Combining Ability Studies In Okra (Abelmoschus Esculentus (L.) Monech)

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Abstract:
Combining ability effects were estimated for different characters of okra in a line x tester mating design, comprising 60 hybrids produced by crossing 4 lines and 15 testers. Parents and hybrids differ significantly for gca and sca effects, respectively. The hybrids Arka Abhay x IC-433675, Varsha Uphar x IC-433673, Arka anamika x IC-328942, Arka Anamika x IC-433670, Parbhani Kranthi x IC-433645 and Varsha Uphar x IC-332454 for fruit yield and most of its component traits.

Key words: combining ability, okra

1.Introduction

Combining ability is a prerequisite in any plant breeding programme either for varietal improvement or for evolving a hybrid. For developing a new variety through conventional breeding programme, selection of potential parents based on their combining ability and few special attributes under consideration is most important. The genetic potential of the parents is expressed in terms of combining ability. Among the parents involved in a large number of crosses, only few exhibits superiority and such parents producing a good hybrid are considered as good general combiners. Sprague and Tatum (1942) gave the concept of combining ability as genetic variation. The general combining ability in respect of a character is the manifestation of additive gene action. The general combining ability is the measure of additive genetic factor where as specific combining ability is due to non-additive genetic factor.

Line x tester analysis proves to be a useful technique for screening a large number of genotypes with reasonable confidence. This design developed by Kemphthorne (1957) is a powerful and commonly used tool for estimation of general and specific combining ability effects by using 4 Lines and 15 Testers in okra.

2.Material And Methods

The present investigation was conducted during kharif-2009 and spring summer 2010 at student farm, college of horticulture, Rajendranagar, Hyderabad. Four diverse Lines (female parents), fifteen testers (male parents) and 60 hybrids obtained from these lines x tester formed the experimental material.

Four lines and fifteen testers were grown in separate plots with staggered sowings to ensure synchronization of flowering and each tester was crossed with all the four lines. Spacing adopted for rows was 60 cm and 30 cm for plant to plant. Emasculation was carried out in the evening

(4.00 pm to 6.30 pm) and the pollination was done in the next day morning (8.0 am to 10.30 am). The process of hybridization was continued for about 30 days to obtain sufficient seed of each cross combination was collected separately as and when the individual fruits attained maturity.

The seeds of 60 crosses and 19 parents were sown in a Randomized Block Design at 45x 15 cm spacing with 3 replications in spring summer on 19/01/2010. Standard cultural practices were followed to raise the normal crop. Data were recorded on five randomly selected plants in each treatments over replications for thirteen characters *viz.,* plant height (1), days to 50% flowering (2), days to maturity (3), node at which first flower appears(4),number of branches per plant (5),number of fruits per plant(6),length of the fruit (7),diameter of the fruit(8),ten pods weight(9), fruit yield per plant (10), fruit yield per hectare(11), node at which mosaic disease appears (12), and days at first mosaic symptoms appear (13).The analysis of general and specific combining ability for 13 characters was done as per model suggested by Kemphthorne (1957).

3.Results And Discussion

Analysis of variance due to different sources of variation for thirteen characters is presented in table-1 and revealed that mean sum of squares due to crosses, lines (females) and testers (males) were significant for all the traits except no. of branches per plant, fruit yield per plant and node at which mosaic disease appears.

The estimates of general combing ability effects of 4 female lines and 15 male testers for thirteen characters (Table-2) indicated that the parents Arka Abhay and Arka Anamika recorded significant and positive gca effects for most of the yield components such as plant height, number of branches per plant, number of fruits per plant, fruit yield per plant and fruit yield per hectare. For the trait days to maturity, Arka Abhay and Arka Anamika recorded desirable negative gca effect. These two parents were good for earliness. The line Varsha Uphar recorded significant and desirable effects for days to 50% flowering.

