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Research Article

Studies on combining ability for yield and contributing traits in okra (*Abelmoschus esculentus L.* Moench)

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Abstract
Fifty-seven lines of okra including ten parents, forty-five hybrids and two standard checks were evaluated in Randomized Block Design with two replications. Combining ability was carried out to study comparisons of lines in combinations for the traits days to 50% flowering, plant height at harvest, the number of branches per plant, the number of nodes per plant, days to first picking, the number of fruits per plant, the mean length of fruit, the mean weight of fruit, yield per plant , yield per plot , yield per hectare and reaction to yellow vein mosaic disease. The result revealed that the variance to general combining ability (gca) is less than specific combining ability (sca), ratio of that is less than unity indicated preponderance of non additive gene action for all the traits. The parent Akola Bahar was good general combiner, whereas, cross combination Shagun x VNR (Super Green) recorded a significant specific combining ability (sca) effects as far as yield is concerned.

Key words
General combining ability, Specific combining ability, Fruit yield, Okra, Combining ability.

INTRODUCTION

Okra is the powerhouse of variable nutrients. It is a good source of vitamin C, providing 20 per cent of daily value for a 2000 calorie diet in 100 g. In 100 g edible part of Okra contains, 89.6 g moisture, 1.9 g protein, 0.2 g fibre, 6.4 g other carbohydrates, 66 mg calcium, 53 mg magnesium, 56 gm phosphorus, 0.35 mg iron, 6.98 mg sodium, 103 mg potassium, 0.19 mg copper, 30 mg Sulphur, 88 IU vitamin A, 0.07 mg thiamine, 0.1 mg riboflavin, 0.6 mg nicotine acid, 13 mg vitamin C and 0.7 g mineral (Chaudhary, 2003; W akode *et al*., 2016). It is low in calories and fat free. Okra is surprisingly a versatile vegetable. It also holds a high place in nutritional charts for its fibrous content and other medicinal benefits. Combining ability studies provide information on the relative importance of GCA and SCA variance for interpreting the genetic basis of important traits. This helps us to access the nature of gene action and in identifying superior parental lines for their per se performance. The best combinations with high general combining ability of individual lines are helpful to get more desirable recombinants which enables for further improvement of the crop. Therefore, present investigation was undertaken to identify the best general combiner inbred lines and also the best hybrids with high SCA effects which can be exploited directly as single cross hybrid.

MATERIALS AND METHODS

The experimental material consisted of ten different genotypes *viz.,* Parbhani Kranti, JOH-05-09, Arka Anamika, Shagun, Akola Bahar, Pbn-1, Ako-107, Pbn-13, VNR (Super Green), and Pusa Sawani. These genotypes represented a wide genetic diversity. The selected ten genotypes were crossed in all possible combinations and produced 45 hybrids. The seed obtained from the crossing block were sown to raise the hybrids. Cultural and agronomic practices were followed as per

the standard recommendations and need based plant protection measures were taken to maintain healthy crop stand. The observations *viz*., days to 50 per cent flowering, plant height at harvest, the number of branches per plant, the number of nodes per plant, days to first picking, the number of fruits per plant, average length of fruit, average weight of fruit, yield per plant (g), yield per plot (kg), yield per hectare (qt) and reaction to yellow vein mosaic disease were recorded. The data generated were utilized to estimate combining ability by method I under model II as suggested by Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance (**Table 1**) revealed significant differences due to general and specific combining ability for all the characters. This suggests the importance of both additive and non additive gene action along with the preponderance of non additive gene effects, which is in agreement with the results reported by Arora (1993), Poshiya and Vashi (1995). The *gca* and *sca* variances were highly significant for days to 50 % flowering, plant height at harvest, the number of branches per plant, the number of nodes per plant, days to first picking, the number of fruits per plant, average fruit length, average fruit weight, yield per plant, yield per plot, yield per hectare and significant for reaction to yellow vein mosaic disease, and non-significant for rest of the characters.

