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Mundhe SS
Department of Agricultural Botany, College of Agriculture, Latur, Vasantrao Naik Krishi Vidyapeeth, Parbhani, Maharashtra, India

Pole SP
Department of Agricultural Botany, College of Agriculture, Latur, Vasantrao Naik Krishi Vidyapeeth, Parbhani, Maharashtra, India

Khandebharad PR
Department of Agricultural Botany, College of Agriculture, Latur, Vasantrao Naik Krishi Vidyapeeth, Parbhani, Maharashtra, India

Diallel analysis for yield and yield component traits in okra (*Abelmoschus esculentus* (L.) Moench)

Mundhe SS, Pole SP and Khandebharad PR

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 combining ability of nine parental lines and their resultant crosses through half diallel mating design in a Randomized block design with two replications. From the current investigation, the parents Arka Anamika, IC-3769-A and Phule Vimukta were found to be the good general combiners as they displayed significant gca effects in desirable direction for most of the characters like plant height, number of branches per plant, fruit length, fruit diameter, fruit weight. From the studies on specific combining ability, it was observed that cross combination Parbhani Kranti x IC-3769-A, Arka Abhay x Varsha Uphar, Varsha Uphar x Phule Vimukta were best specific combinations for most of the traits.

Keywords: Half-diallel, f_1, combining ability, Gea, Sac, 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. 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 (Hadiya *et al.*, 2018) [6]. 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].

Leaves and root extracts are served as demulcent and emollient poultice (Babu and Srinivasan, 1995) [2]. Researchers (Griffing, 1956; Hayman, 1954; Mather and Jinks, 1971) [5, 8, 10] 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) [11]. 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.

Material 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. 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 (%). Griffing's (1956) [5] technique for Method-II, Model-I, was thought to be appropriate for the material under investigation. The Method-II was utilized for the parent scenario as parents as well as one set of F_1's without reciprocals.

Results and Discussion

The analysis of variance (Table 1) revealed that the differences resulting from the treatment

Corresponding Author:
Mundhe SS
Department of Agricultural Botany, College of Agriculture, Latur, Vasantrao Naik Krishi Vidyapeeth, Parbhani, Maharashtra, India

were significant for all of the studied characters in the analysis of mean squares. The treatment means were further subdivided into Parent *versus* cross comparisons, parents, and crosses. The traits plant height, number of branches on each plant, incidence of YVMV, and severity of the fruit borer all differed significantly among the parents. The mean squares due to crosses found to be significant for every character. All the characters, with the exception of the number of branches per plant, fruit length, fruit diameter, and fruit weight, indicated significant differences among the mean squares due to parent and crosses. The analysis of variance for characters under study has been given in Table 2.

The average performance of a genotype in many hybrid combinations is known as GCA, while the performance of a parent in a particular cross is known as SCA. However, if they have the potential to combine well in a specific cross, they are deemed to have good SCA. Parents who have a high and desirable average combining ability are regarded as good general combiners. The cause of GCA is due to the activation of additive genes, however if epistasis is present, GCA will also contain additive x additive types of non-allelic interaction. It has a favorable relationship with heritability in narrow sense. GCA aids in choosing appropriate parents for hybridization. Although epistasis is present, SCA would comprise all three of the epistasis (non-allelic) interaction components: additive x additive, additive x dominance, and dominance x dominance. SCA is typically thought of as a function of dominance variance (non-additive).