Among the testers IC-326893, IC -433670, IC-433673, IC-433695 and IC -331217 were found to be good general combiners for fruit yield plant, fruit yield per hectare, length of the fruit and other agronomically important characters. For earliness, the male parents IC -332453, IC-433672, IC-328942, IC -331026, IC -331067 and IC -331217 were found to be good general combiners for days to 50 % flowering and days to maturity. These results are in conformity with findings of Pratap *et a*l. (1980), Shinde *et al.* (1995), Kumar *et al. (*2005) and Dhake and Banger (2006). Therefore, those parents may be used for hybridization for producing promising recombinations.

The sca effects for hybrids pertaining to different characters are given in table-3. Sca that represents the predominance of non-additive gene action, is a major component that may be utilized in heterosis breeding. The sca effects of the crosses revealed that seven cross combinations had significant and positive sca effects, while Four showed negative and significant Sca effects for fruit yield per plant and fruit yield per hectare. Among them Arka Anamika x IC-433670, Arka Anamika x IC-328942, Parbhani Kranthi x IC-433645, Varsha Uphar x IC -332453, Varsha Uphar x IC -332454 and Varsha Uphar x IC -433673 were found to be best specific combiners for fruit yield. Patil *et al.* (1996) and Rewale *et al.* (2003).

For plant height seven hybrids exhibited significant negative sca effects and four crosses exhibited positive significant sca effects for this trait. The crosses Parbhani Kranti x IC - 328942, Arka Abhay x IC-433645, Arka Anamika x IC-331067 showed highest negative sca effect while Parbhani Kranti x IC-331217, Arka Anamika x IC-332453 showed highest positive sca effect. These hybrids were the best combiners for this trait.

The traits, days to 50 % flowering and days to maturity are desirable for earliness. For days to 50 % flowering, ten hybrids recorded significant negative sca effects (i.e. desirable for earliness) viz., Arka Anamika x IC-328942, Arka Abhay x IC-433673, Varsha Uphar x 331026, Parbhani Kranti x IC-433670, Arka Abhay x IC-331067, Arka Abhay x IC-433672 , Arka Anamika x IC – 433672 and five hybrids viz., Parbhani Kranti x IC-433645, Arka Anamika x IC-331217, Varsha Uphar x IC-433670, Parbhani Kranti x 331067, Arka Anamika x IC-433675 for days to maturity were found to be the best specific combiners for earliness.

Arka Anamika x IC – 433640, Varsha Uphar x IC-331026, Arka Abhay x IC-433640, Varsha Uphar x IC-433695, Varsha Uphar x IC-433675 for node at which the first flower appears; Arka Anamika x IC-433672, Arka Abhay x IC-331217, Arka Abhay x IC-331026, Arka Abhay x IC-433673 for number of branches per plant; Parbhani Kranti x IC-433672, Arka Abhay x IC-332454 and Parbhani Kranti x IC-433695, Arka Anamika x IC-326893, Varsha Uphar x IC-433690, Varsha Uphar x IC-433645 for length of the fruit; Parbhani Kranti x IC-433672, Arka Abhay x IC-433673, Arka Anamika x IC-332454; Parbhani Kranti x IC-433672 for the diameter of the fruit and Varsha Uphar x IC-331217, Arka Anamika x IC-433670, Arka Anamika x IC-331217, Parbhani Kranti x IC-433672 for the ten pods weight were identified as the best crosses as they exhibited high per se performance and high sca effects reorted by Chavadhal and Malkhadale, (1994) and Sanjay *et al*., (2006).

Arka Anamika x IC-326893, Arka Anamika x IC-331217, Parbhani Kranti x IC-433690, Arka Anamika x IC-433690 and Varsha Uphar x IC-433675 for node at which mosaic disease appears; Arka Anamika x IC-331217, Parbhani Kranti x IC-433690, Parbhani Kranti x IC-332453 for days at first mosaic symptom appears were identified as the best crosses for that traits.

crosses with high per se performance and sca effects (Varsha Uphar x IC-433673, Arka Anamika x IC-328942, Arka Anamika x IC-433670, Parbhani Kranti x IC-433645 and Varsha Uphar x IC-332454) for fruit yield per plant also exhibited high sca effects for other important yield components like ten pods weight, number of fruits per plant and diameter of the fruits in the material studied.