The *gca* effects for the ten parents are tabulated in **Table 2a and b**. The *gca* analysis revealed that two parents showed significant *gca* effects for this character. As early flowering cultivars are preferred, the combining ability in negative direction is desirable for this character. Parent JOH-05-09 exhibited significant *gca* effect in desirable negative direction. Parbhani Kranti along with Shagun was the parents that registered significant gca effects in the desirable positive direction for plant height at harvest. Parent VNR [Super Green] displayed a highly significant gca effects for the number of branches per plant. Parent JOH-05-09 recorded a highly significant gca effects for character number of nodes per plant in desirable direction. A cultivar requiring a smaller number of days to first picking is preferred by the farmers. Two parents *viz.,* Parbhani Kranti and Arka Anamika exhibited significant negative gca effects.

Five parents *viz.,* Parbhani Kranti, Ako-107, Pbn-1, VNR [Super Green] and Akola Bahar displayed gca effects in desirable positive direction for the number of fruits per plant. Pbn-13 and Shagun recorded highly significant gca effects in positive direction for average fruit length. Among the parents, Akola Bahar was the only parent that recorded a highly significant gca effects in desirable positive direction, which shows that it is a good combiner for yield character. Similar results were reported by Jawili and Rasco (1990), Nichal *et al.* (2001), Dahake (2004), Kumar *et al.* (2006), Weerasekara (2008), Rekha *et al.* (2015) and Singh *et al*. (2015). The specific combining ability effects (sca) of different hybrids for twelve characters are presented in **Table 3**. The maximum negative sca effects were registered by the hybrid JOH-05-09 X Shagun followed by Shagun X Pusa Sawani, Akola Bahar X VNR [Super Green] and Parbhani Kranti X Ako-107 along with Arka Anamika X Ako-107 for days to 50 % flowering.

For the character of plant height at harvest, the hybrids Shagun X Pbn-1, Arka Anamika X Pusa Sawani, JOH-05-09 X Pbn-1, Arka Anamika X Ako-107, Shagun X Ako-107, Parbhani Kranti X Pbn-13, Parbhani Kranti X Akola Bahar, JOH-05-09 X Shagun, Akola Bahar X Pbn-13,

Table 1. Analysis of Variance for Combining Ability for twelve Characters in 10 x 10 Half Diallel of Okra

Characters	Mean Sum of Squares		
	gca	*sca*	Error
Days to 50% flowering	1.67**	1.87**	0.57
Plant height at harvest	2.08**	10.84**	2.91
Number of branches per plant	1.83**	1.98**	0.25
Number of nodes per plant	2.10**	2.13**	0.87
Days to first Picking	1.63**	1.97**	0.34
Number of fruits per plant	2.42**	2.47**	0.67
Length of fruit	2.79**	2.62**	0.50
Weight of fruit	1.93**	0.65	0.73
Yield per plant	237.81**	507.09**	16.38
Yield per plot	20.14**	42.46**	1.36
Yield per hectare	1.92**	1.94**	0.06
YVMV	1.47*	1.50*	0.37

*, ** - significant at 5 and 1 per cent level, respectively

Table 2a. Estimates of general ability effects for parents

S. No.	Parents	Days to 50 % flowering	Plant height at harvest	Number of branches per plant
1	Parbhani Kranti	-0.38	0.57**	-0.14
2	JOH-05-09	-0.47*	0.32	-0.06
3	Arka Anamika	0.12	-0.01	0.23
4	Shagun	-0.05	0.57**	0.03
5	Akola Bahar	-0.13	-0.22	-0.14
6	Pbn-1	-0.13	0.20	-0.14
7	Ako-107	0.20	-0.51*	-0.52**
8	Pbn-13	0.32	-0.13	0.07
9	VNR (Super Green)	0.03	-0.63*	0.40**
10	Pusa Sawani	0.49*	-0.17	0.28*
	Maximum	0.49	0.57	0.40
	Minimum	-0.47	-0.63	-0.52
	SE	0.206	0.467	0.136
	CD 5%	2.11	4.78	1.39
	CD 1%	2.81	6.35	1.85