General Combining Ability Effects
Parental lines Arka Anamika (2.108), Phule Vimukta (1.681), and EC-305672 (1.508) had the next-highest significant positive GCA effects for plant height, following the parent IC-3769-A (3.068). The outcomes are consistent with Reddy *et al.* (2013) [12] and Akotkar *et al.* (2014) [1]. Two parents, Arka Anamika (-0.261) and Arka Abhay (-0.125), had a significantly negative GCA effect for internodal length among the nine parents under consideration. Similar results were also reported by Chintala and Selvam (2017) [13] and Arvind *et al.* (2021) [14]. The parent, IC-3759 (0.688), had a statistically positive GCA effect on the number of nodes per plant out of the total investigated parents. The parent IC-3769-A (0.542) documented a favorable GCA effect for this feature in the desired direction. The results are in correspondence Wakode *et al.* (2016) [16] and Shwetha *et al.* (2021) [15]. The GCA impacts of the parents Arka Anamika (0.122) and Parbhani Kranti (0.086) were notably significant for number of branches per plant. Similar results were obtained by Lokeswari *et al.* (2018) [18] and Arvind *et al.* (2021) [14]. Out of the total parents studied, two parents *viz.,* Varsha Uphar (0.461) and IC-3769-A (0.288) showed significantly positive GCA effect for fruit length. The results are in similarity with Sugani Devi *et al.* (2017) [17] and Arvind *et al.* (2021) [14]. Two parents, Arka Abhay (0.930) and Phule Vimukta (0.783), among the examined parents, demonstrated a significantly positive GCA effect for the trait fruit diameter. The results were in agreement with and Chavan *et al.* (2021) [20]. The parent, IC-3759 (0.557), reported a statistically positive GCA effect for the character number of fruits per plant out of the parents used in the study. Arka Abhay (0.311) recorded a positive GCA impact in the desired direction. The similar results were also recorded by Wakode *et al.* (2016) [16] and Chintala and Selvam (2017) [13]. Among the parents taken for

study the parent *viz.,* IC-3769-A (0.419) showed significantly positive GCA effect for the trait fruit weight. Similar results were obtained by Wakode *et al.* (2016) [16] and Yogini and Saravanan (2020) [21]. The parent IC-3769-A (7.850) showed a strong positive GCA effect for fruit yield per plant. Additionally, the parents Parbati Kranti (4.270) and Phule VI Mukta (2.090) recorded positive GCA effects in the desired direction. The GCA effect's fruit yield per plant result is comparable to Satish *et al.* (2017) [22] and Anusuya Devi *et al.* (2020) [23]. The negative impacts of GCA for the trait YVMV occurrence are regarded as superior. Konkan Bhendi and Phule Vimukta, the parents, both displayed a significantly negative GCA impact (-2.906 and -1.610, respectively). A negative GCA impact was similarly seen in the expected direction in the parent IC-3759 (-0.378). The significantly negative GCA effects were preferred for the character fruit borer severity. Four parents, namely Arka Anamika (-2.843), EC-305672 (-1.961), IC-3759 (-1.529), and Phule Vimukta (-0.828), among the parents examined, shown significantly negative GCA effects for fruit borer severity.

From the study of general combining ability, it was found that the parent IC-3769-A was discovered to be the best general combiner for fruit yield per plant (7.850) in the current investigation. Additionally, it exhibited highly favorable GCA effects on the plant height (3.068), fruit length (0.288), and fruit weight (0.419). When it came to features like plant height (1.681), fruit diameter (0.783), YVMV incidence (-1.610) and fruit borer severity (-0.828), the parent Phule Vimukta found the best general combiner. Additionally, for plant height (2.108), internodal length (-0.261), number of branches per plant (0.122) and fruit borer severity (-2.843), the parent Arka Anamika showed significantly desirable GCA effects. According to the results of the current experiment, the parents IC-3769-A, Phule Vimukta and Arka Anamika identified as best general combiners for the majority of yield-contributing traits examined. Therefore, these parents can be used in the hybridization programmed for developing superior hybrids for commercial exploitation. Giram (2016) [24], and Chavan *et al.* (2021) [20] all found similar results for the effects of general combining ability.

Specific Combining Ability Effects
For the trait plant height SCA effects that are significantly positive are desired and regarded as superior. Varsha Uphar x Arka Anamika (5.857) demonstrated the highest significant positive SCA effects. The similar significant and favourable SCA findings were also attained by Anusuya Devi *et al.* (2020) [23] and Shwetha *et al.* (2021) [15]. The cross EC-305672 x Phule Vimukta (-0.838) had the highest negative significant SCA effect for internodal length among the entire cross combinations examined. The results are in accordance with Verma *et al.* (2016) [25] and Sugani Devi *et al.* (2017) [17]. For the number of nodes per plant, the cross combination Parbhani Kranti x IC-3769-A (4.070) showed the largest significant positive SCA effect. Verma *et al.* (2016) [25] and Shwetha *et al.* (2021) [15] also identified similar results for SCA effects for the trait number of nodes per plant. The cross Parbhani Kranti x IC-3769-A (0.764) showed the strongest favorable SCA effects for number of branches per plant. Similar results were also identified by Arvind *et al.* (2021) [14] and Shwetha *et al.* (2021) [15]. The cross Parbhani Kranti x IC-3769-A (1.005) had the most significant positive SCA effects of all the cross combinations examined for fruit length. The