Most of the superior crosses in the material studied with high sca effects and per se performance for days to 50 % flowering (Arka Anamika x IC-328942, Arka Abhay x IC-433673), number of branches per plant (Arka Anamika x IC-433672, Arka Abhay x IC-331217), number of fruits per plant (Parbhani Kranti x IC-433672, Arka Abhay x IC-332454), diameter of the fruit (Parbhani Kranti x IC-433672, Arka Anamika x IC-332454), length of the fruit (Varsha Uphar x IC-433695, Arka Anamika x IC-326893), pods weight (Varsha Uphar x IC-331217, Arka Anamika x IC-433670), node at which mosaic disease appears (Arka Anamika x IC-326893, Arka Anamika x IC-331217), days at first mosaic disease appears (Arka Anamika x IC-331217, Parbhani Kranti x IC-433690) involved parents with medium x high, high x low, low x low gca effects (Singh and Singh, 1979 and Chavadhal and Markhandale, 1994) for such crosses selection, The superior cross for fruit yield per plant and pod

weight (Varsha Uphar x IC-433673) involved low x low general combiners suggesting that epistatic gene action, might be due to genetic diversity in the form of heterozygous loci.

From the present study, it can be concluded that, the promising cross combinations (Arka Anamika x IC-331217, Arka Abhay x IC-332454, Arka Abhay x IC-331217, Arka Anamika x IC-326893, Arka Anamika x IC-433670 Varsha Uphar x IC-433673) which exhibited good per se performance for fruit yield also possessed high sca effects coupled with higher magnitude of heterosis for associated traits and further, these crosses mostly involved parents having high x low gca effects. Similar results were reported earlier by Elangoven *et al.*, (1981); Kumar *et al.*, (2005) and Weersekara *et al*., (2008) which indicated the pre-dominance of non additive gene action in the inheritance. These crosses could be included for exploitation of hybrid vigour in Okra. However, it needs further testing before recommended these combinations for exploitation on large scale.

Source of variation	df	Plant height (cm)	Days to 50% flowering	Days to maturity	Node at which 1st flower appears	No. of branches/ plant	No. of fruits/plant	Length of the fruit	Diameter of the fruit	Ten pods weight (g)	Fruit yield/plant	Fruit yield/ha	Node at which mosaic disease appears	Days at first mosaic symptom appear
Replications	2	20.56	35.59**	0.88**	0.75**	0.20	1.52	0.29	0.02	5.03	221.61	4.14	**6.63**	45.56
Treatments	78	571.61**	13.00**	0.44**	0.34**	2.30**	12.78**	6.72**	0.04**	244.40**	1894.67**	41.38**	60.16**	1885.78**
Parents	18	464.96**	9.41**	0.24**	0.25**	0.92**	2.10	6.08**	0.07**	74.28**	118.01	2.57	47.47**	1643.85**
Parents vs. Crosses	1	125.11	49.12**	5.12**	1.16**	5.84**	175.26**	2.45*	0.10**	1505.80**	32754.85**	726.73**	4.14	126.66
Crosses	59	611.12**	13.48**	0.42**	0.36**	2.67	13.2**	6.99**	0.03**	274.92**	1913.65	41.60**	64.98**	1989.40**
Lines	3	366.63**	10.44**	0.12**	0.03	0.09	0.12	1.97*	0.01	12.96	17.33	0.37	98.02	3400.00**
Testers	14	469.44**	7.51**	0.22**	0.19**	1.14**	2.50	4.87**	0.07**	91.19	141.39	3.08	40.02	1365.71**
Lines X Testers	1	697.23**	33.01**	0.52**	1.74**	0.20	2.45	35.25**	0.34**	21.44	92.65	1.99	0.24	269.47
Error	156	57.51	1.11	0.02	0.07	0.11	2.26	0.59	0.006	31.82	264.14	5.94	5.77	199.41