Table 2a. Contd…

S. No.	Parents	Number of nodes per plant	Days to first picking	Number of fruits per plant
1	Parbhani Kranti	0.28	-0.40*	0.62**
2	JOH-05-09	0.70**	-0.11	-0.47**
3	Arka Anamika	-0.30	-0.32*	-0.43
4	Shagun	-0.09	0.14	-0.43
5	Akola Bahar	0.62	0.02	0.20
6	Pbn-1	0.16	0.14	0.41
7	Ako-107	-0.22	0.14	0.53*
8	Pbn-13	-0.34	0.18	-0.47*
9	VNR (Super Green)	-0.34	0.31	0.28
10	Pusa Sawani	-0.47*	-0.11	-0.26
	Maximum	0.70	0.31	0.62
	Minimum	-0.47	-0.40	-0.47
	SE	0.255	0.158	0.224
	CD 5%	2.61	1.62	2.30
	CD 1%	3.47	2.16	3.05

*, ** - significant at 5 and 1 per cent level, respectively

Pbn-1 X VNR [Super Green] displayed highly significant positive sca effects. The hybrid Parbhani Kranti X Ako-107 recorded maximum sca effects for character number of branches per plant in positive direction. Highly significant positive sca effects were recorded for the number of nodes per plant by JOH-05-09 X Pbn-1, Pbn-1 X Pusa Sawani, Parbhani Kranti X Akola Bahar, Parbhani Kranti X Pbn-1, Arka Anamika X VNR [Super Green], Shagun X Ako-107, Ako-107 X Pbn-13, JOH-05-09 X Shagun and Pbn-13 X Pusa Sawani. The sca effects in the negative direction are considered desirable for the character of days to first picking.

Out of 45 crosses, twenty-two crosses recorded highly significant sca effects for days to first harvesting out of which, only twelve recorded highly significant sca effects in desirable negative direction. The maximum negative sca effects were registered by the combination Akola

Table 2b. Estimates of general combining ability effects for parents

S. No.	Parents	Average length of fruit	Average fruit weight	Yield per plant
1	Parbhani Kranti	-0.31	-0.72**	-0.36
2	JOH-05-09	-0.60**	0.24	3.35**
3	Arka Anamika	0.11	-0.01	-3.90**
4	Shagun	0.57	-0.34	-2.90**
5	Akola Bahar	-0.43	-0.01	10.85**
6	Pbn-1	0.40	0.03	1.27
7	Ako-107	0.28	0.45**	-0.11
8	Pbn-13	0.73**	0.37	-3.32**
9	VNR (Super Green)	-0.18	0.45	-1.69
10	Pusa Sawani	-0.56	-0.47	-3.19**
	Maximum	0.73	0.45	10.85
	Minimum	-0.60	-0.72	-3.90
	SE	0.194	0.240	1.108
	CD 5%	1.99	2.45	11.33
	CD 1%	2.64	3.26	15.05

Table 2b. Contd….

S. No.	Parents	Yield per plot	Yield per hectare	YVMV
1	Parbhani Kranti	-0.20	-0.04	0.12
2	JOH-05-09	0.98**	0.21**	0.24
3	Arka Anamika	-1.10**	-0.23**	0.03
4	Shagun	-0.86**	-0.18**	-0.09
5	Akola Bahar	3.16**	0.68**	-0.51**
6	Pbn-1	0.39	0.08	-0.51**
7	Ako-107	-0.02	0.00	-0.22
8	Pbn-13	-0.98**	-0.21**	0.49**
9	VNR (Super Green)	-0.47	-0.10	0.37*
10	Pusa Sawani	-0.90**	-0.20**	0.08
	Maximum	3.16	0.68	0.49
	Minimum	-1.10	-0.23	-0.51
	SE	0.319	0.068	0.166
	CD 5%	3.27	0.70	1.70
	CD 1%	4.35	0.94	2.25

Bahar X Pbn-1, Parbhani Kranti X Pusa Sawani followed by Parbhani Kranti X Akola Bahar. For the number of fruits per plant, the cross Ako-107 X Pusa Sawani displayed a highly significant sca effects for this character, seventeen crosses showed highly significant sca effects in desirable positive direction. For average fruit length sixteen crosses exhibited highly significant sca effects in desirable positive direction out of which VNR (Super Green) X Pusa Sawani displayed a highly significant sca effect. For average fruit weight, Pbn-1 X Pusa Sawani displayed a highly significant sca effects in positive direction.