outcomes are consistent with the earlier findings of Sapavadiya *et al.* (2019) [26]. For the character fruit diameter, the cross combinations Konkan Bhendi x EC-305672 (3.328) reported the most significant positive SCA effect. The results are in correspondence with Harne (2014) [7]. The cross combination Parbhani Kranti x IC-3769-A (3.642) displayed the strongest significant positive SCA effects for the number of fruits per plant. The similar results were also recorded by Satish *et al.* (2017) [22] and Yogini and Saravanan (2020) [21]. The cross-combination Arka Anamika x EC-305672 (1.275) exhibited highest and significant positive SCA effect for fruit weight. Similar SCA effects for fruit weight were found by Anusuya Devi *et al.* (2020) [23] and Arvind *et al.* (2021) [14]. The cross Parbhani Kranti x IC-3769-A (48.575) had the largest positive significant SCA effect for the trait fruit yield per plant. The results for fruit yield per plant are in agreement with the previous findings of Tiwari *et al.* (2016) and Paul *et al.* (2017). The cross Arka Abhay x Varsha Uphar (-5.514) exhibited highest negative SCA effect for YVMV incidence. Amongst the crosses, cross Parbhani Kranti x IC-3769-A (-10.437) exhibited highest significant negative SCA effect for fruit borer severity.

It was found in the current investigation that the crosses Parbhani Kranti x IC-3769-A, Arka Abhay x Varsha Uphar, Arka Anamika x IC-3769-A, and Arka Anamika x EC-305672 reported significant and desirable SCA effects for fruit yield per plant and the majority of the yield contributing traits under study. Therefore, there is a chance that these hybrids could be used in breeding programmes. The results are consistent with the earlier research by Akotkar *et al.* (2014) [1], and Arvind *et al.* (2021) [14] for specific combining ability effects.

Table 6 displays the outcome for a few superior crosses with their individual mean performance. It shows that parents of the crosses had general combiners of the high x high, high x medium, high x low, medium x medium, low x low, and low x low types. Malhotra (1983) hypothesized that a high SCA impact resulting from the use of a single effective general combiner could be the result of a complementary type of gene effect. Additionally, the pedigree technique of breeding can be used to leverage high SCA effects involving medium x medium, medium x high, or high x high general combiners for the development of inbred lines. The desired SCA effects brought about by a good x good general combiner are anticipated to have a fixable additive x additive type of gene action. The additive genetic system present in the good combiner and the epistatic effect present in the crosses may have resulted in favorable SCA effects involving parents with either good GCA effects or poor SCA effects, acting in a complimentary manner to maximize desirable plant traits (Singh *et al.,* 1983) [32]. Among the 33 cross combinations shown in Table 4.11 one cross had a high x high combination, three had high x medium combinations, eight had high x low, eight had medium x medium combinations, six had medium x low, and seven had low x low combiners. From the results it can be concluded that the level of GCA effects of the parents involved need not necessarily affect the ideal SCA effect of any cross combination.

According to Dubey (1975) [29], the interaction between the dominant allele from a good combiner and the recessive allele from a poor combiner may be the cause of the acceptable performance of combination with parents with high x low GCA effects. A high x low cross can also produce strong transgressive segregants for the desired traits because genes with high potentials and their particular buffers tend to segregate (Langham, 1961) [30]. According to Singh *et al.* (1983) [32], if the additive genetic system present in the good combiner and the epistatic effect present in the crosses act in a complementary manner to maximize desirable plant attributes that could be exploited for further breeding purposes, hybrids involving one parent with significant GCA effect and the other with poor GCA effect would throw up transgressive segregants giving rise to new population.

Table 1: Analysis of variance for different characters in 9 x 9 half diallel set of okra.