Table 1: Analysis Of Variance For Combining Ability Of Thirteen Characters In Okra
* Significant At 5% Level;   ** Significant At 1% Level

Table 2: Estimates Of General Combining Ability (Gca) For Lines And Testers For Thirteen Characters In Okra

S. No.	Parents	Plant height (cm)	Days to 50% flowering	Days to maturity	Node at which 1st flower appears	No. of branches/ plant	No.of fruits/plant	Length of the fruit	Diameter of the fruit	Ten pods weight (g)	Fruit yield/ plant	Fruit yield/ha	Node at which mosaic	Days at first mosaic
	LINES													
1	ARKA ABHAY	8.33*	-0.15**	-0.05**	0.00	0.02**	0.40**	0.81	0.03	3.53*	9.04**	1.32**	-0.46	-1.50
2	ARKA ANAMIKA	2.58	0.43**	-0.08**	-0.01	0.36	0.10	-0.23	0.04	2.42	5.00**	0.71*	-1.34	-6.17
3	PARBHANI KRANTI	2.28	0.29**	0.08**	-0.04	-0.31	-0.22	-0.37	-0.03	-4.61	-8.15	-1.23	0.93**	4.50
4	VARSHA UPHAR	-13.19**	-0.57**	0.05**	0.05	-0.07	-0.28	-0.21	-0.04	-1.35	-5.88	-0.80	0.86*	3.17
	TESTERS													
1	IC-332453	-7.89**	-0.04**	-0.10**	0.03*	-0.22	-0.45	-0.45	0.05	2.53	-2.48	-0.39	0.84	15.00
2	IC-433640	2.71	0.29	-0.06**	-0.14	0.38	-0.64	-0.63	0.01	-3.68	-11.07	-1.66	1.59	2.50
3	IC-326893	10.29	-1.46**	-0.45**	0.02	0.74	0.40	0.47**	0.006**	6.20	1.19**	0.74**	-2.03	-7.50
4	IC-332454	-4.10**	0.71**	0.41**	-0.12	-0.47	-1.09	-0.40	0.01	1.33	-8.19	-1.24	-0.71	-2.50
5	IC-433672	-4.31**	-0.54**	-0.09**	0.06**	0.62	-0.32	0.07	0.02	1.66	-3.51	-0.17	-0.78	2.50
6	IC-433670	2.92	1.21**	0.04**	-0.07	-0.21	0.92*	0.28*	-0.02	4.48	2.89**	2.18**	0.34	7.50
7	IC-328942	-4.54**	-0.29**	0.08**	0.20	-0.10	-2.27	-1.25	-0.10	-6.00	-29.08	-4.33	-2.60	-12.50
8	IC-433690	2.96	-0.21**	0.17**	-0.12	-0.33	-0.55	0.75	0.06	6.21	2.05	0.28	3.80**	12.50
9	IC-433673	3.65	1.21**	0.39**	0.13	-0.03	1.43**	0.11	-0.03	-5.84	3.30**	0.77**	2.26*	5.00
10	IC-331026	-2.72**	0.29	-0.23**	0.25	0.41	0.99*	0.29*	-0.06	-6.89	0.66	0.07	-0.92	-5.00
11	IC-433695	2.66	-1.63**	-0.13**	0.07	-0.03	0.93*	0.92	0.04	-1.91	6.79**	0.98**	2.81*	7.50
12	IC-331067	-6.00**	-0.88**	-0.05**	-0.16**	0.06*	-0.14	-0.23	0.04	-3.37	-5.05	-0.77	-2.17	-10.00
13	IC-433675	0.64	0.54*	0.12**	-0.30**	-0.07	-0.52	0.26*	-0.03	-2.93	-7.45	-1.13	-2.35	-10.00
14	IC-433645	8.91	0.79**	-0.01**	-0.01	-0.77	-0.89	-0.35	0.02	1.55	-7.72	-1.17	2.28*	10.00
15	IC-331217	-5.18**	0.04	-0.11**	0.14**	0.03	3.00	0.15	0.01**	6.66	39.68	5.86	-2.35	-15.00