The marketable green fruit yield is an important character for the Okra crop. Out of 45 crosses, nineteen crosses exhibited highly significant sca effects in desirable positive direction. The hybrid Shagun X VNR [Super Green] displayed highly significant sca effects in positive direction. The hybrid Shagun x Pusa Sawani recorded highly significant sca effects in desirable negative direction for reaction to yellow vein mosaic virus. Similar results were also reported by Rajani *et al.* (2001), Dahake (2004), Kumar *et al.* (2004), Weerasekara *et al.* (2008), Singh *et al.* (2010) Wammanda *et al.* (2010) Rekha *et al.* (2015) and Singh *et al.* (2015).

Table 3. Estimates of specific combining ability effects for hybrids

S. No	Crosses	Days to 50% flowering	Plant height at harvest	Number of branches per plant
1	Parbhani Kranti X JOH-05-09	1.80**	2.05**	-0.32
2	Parbhani Kranti X Arka Anamika	-0.29	0.38	-0.11
3	Parbhani Kranti X Shagun	-0.12	1.80**	-0.40*
4	Parbhani Kranti X Akola Bahar	0.46	3.09**	-0.73**
5	Parbhani Kranti X Pbn-1	-0.04	-6.33**	0.77**
6	Parbhani Kranti X Ako-107	-1.37**	-2.12**	2.14**
7	Parbhani Kranti X Pbn-13	1.00**	3.50**	0.56**
8	Parbhani Kranti X VNR (Super Green)	0.30	-1.50**	-0.28
9	Parbhani Kranti X Pusa Sawani	-1.16**	1.55*	-1.15**
10	JOH-05-09 X Arka Anamika	-1.20**	-3.37**	0.31
11	JOH-05-09 X Shagun	-1.54**	3.05**	0.02
12	JOH-05-09 X Akola Bahar	0.55	2.34**	0.68**
13	JOH-05-09 X Pbn-1	0.55	5.42**	-0.32
14	JOH-05-09 X Ako-107	0.21	0.13	1.56**
15	JOH-05-09 X Pbn-13	-0.41	1.25*	-0.53**
16	JOH-05-09 X VNR (Super Green)	0.38	-3.75**	-0.86**
17	JOH-05-09 X Pusa Sawani	0.92**	0.30	1.27**
18	Arka Anamika X Shagun	0.88**	1.38*	1.22**
19	Arka Anamika X Akola Bahar	-0.04	-1.83**	-0.61**
20	Arka Anamika X Pbn-1	-0.04	-0.25	0.89**
21	Arka Anamika X Ako-107	-1.37	3.46**	-0.23
22	Arka Anamika X Pbn-13	-0.50	0.59	-0.82**
23	Arka Anamika X VNR (Super Green)	1.30**	-2.41**	0.85**
24	Arka Anamika X Pusa Sawani	-0.16	6.13**	0.47*
25	Shagun X Akola Bahar	0.13	1.09	0.10
26	Shagun X Pbn-1	-0.37	7.17**	-0.90**
27	Shagun X Ako-107	-0.20	3.38**	-1.03**
28	Shagun X Pbn-13	0.67*	0.00	-0.11
29	Shagun X VNR (Super Green)	-0.04	0.50	1.06**
30	Shagun X Pusa Sawani	-1.50**	0.05	1.18**
31	Akola Bahar X Pbn-1	-1.29**	0.46	-0.23
32	Akola Bahar X Ako-107	-0.12	1.67**	-0.86**
33	Akola Bahar X Pbn-13	-0.25	2.80**	-0.06
34	Akola Bahar X VNR (Super Green)	-1.45**	-0.70	0.72**
35	Akola Bahar X Pusa Sawani	-0.41	-2.66**	-0.65**
36	Pbn-1 X Ako-107	0.88**	-3.25**	-0.36
37	Pbn-1 X Pbn-13	0.75**	-0.12	2.06**
38	Pbn-1 X VNR (Super Green)	-0.45	2.38**	-0.78**
39	Pbn-1 X Pusa Sawani	-0.41	-3.58**	-0.65**
40	Ako-107 X Pbn-13	0.42	-4.41**	1.93**
41	Ako-107 X VNR (Super Green)	-0.71*	-1.91**	-1.40**
42	Ako-107 X Pusa Sawani	0.75**	1.13	0.22
43	Pbn-13 X VNR (Super Green)	1.09**	-1.29**	-0.98**
44	Pbn-13 X Pusa Sawani	-0.37	-2.75**	-1.86**
45	VNR (Super Green) X Pusa Sawani	1.42**	1.25*	0.31
	Maximum	1.80	7.17	2.14
	Minimum	-1.54	-6.33	-1.86
	SE (ii)	0.695	1.57	0.46
	SE (ij)	0.279	0.63	0.18
	CD 5%	2.11	4.78	1.39
	CD 1%	2.80	6.35	1.84