Source	def.	Plant Height (cm)	Internodal Length (cm)	Number of Nodes per Plant	Number of Branches Per Plant	Fruit Length (cm)
Treatment	44	67.674**	0.435**	4.091**	0.194**	0.852**
Parent	8	101.760**	0.122	1.828	0.174**	0.457
Crosses	35	22.261*	0.467**	3.808*	0.204**	0.963**
P x C	1	1384.466**	1.832**	32.101**	0.011	0.113
Error	44	11.128	0.078	1.812	0.042	0.366

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

Source	def.	Fruit Diameter (mm)	Number of Fruits Per Plant	Fruit Weight (gm)	Fruit Yield Per Plant (gm)	YVMV Incidence (%)	Fruit Borer Severity (%)
Treatment	44	5.826**	3.573**	1.149**	830.573**	26.210**	71.872**
Parent	8	5.479	1.110	0.173	182.210	25.865**	57.190**
Crosses	35	6.057**	3.065**	1.404**	903.961**	26.122**	71.658**
P x C	1	0.541	41.074**	0.007	3448.882**	32.059**	196.840**
Error	44	2.545	1.265	0.499	299.055	1.447	2.695

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

Table 2: Analysis of variance for combining ability in 9 x 9 half diallel set of okra.

Source	def.	Plant Height (cm)	Internodal Length (cm)	Number of Nodes per Plant	Number of Branches Per Plant	Fruit Length (cm)
G.C.A.	8	57.040**	0.326**	2.293*	0.097**	0.606**
S.C.A.	36	28.681**	0.194**	1.990**	0.078**	0.386**
Error	44	5.564	0.039	0.906	0.021	0.183

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

Source	def.	Fruit Diameter (mm)	Number of Fruits Per Plant	Fruit Weight (gm)	Fruit Yield Per Plant (gm)	YVMV Incidence (%)	Fruit Borer Severity (%)
G.C.A.	8	3.747*	1.284	0.558*	185.458	23.954**	41.151**
S.C.A.	36	2.728**	1.898**	0.578**	466.360**	10.694**	34.777**
Error	44	1.273	0.632	0.250	149.527	0.750	1.347

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

Table 3: General combining ability effects of parents for different characters in 9 x 9 half diallel set of okra.

Sr. No.	Parents	Plant Height (cm)	Internodal Length (cm)	Number of Nodes Per Plant	Number of Branches Per Plant	Fruit Length (cm)	Fruit Diameter (mm)
1	Parbhani Kranti	-2.476**	0.158**	-0.649*	0.086*	-0.142	0.201
2	Konkan Bhendi	-0.490	0.336**	-0.628*	0.059	-0.231	-0.611
3	Arka Abhay	-1.159	-0.125*	0.083	-0.023	-0.058	0.930**
4	Varsha Uphar	-3.827**	-0.045	-0.190	-0.196**	0.461**	-0.421
5	Arka Anamika	2.108**	-0.261**	-0.099	0.122**	0.001	-0.650*
6	IC-3769-A	3.068**	-0.058	0.542	-0.005	0.288*	0.301
7	EC-305672	1.508*	-0.066	0.110	-0.06	0.011	-0.291
8	IC-3759	-0.411	-0.012	0.688*	0.04	-0.249*	-0.243
9	Phule VI Mukta	1.681*	0.073	0.142	-0.023	-0.083	0.783*
	S.E. (gi) ±	0.67	0.06	0.27	0.04	0.12	0.32
	C.D. at 5%	1.35	0.11	0.55	0.08	0.24	0.65

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

Sr. No.	Parents	Number of Fruits Per Plant	Fruit Weight (gm)	Fruit Yield Per Plant (gm)	YVMV Incidence (%)	Fruit Borer Severity (%)
1	Parbhani Kranti	0.066	0.147	4.270	0.185	2.390**
2	Konkan Bhendi	0.047	-0.235	-1.665	-2.906**	0.820*
3	Arka Abhay	0.311	-0.221	-1.035	1.665**	1.850**
4	Varsha Uphar	-0.480*	-0.169	-5.583	1.325**	-0.167
5	Arka Anamika	-0.098	-0.071	-2.512	-0.045	-2.843**
6	IC-3769-A	0.225	0.419**	7.850*	0.632*	2.268**
7	EC-305672	-0.443	0.081	-3.030	1.131**	-1.961**
8	IC-3759	0.557*	-0.154	-0.384	-0.378	-1.529**
9	Phule Vimukta	-0.184	0.203	2.090	-1.610**	-0.828*
	S.E. (gi) ±	0.23	0.14	3.48	0.25	0.33
	C.D. at 5%	0.46	0.29	7.01	0.50	0.67