S. No.	Crosses	Plant height (cm)	Days to 50% flowering	Days to maturity	Node at which 1st flower appears	No. of branches/plant	No.of fruits/plant	Length of the fruit	Diameter of the fruit	Ten pods weight (g)	Fruit yield/plant	Fruit yield/ha	Node at which mosaic disease appears	Days at first mosaic symptom appears
1	ARKA ABHAY x IC-332453	-6.5894	-0.6000	0.3277	-0.6663	-0.5861**	-0.2371	0.0471	0.0086	-2.3756	-6.0259	-0.8676	3.8337**	19.0000*
2	ARKA ABHAY x IC-433640	-10.0552*	1.7333**	0.5861	-0.4213**	-1.0228	-0.2404	-0.7246	-0.0439	-7.7389*	-11.9609	-1.7476	1.0253	1.5000
3	ARKA ABHAY x IC-326893	25.5389	-0.1833	-0.0148	-0.0172	0.1189	-0.7854	-2.7504	-0.0231	-2.8081	-12.2167	-1.7776	2.4428	21.5000**
4	ARKA ABHAY x IC-332454	0.4398	1.6500**	-0.1106	0.4820**	0.3947*	2.3296**	1.9562	-0.0664	11.9578	40.1666	5.9749	-6.8672	-43.5000
5	ARKA ABHAY x IC-433672	-5.4052	-1.4333*	-0.1514	0.3587*	0.3806*	0.4129	-0.4854	-0.1122*	-7.9422*	-3.9601	-0.9326	0.6953	21.5000**
6	ARKA ABHAY x IC-433670	-7.8486	3.1500	0.5786	0.0695	-1.0736	-1.1921	-0.8613	0.0861	0.5903	-11.9876	-1.7542	1.8628	6.5000
7	ARKA ABHAY x IC-328942	8.1014	0.6500	-0.3731	-0.1372	0.2239	0.7196	0.7496	0.0661	-5.0964	0.0791	0.0349	-4.9763	-33.5000
8	ARKA ABHAY x IC-433690	2.6914	-0.4333	-0.0173	0.1137	0.2256	1.6804	0.8162	-0.0097	-10.3614**	3.8641	0.5983	0.9937	21.5000**
9	ARKA ABHAY x IC-433673	-4.7386	-1.8500**	0.0769	-0.2247	0.4297*	-2.0888*	2.3537	0.1244**	3.3711	-15.9226	-2.3392	1.7128	9.0000
10	ARKA ABHAY x IC-331026	1.1748	1.0667	-0.2139*	0.5553	0.4356*	-1.3079	1.7087	0.0036	5.9261	-5.9684	-0.8592	1.5853	19.0000*
11	ARKA ABHAY x IC-433695	-16.3469	-0.6833	-0.1606	-0.2947	-0.1444	0.6104	-0.1754	-0.0414	-1.7756	4.6228	0.7066	3.4862*	6.5000
12	ARKA ABHAY x IC-331067	13.4673	-1.4333*	-0.0264	0.0562	-0.9186	0.0396	-0.2346	0.0536	-0.2756	-1.6451	-0.2167	5.3120	24.0000**

13	ARKA ABHAY x IC-433675	5.6706	-2.8500	-0.2239*	0.6753	0.8072	1.6729	0.5204	0.0586	11.6636	31.7291**	4.7249**	-5.2297	-36.0000
14	ARKA ABHAY x IC-433645	-12.9436**	2.2333	0.1177	-0.3272*	0.2197	-2.2396*	-1.2988**	-0.0447	5.6211	-19.0134*	-2.7909*	-0.6538	-6.0000
15	ARKA ABHAY x IC-331217	6.8431	-1.0167	-0.3948	-0.2222	0.5097**	0.6262	-1.6213	-0.0597	-0.7564	8.2391	1.2458	-5.2230	-31.0000