* Significant at 5 per cent level and ** significant at 1 per cent level

Table 3 Contd….

S. No.	Crosses	Number of nodes per plant	Days to first picking	Number of fruits per plant
1	Parbhani Kranti X JOH-05-09	-1.81**	-0.93**	-0.61*
2	Parbhani Kranti X Arka Anamika	-0.31	0.78**	0.84**
3	Parbhani Kranti X Shagun	0.98**	-0.68**	1.34**
4	Parbhani Kranti X Akola Bahar	2.27**	-1.55*	1.22**
5	Parbhani Kranti X Pbn-1	2.23**	0.32	0.51
6	Parbhani Kranti X Ako-107	-0.39	-1.32**	1.39**
7	Parbhani Kranti X Pbn-13	0.73*	0.28	0.39
8	Parbhani Kranti X VNR (Super Green)	-0.27	-0.84**	0.14
9	Parbhani Kranti X Pusa Sawani	-1.64**	-1.57**	-2.82**
10	JOH-05-09 X Arka Anamika	1.27**	-1.49**	0.43
11	JOH-05-09 X Shagun	1.56**	0.03	-0.07
12	JOH-05-09 X Akola Bahar	0.86**	0.16	-0.20
13	JOH-05-09 X Pbn-1	2.81**	-0.97**	0.09
14	JOH-05-09 X Ako-107	-2.81**	1.03**	-1.03**
15	JOH-05-09 X Pbn-13	-0.69*	-0.01	2.47**
16	JOH-05-09 X VNR (Super Green)	0.81*	0.36	0.22
17	JOH-05-09 X Pusa Sawani	-0.56	0.28	-1.24**
18	Arka Anamika X Shagun	-1.94**	0.24	-1.61**
19	Arka Anamika X Akola Bahar	-1.14**	-1.36**	0.26
20	Arka Anamika X Pbn-1	-1.19**	-1.26**	0.05
21	Arka Anamika X Ako-107	-0.31	-0.26	2.57**
22	Arka Anamika X Pbn-13	0.31	0.20	-0.07
23	Arka Anamika X VNR (Super Green)	1.81**	1.07**	0.68*
24	Arka Anamika X Pusa Sawani	0.94**	-0.01	1.22**
25	Shagun X Akola Bahar	-0.85*	-0.09	1.76**
26	Shagun X Pbn-1	-2.39**	0.78**	1.55**
27	Shagun X Ako-107	1.98**	0.28	-0.57
28	Shagun X Pbn-13	-0.39	0.24	0.43
29	Shagun X VNR (Super Green)	-1.39**	-0.39	-1.32**
30	Shagun X Pusa Sawani	0.73*	0.03	-2.28**
31	Akola Bahar X Pbn-1	-0.60	-1.91**	0.93**
32	Akola Bahar X Ako-107	0.27	0.91**	-0.20
33	Akola Bahar X Pbn-13	1.40**	0.86**	2.80**
34	Akola Bahar X VNR (Super Green)	0.40	-0.26	-0.45
35	Akola Bahar X Pusa Sawani	0.52	0.66**	-0.41
36	Pbn-1 X Ako-107	-1.27**	-0.22	1.09**
37	Pbn-1 X Pbn-13	-0.64	0.24	-0.91**
38	Pbn-1 X VNR (Super Green)	0.86*	0.11	-0.66*
39	Pbn-1 X Pusa Sawani	2.48**	0.53*	-1.11**
40	Ako-107 X Pbn-13	1.73**	0.74**	0.97**
41	Ako-107 X VNR (Super Green)	0.23	0.61**	1.22**
42	Ako-107 X Pusa Sawani	-0.64	0.03	3.76**
43	Pbn-13 X VNR (Super Green)	-0.64	0.57**	-1.28**
44	Pbn-13 X Pusa Sawani	1.48**	-0.51*	1.26**
45	VNR (Super Green) X Pusa Sawani	0.48	-0.14	2.51**
	Maximum	2.81	1.07	3.76
	Minimum	-2.81	-1.91	-2.82
	SE (ii)	0.86	0.53	0.76
	SE (ij)	0.34	0.21	0.30
	CD 5%	2.61	1.62	2.29
	CD 1%	3.46	2.15	3.05