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

Table 4: Specific combining ability effects of hybrids for different characters 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	Fruit Length (cm)
1	Parbhani Kranti x Konkan Bhendi	3.908	-0.055	-1.634	-0.400**	0.564
2	Parbhani Kranti x Arka Abhay	3.557	-0.089	1.605	-0.018	-0.008
3	Parbhani Kranti x Varsha Uphar	1.576	-0.353	-1.573	-0.245	-0.387
4	Parbhani Kranti x Arka Anamika	-2.469	0.242	-0.489	0.636**	-0.047
5	Parbhani Kranti x IC-3769-A	5.546*	-0.300	4.070**	0.764**	1.005*
6	Parbhani Kranti x EC-305672	4.786*	0.097	-0.173	-0.182	0.023
7	Parbhani Kranti x IC-3759	-6.065**	0.183	2.825**	0.218	0.003
8	Parbhani Kranti x Phule Vimukta	1.833	-0.222	-0.855	-0.518**	-0.543
9	Konkan Bhendi x Arka Abhay	0.100	0.408*	0.484	0.109	0.261
10	Konkan Bhendi x Varsha Uphar	5.754**	-0.027	-0.143	0.282*	-0.148
11	Konkan Bhendi x Arka Anamika	1.069	-0.001	-0.884	-0.436**	-2.308**
12	Konkan Bhendi x IC-3769-A	0.204	0.067	-0.250	0.191	-0.466
13	Konkan Bhendi x EC-305672	3.299	-0.026	1.107	-0.155	0.202
14	Konkan Bhendi x IC-3759	0.968	-0.270	1.155	0.045	0.632
15	Konkan Bhendi x Phule Vimukta	0.916	0.250	0.175	-0.291*	-0.144
16	Arka Abhay x Varsha Uphar	5.738**	-0.631**	3.345**	0.064	-0.181
17	Arka Abhay x Arka Anamika	3.333	-0.595**	0.08	0.145	-0.501
18	Arka Abhay x IC-3769-A	3.718	-0.743**	-1.211	-0.127	-0.228
19	Arka Abhay x EC-305672	0.448	0.375*	-0.455	0.027	0.659
20	Arka Abhay x IC-3759	3.047	0.626**	-0.432	0.027	0.229
21	Arka Abhay x Phule Vimukta	0.810	0.291	0.139	-0.009	0.273
22	Varsha Uphar x Arka Anamika	5.857**	0.401*	0.227	0.218	0.730

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

Sr. No.	Crosses	Plant Height (cm)	Internodal Length (cm)	Number of Nodes Per Plant	Number of Branches Per Plant	Fruit Length (cm)
23	Varsha Uphar x IC-3769-A	4.792*	0.303	0.211	0.045	0.483
24	Varsha Uphar x EC-305672	1.432	0.060	0.018	0.200	-0.510
25	Varsha Uphar x IC-3759	1.456	0.187	-0.409	-0.400**	-0.810*
26	Varsha Uphar x Phule Vimukta	4.493*	0.181	1.036	0.164	0.779*
27	Arka Anamika x IC-3769-A	0.662	-0.241	0.820	-0.173	0.413
28	Arka Anamika x EC-305672	0.597	-0.264	1.702	-0.018	0.860*
29	Arka Anamika x IC-3759	3.596	-0.483**	0.125	-0.218	0.470
30	Arka Anamika x Phule Vimukta	1.353	-0.603**	0.245	-0.155	-0.056
31	IC-3769-A x EC-305672	-0.423	0.333	-0.214	-0.191	-0.257
32	IC-3769-A x IC-3759	0.901	-0.810**	-0.841	-0.091	0.163
33	IC-3769-A x Phule Vimukta	0.378	0.279	0.005	-0.127	0.257
34	EC-305672 x IC-3759	4.456*	-0.538**	0.291	0.064	-0.530
35	EC-305672 x Phule Vimukta	1.613	-0.838**	0.486	0.127	-0.106
36	IC-3759 x Phule Vimukta	-2.637	0.238	0.159	0.227	-0.136
	S.E. Sij (±)	2.157	0.180	0.870	0.133	0.391
	S.E.± Sii Sjj	2.661	0.223	1.074	0.164	0.482
	C.D. at 5% (Sij)	4.348	0.364	1.754	0.268	0.788
	C.D. at 1% Sii Sjj	5.363	0.448	2.164	0.331	0.972