S. No.	Crosses	Plant height (cm)	Days to 50% flowering	Days to maturity	Node at which 1st flower appears	No. of branches/ plant	No. of fruits/plant	Length of the fruit	Diameter of the fruit	Ten pods weight (g)	Fruit yield/plant	Fruit yield/ha	Node at which mosaic disease appears	Days at first mosaic symptom appears
16	ARKA ANAMIKA x IC-332453	-14.0941**	-2.1778	-0.1778	0.1857	-0.6932	-1.3313	-0.4481	0.0591	-2.0656	-17.9492	-2.6333	-0.4894	-6.3333
17	ARKA ANAMIKA x IC-433640	-2.6632	1.8222**	0.2138*	-0.5093**	1.1268	-0.4113	-0.6797	-0.0234	2.0511	-2.7709	-0.3833	1.0556	-13.8333
18	ARKA ANAMIKA x IC-326893	-9.1357*	-0.0944	0.0430	-0.2352	-0.3249	3.0903	0.9478*	0.0074	6.1486	42.0233	6.2267	-4.6603**	-33.8333
19	ARKA ANAMIKA x IC-332454	-6.7016	-2.9278	0.1338	-0.1227	-0.1757	-0.0113	0.5711	0.1241**	1.9711	-0.6801	-0.0742	3.5297*	31.1667
20	ARKA ANAMIKA * x IC-433672	5.0768	-1.3444*	0.3097*	-0.0627	0.6334**	-1.4613	0.5294	-0.0584	-7.8756*	-22.4734*	-3.6750*	6.8956	36.1667
21	ARKA ANAMIKA x IC-433670	16.2934	1.5722*	-0.1637	0.1548	-0.9674	0.9703	0.3903	-0.0401	10.5669**	26.2991**	3.9233**	-7.0336	-48.8333
22	ARKA ANAMIKA x IC-328942	20.6968	-1.9278**	-0.0387	-0.1985	-0.2999	1.9120*	2.5978	-0.0168	8.9703**	27.6991**	4.1325**	8.5572	41.1667
23	ARKA ANAMIKA x IC-433690	-3.0799	1.6556**	-0.5295	0.0157	0.6551	1.0462	-1.9022	0.0741	-0.2747	9.4041	1.4192	2.4739	6.1667
24	ARKA ANAMIKA x IC-433673	11.2268*	1.57228*	0.1947*	-0.3060*	-0.2641	-1.5663	0.4153	-0.0918*	-0.0189	-15.2092	-2.2317	-8.9503	-46.3333
25	ARKA ANAMIKA x IC-331026	1.1968	3.1556	-0.0395	0.0673	-2.0182	-2.4155**	-1.2397**	-0.0093	-5.7672	-30.4684**	-4.4883**	3.3689*	13.6667
26	ARKA ANAMIKA x IC-433695	-8.4782	-0.9278	-0.2462**	0.7273	1.1551	0.9695	-0.3639	0.0024	-10.3256**	-4.7306	-0.6692	-3.1869*	1.1667
27	ARKA ANAMIKA	-10.9574*	2.3222	0.4113	0.2482	-0.9657	-1.0347	-	-0.1759	-3.6856	-16.3351	-2.3925	1.8722	18.6667*