* Significant at 5 per cent level and ** significant at 1 per cent level

Table 3 Contd.

S. No	Crosses	Average fruit length	Average fruit weight	Yield per plant
1	Parbhani Kranti X JOH-05-09	1.53**	-0.62	28.71**
2	Parbhani Kranti X Arka Anamika	0.32	0.13	34.46**
3	Parbhani Kranti X Shagun	-1.64**	0.46	33.46**
4	Parbhani Kranti X Akola Bahar	-1.64**	1.13**	7.21**
5	Parbhani Kranti X Pbn-1	1.53**	0.08	-52.71**
6	Parbhani Kranti X Ako-107	2.15**	1.17**	-34.33**
7	Parbhani Kranti X Pbn-13	-0.31	-0.75*	-18.62**
8	Parbhani Kranti X VNR (Super Green)	2.11**	-0.83*	-16.25**
9	Parbhani Kranti X Pusa Sawani	0.48	0.58	-13.75**
10	JOH-05-09 X Arka Anamika	0.11	0.17	0.75
11	JOH-05-09 X Shagun	0.15	0.50	-6.75**
12	JOH-05-09 X Akola Bahar	0.15	0.67*	-15.00**
13	JOH-05-09 X Pbn-1	-1.68**	-1.37**	8.08**
14	JOH-05-09 X Ako-107	0.44	0.71*	14.46**
15	JOH-05-09 X Pbn-13	1.48**	0.79	5.17**
16	JOH-05-09 X VNR (Super Green)	0.40	-0.29	2.04
17	JOH-05-09 X Pusa Sawani	-1.22**	-0.37	-28.46**
18	Arka Anamika X Shagun	-1.06**	-0.75**	-23.00**
19	Arka Anamika X Akola Bahar	1.44**	0.92**	-36.75**
20	Arka Anamika X Pbn-1	-1.39**	0.38	11.33**
21	Arka Anamika X Ako-107	0.23	0.46	-0.79
22	Arka Anamika X Pbn-13	1.28**	-1.46**	7.42**
23	Arka Anamika X VNR (Super Green)	-0.31	0.96**	-1.71
24	Arka Anamika X Pusa Sawani	-1.43**	-0.62	-27.71**
25	Shagun X Akola Bahar	-1.02**	-0.25	-32.75**
26	Shagun X Pbn-1	1.15**	-0.29	-22.17**
27	Shagun X Ako-107	0.78**	0.29	-10.79**
28	Shagun X Pbn-13	-1.18**	-0.12	0.42
29	Shagun X VNR (Super Green)	-0.27	-0.21	36.29**
30	Shagun X Pusa Sawani	1.11**	0.21	30.29**
31	Akola Bahar X Pbn-1	1.65**	-0.62	34.58**
32	Akola Bahar X Ako-107	2.28**	0.46	35.96**
33	Akola Bahar X Pbn-13	-1.68**	0.04	14.17**
34	Akola Bahar X VNR (Super Green)	-2.77**	-0.54	28.54**
35	Akola Bahar X Pusa Sawani	-1.39**	1.38**	15.04**
36	Pbn-1 X Ako-107	0.44	-1.58**	11.54**
37	Pbn-1 X Pbn-13	0.48	0.00	4.75**
38	Pbn-1 X VNR (Super Green)	2.40**	-0.08	-1.87
39	Pbn-1 X Pusa Sawani	-0.22	1.83**	-7.87**
40	Ako-107 X Pbn-13	-2.89**	0.08	-6.37**
41	Ako-107 X VNR (Super Green)	-2.97**	0.00	-15.50**
42	Ako-107 X Pusa Sawani	1.40**	-0.58	-10.00**
43	Pbn-13 X VNR (Super Green)	0.57*	0.08	-17.29**
44	Pbn-13 X Pusa Sawani	1.94**	0.00	11.71**
45	VNR (Super Green) X Pusa Sawani	2.86**	-0.08	17.58**
	Maximum	2.86	1.83	36.29
	Minimum	-2.97	-1.58	-52.71
	SE (ii)	0.65	0.81	3.73
	SE (ij)	0.26	0.32	1.49
	CD 5%	1.98	2.45	11.33
	CD 1%	2.63	3.25	15.05

