids with SCA effects and GCA effects of parents

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Mean performance and Specific combining ability effects for different traits

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Conflict of interest

The authors have no conflict of interest.

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