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	x IC-331067									2.2997				
28	ARKA ANAMIKA x IC-433675	4.7659	-2.4278	-0.2528**	-0.1093	1.0134	0.0220	0.1819	0.0557	2.3669	-0.0809	0.0158	3.4339*	28.6667
29	ARKA ANAMIKA x IC-433645	-9.8549*	1.9889**	0.4422	-0.0385	0.0759	0.1995	-0.3706	-0.0109	-10.7889**	-10.6867	-1.5600	-2.5269	-1.3333
30	ARKA ANAMIKA x IC-331217	5.7084	-2.2611	-0.3003**	0.1832	1.0493	0.0220	1.6703	0.1041*	8.7269**	15.9591	2.3900	-4.3394**	-26.3333**
31	PARBHANI KRANTI x IC-332453	4.9306	2.9556	-0.0985	0.2208	0.0883	-0.7880	0.1388	-0.0396	7.3622*	1.1388	0.1920	-2.2534	-17.0000*
32	PARBHANI KRANTI x IC-433640	4.7281	3.3778	-0.4502	0.1791	-0.3917*	1.0087	0.8072	0.0079	1.2689	11.8872	1.7853	-2.1384	5.5000
33	PARBHANI KRANTI x IC-326893	-10.2411*	0.0389	0.1657	0.0199	0.3367	-1.7230*	0.7047	-0.0379	-2.2603	-21.4187*	-3.1413*	-1.4943	-4.5000
34	PARBHANI KRANTI x IC-332454	2.6231	0.8722	-0.1435	-0.5742	0.2592	-1.3213	0.2847	0.1121*	0.4156	-14.8020	-2.1688	3.3091*	10.5000
35	PARBHANI KRANTI x IC-433672	7.3248	-0.8778	-0.1543	-0.2042	0.7883	2.3753**	-0.0803	0.1429**	8.3622*	38.7313	5.3937	-8.1851	-54.5000
36	PARBHANI KRANTI x IC-433670	-5.3852	-1.6278**	-0.1277	-0.1301	-0.2725	-1.7097	-0.6328	0.0246	7.2781*	-8.5895	-1.2513	0.3824	20.5000*
37	PARBHANI KRANTI x IC-328942	-23.4286	1.8722**	-0.3427	0.1666	0.2817	-1.0480	-1.3887**	0.0446	-3.7053	-12.3495	-1.8055	-0.9434	0.5000

38	PARBHANI KRANTI x IC-433690	2.5014	-1.5444*	0.1898*	-0.0259	-0.3967*	-2.4372**	-0.7120	-0.1779	-11.0803	-35.8112	-5.2822	-3.9034**	-24.5000**
39	PARBHANI KRANTI x IC-433673	-13.6386**	0.0389	0.1007	0.6024	-0.0458	-0.7030	0.4255	0.0396	5.2522	1.3955	0.2437	1.3391	3.0000
40	PARHHANI KRANTI x IC-331026	6.4348	-2.3778	-0.0435	-0.1676	0.8633	2.2545*	0.0138	-0.0413	-2.0094	18.2197	2.7237	3.0182*	13.0000
41	PARBHANI KRANTI x IC-433695	26.4431	2.5389	0.7365	-0.0242	-1.3733	0.4462	-0.5870	0.0004	4.8256	10.5662	1.5828	-0.4543	0.5000
42	PARBHANI KRANTI x IC-331067	-8.1827	-1.2111*	-0.2693**	-0.3467*	1.7392	-1.9913*	2.2005	0.0521	0.5689	-17.4903	-2.5705	-0.4618	-2.0000
43	PARBHANI KRANTI x IC-433675	-4.8594	1.7056**	0.1865*	-0.1876	-0.4383*	1.7753*	0.7588	0.0671	-3.1786	11.8205	1.7745	4.6166**	18.0000*
44	PARBHANI KRANTI x IC-433645	25.0198	-2.8778	-0.3085**	0.1433	-0.8092	1.6162	0.6897	0.0637	5.8322	24.9447**	3.7220**	4.4757**	-2.0000
45	PARBHANI KRANTI x IC-331217	-14.2702**	3.8722	0.5590	0.3283	-0.6292**	2.2453*	-2.6228	-0.2579	-18.9319	-8.2428	-1.1980	2.6932	33.0000