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

Sr. No.	Crosses	Fruit Diameter (mm)	Number of Fruits Per Plant	Fruit Weight (gm)	Fruit Yield Per Plant (gm)	YVMV Incidence (%)	Fruit Borer Severity (%)
1	Parbhani Kranti x Konkan Bhendi	-0.274	-1.181	0.363	-9.075	-1.053	6.941**
2	Parbhani Kranti x Arka Abhay	-0.505	1.305	0.188	18.500	-2.364**	-5.539**
3	Parbhani Kranti x Varsha Uphar	-0.754	-0.254	0.356	-0.007	0.756	9.328**
4	Parbhani Kranti x Arka Anamika	1.475	-0.785	0.199	-5.564	6.136**	4.244**
5	Parbhani Kranti x IC-3769-A	-1.136	3.642**	0.669	48.575**	-4.210**	-10.437**
6	Parbhani Kranti x EC-305672	1.716	-0.690	0.106	-5.350	2.570**	0.602
7	Parbhani Kranti x IC-3759	0.589	2.360**	-0.358	23.314*	-0.320	-3.220**
8	Parbhani Kranti x Phule Vimukta	-1.358	-0.699	-0.605	-16.380	-0.529	2.319*
9	Konkan Bhendi x Arka Abhay	1.407	0.024	0.240	5.555	1.867*	7.647**
10	Konkan Bhendi x Varsha Uphar	-0.542	0.015	0.518	6.833	-1.133	-3.591**
11	Konkan Bhendi x Arka Anamika	-1.483	-1.167	-2.729**	-50.283**	-0.368	-2.906**
12	Konkan Bhendi x IC-3769-A	-1.064	0.510	-0.289	1.045	5.760**	-5.797**
13	Konkan Bhendi x EC-305672	3.328**	0.878	-0.052	8.255	-3.149**	2.063
14	Konkan Bhendi x IC-3759	2.680**	0.878	0.634	21.854	0.140	-3.780**
15	Konkan Bhendi x Phule Vimukta	-0.146	-0.031	0.066	-0.895	-2.148**	-7.940**
16	Arka Abhay x Varsha Uphar	0.217	2.501**	0.504	35.163**	-5.514**	-2.261*
17	Arka Abhay x Arka Anamika	-1.024	0.819	-0.014	4.507	2.651**	-6.206**
18	Arka Abhay x IC-3769-A	0.595	-0.854	0.126	-9.965	1.959*	8.453**
19	Arka Abhay x EC-305672	0.287	0.065	-1.336**	-21.575	3.885**	-6.677**
20	Arka Abhay x IC-3759	2.639*	1.015	0.249	10.334	-1.801*	3.180**
21	Arka Abhay x Phule Vimukta	-2.187*	-0.295	0.092	-0.380	0.526	2.420*
22	Varsha Uphar x Arka Anamika	0.497	0.160	-0.895*	-10.970	-2.289**	1.211

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

Sr. No.	Crosses	Fruit Diameter (mm)	Number of Fruits Per Plant	Fruit Weight (gm)	Fruit Yield Per Plant (gm)	YVMV Incidence (%)	Fruit Borer Severity (%)
23	Varsha Uphar x IC-3769-A	-0.744	-0.313	0.115	-0.977	3.829**	-2.950**
24	Varsha Uphar x EC-305672	-0.962	-0.145	0.052	-1.287	2.820**	8.900**
25	Varsha Uphar x IC-3759	-1.41	-0.695	-1.613**	-30.828**	-0.986	-5.573**
26	Varsha Uphar x Phule Vimukta	1.164	1.646*	0.960*	31.438**	-3.504**	-3.494**
27	Arka Anamika x IC-3769-A	-2.125*	1.205	0.937*	31.782**	-4.256**	-4.225**
28	Arka Anamika x EC-305672	-0.803	2.224**	1.275**	45.292**	-5.085**	-1.445
29	Arka Anamika x IC-3759	-3.081**	0.674	0.560	3.181	1.239	6.032**
30	Arka Anamika x Phule Vimukta	2.693**	-0.385	-0.227	-6.218	6.061**	-5.138**
31	IC-3769-A x EC-305672	2.116*	-0.599	-0.425	-10.520	2.443**	2.444*
32	IC-3769-A x IC-3759	-0.531	-0.399	0.2	-11.651	0.643	-7.769**
33	IC-3769-A x Phule Vimukta	1.242	0.642	0.243	10.560	-1.776*	-1.069
34	EC-305672 x IC-3759	-1.38	0.269	-0.173	-1.351	3.623**	-2.934**
35	EC-305672 x Phule Vimukta	-1.816	-0.14	0.010	-0.975	1.445	-5.860**
36	IC-3759 x Phule Vimukta	-0.713	-0.04	-0.075	-0.511	2.874**	6.408**
	S.E. Sij (±)	1.032	0.727	0.457	11.183	0.792	1.062
	S.E.± Sii Sjj	1.273	0.897	0.564	13.795	0.977	1.310
	C.D. at 5% (Sij)	2.079	1.466	0.921	22.538	1.596	2.139
	C.D. at 1% Sii Sjj	2.565	1.808	1.136	27.803	1.969	2.639