* Significant at 5 per cent level and ** significant at 1 per cent level

Table 3 Contd.

S. No	Crosses	Yield per plot	Yield per hectare	YVMV
1	Parbhani Kranti X JOH-05-09	8.44**	1.80**	0.81**
2	Parbhani Kranti X Arka Anamika	10.10**	2.15**	0.02
3	Parbhani Kranti X Shagun	9.83**	2.10**	1.15**
4	Parbhani Kranti X Akola Bahar	2.16**	0.46**	0.56*
5	Parbhani Kranti X Pbn-1	-15.20**	-3.24**	0.56*
6	Parbhani Kranti X Ako-107	-9.84**	-2.10**	1.27**
7	Parbhani Kranti X Pbn-13	-5.26**	-1.12**	-0.44
8	Parbhani Kranti X VNR (Super Green)	-4.60**	-0.98**	-0.81**
9	Parbhani Kranti X Pusa Sawani	-3.88**	-0.82**	0.98
10	JOH-05-09 X Arka Anamika	0.19	0.04	0.40
11	JOH-05-09 X Shagun	-1.95**	-0.42**	1.02**
12	JOH-05-09 X Akola Bahar	-4.37**	-0.94**	-0.06
13	JOH-05-09 X Pbn-1	2.35**	0.51**	0.44
14	JOH-05-09 X Ako-107	4.16**	0.89**	1.15**
15	JOH-05-09 X Pbn-13	1.52**	0.32**	-0.56*
16	JOH-05-09 X VNR (Super Green)	0.56	0.12	-0.44
17	JOH-05-09 X Pusa Sawani	-8.26**	-1.76**	0.86**
18	Arka Anamika X Shagun	-6.64**	-1.42**	1.23**
19	Arka Anamika X Akola Bahar	-10.66**	-2.28**	0.65**
20	Arka Anamika X Pbn-1	3.24**	0.70**	-1.35**
21	Arka Anamika X Ako-107	-0.26	-0.06	-0.64**
22	Arka Anamika X Pbn-13	2.15**	0.46**	0.65**
23	Arka Anamika X VNR (Super Green)	-0.51	-0.11	0.77**
24	Arka Anamika X Pusa Sawani	8.02**	-1.71**	0.06
25	Shagun X Akola Bahar	-9.46**	-2.01**	-0.23
26	Shagun X Pbn-1	-6.37**	-1.35**	-1.23**
27	Shagun X Ako-107	-3.15**	-0.67**	1.48**
28	Shagun X Pbn-13	0.29	-0.06	-1.23**
29	Shagun X VNR (Super Green)	10.55**	2.25**	0.90
30	Shagun X Pusa Sawani	8.78**	1.88**	-1.81**
31	Akola Bahar X Pbn-1	10.02**	2.15**	1.19**
32	Akola Bahar X Ako-107	10.42**	2.22**	-1.10**
33	Akola Bahar X Pbn-13	4.14**	0.88**	1.19**
34	Akola Bahar X VNR (Super Green)	8.23**	1.76**	0.31
35	Akola Bahar X Pusa Sawani	4.36**	0.94**	0.11
36	Pbn-1 X Ako-107	3.35**	0.72**	-0.60**
37	Pbn-1 X Pbn-13	1.41**	0.31**	1.19**
38	Pbn-1 X VNR (Super Green)	-0.60	-0.12	0.31
39	Pbn-1 X Pusa Sawani	-2.31**	-0.57**	1.11**
40	Ako-107 X Pbn-13	-1.83**	-0.39**	0.90**
41	Ako-107 X VNR (Super Green)	-4.49**	-0.96**	-0.98**
42	Ako-107 X Pusa Sawani	-2.91**	-0.62**	-1.69**
43	Pbn-13 X VNR (Super Green)	-4.98**	-1.07**	0.31
44	Pbn-13 X Pusa Sawani	3.40**	0.73**	-0.39
45	VNR (Super Green) X Pusa Sawani	5.09**	1.09**	0.73**
	Maximum	10.55	2.25	1..48
	Minimum	-15.20	-3.24	-1.81
	SE (ii)	1.07	0.23	0.56
	SE (ij)	0.43	0.09	0.22
	CD 5%	3.27	0.70	1.69
	CD 1%	4.34	0.93	2.25