S. No.	Crosses	Plant height (cm)	Days to 50% flowering	Days to maturity	Node at which 1st flower appears	No. of branches/plant	No.of fruits/plant	Length of the fruit	Diameter of the fruit	Ten pods weight (g)	Fruit yield/plant	Fruit yield/ha	Node at which mosaic disease appears	Days at first mosaic symptom appears
46	VARSHA UPAHAR x IC-332453	15.7528	-0.1778	0.0514	0.2599	1.1910	2.3564**	0.2622	-0.0281	-2.9211	22.8363*	3.3089*	-1.0908	4.3333
47	VARSHA UPAHAR x IC-433640	7.9903	-0.1778	-0.3497	0.7516	0.2877	-0.3569	0.5972	0.0594	4.4189	2.8446	0.3456	0.0576	6.8333
48	VARSHA UPAHAR x IC-326893	-6.1622	0.2389	-0.1939*	0.2324	-0.1307	-0.5819	1.0980*	0.0536	-1.0803	-8.3879	-1.3078	3.7117	16.8333*
49	VARSHA UPAHAR x IC-332454	3.6387	0.4056	0.1203	0.2149	-0.4782	-0.9969	-2.8120	-0.1697	-14.344	-24.6845**	3.7319**	0.0284	1.8333
50	VARSHA UPAHAR x IC-433672	-6.9963	3.6556	-0.0039	-0.0918	-1.8023	-1.3269	0.0363	0.0278	7.4556*	-12.2979	-0.7861	0.5942	-3.1667
51	VARSHA UPAHAR x IC-433670	-3.0597	-3.0944	-0.2872**	-0.0943	2.3135	1.9314*	1.1038*	-0.0706	-18.4353	-5.7220	-0.9178	4.7884	21.8333**
52	VARSHA UPAHAR x IC-328942	-5.3697	-0.5944	0.7544	0.1691	-0.2057	-1.5836	-1.9587	-0.0939*	-0.1686	-15.4287	-2.3619	-2.6374	-8.1667
53	VARSHA UPAHAR x IC-433690	-2.1130	0.3222	0.3569	-0.1034	-0.4840	-0.2894	1.7980	0.1136*	21.7164	22.5430*	3.2647*	0.4359	-3.1667
54	VARSHA UPAHAR x IC-433673	7.1503	0.2389	-0.3722	-0.0718	-0.1198	4.3581	-3.1945	-0.0722	8.6044**	29.7363**	4.3272*	5.8984	34.3333
55	VARSHA UPAHAR x IC-331026	-8.8063*	-1.8444**	0.2969**	-0.4551**	0.7193	1.4689	-0.4828	0.0469	1.8506	18.2171	2.6239	-7.9724	-45.6667
56	VARSHA UPAHAR x IC-433695	-1.6180	-0.9278	-0.3297	-0.4084**	0.3627	-2.0261*	1.1263*	0.0386	7.2756*	-10.4584	-1.6203	0.1551	-8.1667
57	VARSHA UPAHAR x IC-331067	5.6728	0.3222	-0.1156	0.0424	0.1452	2.9864	0.3338	0.0703	3.3922	35.4705	5.1797	-6.7224	-40.6667

58	VARSHA UPAHAR x IC-433675	-5.5772	3.5722	0.2903**	-0.3784*	-1.3823	-3.4702	-1.4612**	-0.1814	-10.8519**	-43.4687	-6.5153	-2.8208*	-10.6667
59	VARSHA UPAHAR x IC-433645	-2.2213	-1.3444*	-0.2514**	0.2224	0.5135	0.4239	0.9797*	-0.0081	-0.6644	4.7555**	0.6289	-1.2949	9.3333
60	VARSHA UPAHAR x IC-331217	1.7187	-0.5944	0.1361	-0.2893	-0.9298	-2.8936**	2.5738	0.2136	10.9614**	-15.9554	-2.4378	6.8692	24.3333**

Table 3: Estimates Of Specific Combining Ability (Sca) Effects For Thirteen Characters In Okra

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