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

Table 5: Hybrids showing maximum SCA effects for different characteristics in okra.

Sr. No.	Characters	Best specific combiners	SCA effects	Individual performance of crosses	GCA status of parents
1	Plant Height	Varsha Uphar x Arka Anamika	5.857**	68.13	Low x High
		Konkan Bhendi x Varsha Uphar	5.754**	65.43	Medium x Low
		Arka Abhay x Varsha Uphar	5.738**	64.75	Low x Low
2	Internodal length (cm)	EC-305672 x Phule Vimukta	-0.838**	4.35	Medium x Medium
		IC-3769-A x IC-3759	-0.810**	4.30	Medium x Medium
		Arka Abhay x IC-3769-A	-0.743**	4.26	High x Medium
3	Number of Nodes Per Plant	Parbhani Kranti x IC-3769-A	4.070**	19.63	Low x High
		Arka Abhay x Varsha Uphar	3.345**	18.90	Medium x Medium
		Parbhani Kranti x IC-3759	2.825**	18.53	Low x High
4	Number of Branches Per Plant	Parbhani Kranti x IC-3769-A	0.764**	2.70	Medium x Medium
		Parbhani Kranti x Arka Anamika	0.636**	2.70	Medium x High
		Konkan Bhendi x Varsha Uphar	0.282*	2.00	Medium x Low
5	Fruit Length (cm)	Parbhani Kranti x IC-3769-A	1.005*	12.47	Low x High
		Arka Anamika x EC-305672	0.860*	12.19	Medium x Medium
		Varsha Uphar x Phule Vimukta	0.779*	12.48	High x Low
6	Fruit Diameter (mm)	Konkan Bhendi x EC-305672	3.328**	18.50	Low x Low
		Arka Anamika x Phule Vimukta	2.693**	18.90	Low x High
		Konkan Bhendi x IC-3759	2.680**	17.90	Low x Low

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

Sr. No.	Characters	Best specific combiners	SCA effects	Individual performance of crosses	GCA status of parents
7	Number of Fruits Per Plant	Parbhani Kranti x IC-3769-A	3.642**	19.30	Medium x Medium
		Arka Abhay x Varsha Uphar	2.501**	17.70	Medium x Low
		Parbhani Kranti x IC-3759	2.360**	18.35	Medium x High
8	Fruit Weight (gm)	Arka Anamika x EC-305672	1.275**	11.74	Low x Medium
		Varsha Uphar x Phule Vimukta	0.960*	11.45	Low x Medium
		Arka Anamika x IC-3769-A	0.937*	11.74	Low x High
9	Fruit Yield Per Plant (gm)	Parbhani Kranti x IC-3769-A	48.575**	215.63	High x High
		Arka Anamika x EC-305672	45.292**	194.68	Low x Low
		Arka Abhay x Varsha Uphar	35.163**	183.48	Low x Low
10	YVMV Incidence (%)	Arka Abhay x Varsha Uphar	-5.514**	8.80	Low x Low
		Arka Anamika x EC-305672	-5.085**	7.33	Medium x Low
		Arka Anamika x IC-3769-A	-4.256**	7.66	Medium x Medium
11	Fruit Borer Severity (%)	Parbhani Kranti x IC-3769-A	-10.437**	10.35	Low x Low
		Konkan Bhendi xPhule Vimukta	-7.940**	8.18	Medium x Medium
		IC-3769-A x IC-3759	-7.769**	9.10	Low x High

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

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