* Significant at 5 per cent level and ** significant at 1 per cent level

Table 4. Best General and Specific Combiners for nine characters in 10 x 10 half diallel of okra

S. No.	Character	GCA	SCA
1	Days to 50% Flowering	JOH-05-09 (-0.47)	JOH-05-09 X Shagun (-1.54)
2	Plant height at harvest	Shagun (0.57)	Shagun X Pbn 1 (7.17)
3	Number of branches per plant	VNR (Super Green) (0.40)	Parbhani Kranti X Ako-107 (2.14)
4	Number of nodes per plant	JOH-05-09 (0.70)	JOH-05-09 X Pbn-1 (2.81)
5	Days to first Picking	Parbhani Kranti (-0.40)	Akola Bahar X Pbn-1 (-1.91)
6	Number of fruits per plant Length	Parbhani kranti (0.62)	Ako-107 X Pusa Sawani (3.76)
7	of frui	Pbn-13 (0.73)	VNR (Super Green) X Pusa sawani (2.86)
8	Weight of fruit	VNR (Super green) (0.45)	Akola Bahar X Ako 107 (10.42)
9	Yield per plot	Akola bahar (3.16)	Shagun x VNR (Super Green) (10.55)

The best general and specific combiners for all the characters displayed in **Table 4**. For days to 50 % flowering, parent JOH-05-09 displayed a highly significant negative gca effect while JOH-05-09 X Shagun displayed a highly significant negative sca effect. Similarly, for plant height at harvest, parent Shagun displayed a highly significant positive gca effect while shagun x Pbn-1 displayed a highly positive sca effect. For the number of nodes per plant, JOH-05-09 showed a highly significant positive gca effect while JOH-05-09 X Pbn-1 displayed a higher sca effects. For yield character, parent Akola Bahar displayed a highly significant positive gca effect while cross Akola Bahar X Ako- 107 displayed a higher sca effects. Singh *et al.* (1984), Jawili and Rasco (1990), Patil *et al.* (1996), Pathak *et al*. (2001), Nichal *et al.* (2001), Rajani *et al.* (2001), Dahake (2004), Kumar *et al.* (2004), Weerasekara *et al.* (2008), Singh *et al.* (2010), Wammanda *et al.* (2010), Bhatt *et al.* (2015), Rekha *et al.* (2015) and Singh *et al.* (2015) also studied combining ability in Okra and reported the list of good general and specific combiners for all the characters based on gca and sca effects.

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