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Makdoomi MI
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Kouser P Wani
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

SH Khan
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

M Ashraf Bhat
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

K Hussain
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

B Afroza
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Ambreen Nabi
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Correspondence
SH Khan
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Combining ability analysis in okra (*Abelmoschus esculentus* (L.) Moench)

Makdoomi MI, Kouser P Wani, SH Khan, M Ashraf Bhat, K Hussain, B Afroza and Ambreen Nabi

Abstract
Analysis of variance for combining ability studies in okra revealed that variances due to gca and sca were significant for all the growth, yield and yield attributing characters suggesting the importance of both types of variances in the inheritance of the traits. GCA and SCA also interacted significantly with the environments. The estimates of dominance variance were higher in magnitude than corresponding estimates of additive variance indicating the preponderance of non-additive gene action. None of the parents exhibited desirable gca effects for all the traits simultaneously. The overall ranking of genotypes revealed that the parents SKBS-11, Arka Anamika, Parbhani Kranti, Azad Ganga and Pant bhindi exhibited significant desirable gca effects for most of the traits. None of the crosses exhibited significant desirable sca effects for all the traits simultaneously. However, the crosses SKBS-11 x Azad Ganga; SKBS-11 x Parbhani Kranti; IC-117018 x Arka Anamika were found to be desirable for most of the traits.

Keywords: *Abelmoschus esculentus* (L.) combining ability effects, gca, sca, diallel

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) is a powerhouse of variable nutrients. Okra is a highly nutritious vegetable besides having medicinal importance. It is a potential source of numerous minerals like phosphorus, potassium, sulphur, calcium, iron, sodium etc and vitamins A, B and C. The amount of ascorbic acid content varies from 13-18 mg/100 g of fresh fruit weight, while as green tender fruits and immature seeds have a little protein content 2.08 and 2.09 % respectively. Dry mature seeds contain 18-20 % oil and 20-23% crude protein. It is an excellent source of fibre and iodine (Singh *et al.,* 2001) [10]. Fresh okra fruits contain both soluble and insoluble fibres. The soluble fibre is in the form of gums and pectins. It helps to lower serum cholesterol, reducing the risk of heart diseases. The insoluble fibre present in the fruits helps to keep the intestinal tract healthy, decreasing the risk of colon cancer and also helps to stabilize the blood sugar. It is also reported to be useful for persons suffering from genitor- urinary disorders. The yield potential of okra is low. The productivity of this crop should be increased by improving the genetic architecture through hybridization and recombination. Indeed knowledge of combining ability, heterosis of yield and its component characters should be placed greater emphasis for the improvement of this crop. Now the choice of parents for hybridization is an important step for obtaining superior crosses. The common approach of choosing parents purely on the basis of their *per se* performance does not necessarily yield fruitful results (Allard, 1960) [2] whereas as choosing parents on the basis of their combining ability and nature and extent of gene action for yield and yield attributing traits has been found to be useful tool before going for a hybridization programme. In the present study, diallel analysis over environments as proposed by Singh (1973b, 1979) [13] has been used to obtain information on combining ability, gene action and genetic parameters.

Materials and Methods
The experiment was conducted during *Kharif* 2012 at three locations viz., Vegetable Experimental Farm, SKUAST-Kashmir, Shalimar; Mountain Research Centre for Field Crops, Khudwani and Regional Research Station and Faculty of Agriculture, Wadura. Also, the crosses were evaluated at the farmer's field at Palpora, Srinagar on the basis of questionnaire developed. The basic materials consisted of ten diverse genotypes of okra (*Abelmoschus esculentus* (L.) Moench) viz., SKBS-11, Pant bhindi, IC-117018, Azad Ganga, Parbhani Kranti, Lam-1, GO-2, Red Bhindi, Arka Anamika and Pusa Sawani. These lines/ varieties have been maintained by the Division of Vegetable Science, SKUAST-K, Shalimar and have been selected for the present study on the basis of genetic variability for various agronomic

traits and maturity parameters. The genotypes represented wide genetic diversity. The selected ten genotypes were crossed in all possible combinations and produced forty five F_1 crosses. The seeds obtained from the crossing block were sown during August 2012 to raise the hybrids. Cultural and agronomic practices were followed as per the standard recommendation and need based plant protection measures were taken to maintain healthy crop stand. The observations like days to first flowering, days to first pod picking, plant height (cm), number of nodes, internodal length (cm), pod length (cm), pod girth (cm), avg. pod weight (g), number of pods per plant, pod yield per plant (g), number of seeds per pod, 100 seed weight (g), seed yield per plant (g) and pod yield (t/ha) were recorded.

Results and Discussion

Diallel analysis was performed in the present study by crossing ten genetically diverse lines of Okra (*Abelmoschus Esculentus* (L.) Moench)"in all possible combinations and information was generated by adopting Griffing's (1956) [3] model I and method II and Hayman's component analysis.

A. Analysis of variance for combining ability

Analysis of variance for combining ability (table 1a and 1b) revealed that the mean squares due to environments were significant for all traits under consideration, revealing that the environments chosen for the present investigation were diverse. Mean squares for general and specific combining ability were also significant for all traits under study in the pooled analysis. The mean squares due to gca x environment and sca x environment were found significant for all the traits. Variances due to sca $(\hat{\sigma}^2 s)$ were higher in magnitude than the corresponding gca variances $(\hat{\sigma}^2 g)$ for all the traits under consideration in all individual environments as well as in pooled analysis. The magnitude of dominance variance was higher in range in all cases indicating the preponderance of non-additive gene action. The ratio of additive genetic variance to dominance variance $(\hat{\sigma}^2 A / \hat{\sigma}^2 D)$ was less than unity for all the traits.

Ahmad *et al.* (1997) [1] found highly significant variances due to sca and gca for all characters in okra and reported predominance of non-additive gene action for all traits except fruit girth. Nichal *et al*. (2000) [5] found the importance of both additive and non-additive genetic components of variation in okra but the greater value of mean squares due to sca indicated the greater role of additive variance in the inheritance for all characters except average fruit weight.

Both additive and non-additive gene effects were involved in the inheritance of traits viz days to flowering, plant height, fruit length, fruit width in okra as was reported by Singh and Singh (2003) [11]. Similarly Shushmita *et al.* (2003) [9] reported highly significant variances due to gca and sca for all characters in okra with preponderance of additive gene action.

Jindal and Ghai (2005) [4] observed high variances for sca and gca effects for days to 50% flowering, plant height, fruit length, fruit girth, fruit weight and fruit yeild in okra. Shekhawat *et al.* (2005) [8] reported importance of additive and non-additive gene effects for plant height, number of fruits per plant and yield per plant.

Pal and Sabesan (2009) [6] found highly significant gca and sca for all traits in okra, with importance of additive gene action for number of ridges and fruit yield and importance of non-additive gene action for plant height, number of nodes on stem, number of fruits, fruit length and fruit weight.

B. Combining ability effects

General combining ability effects

The perusal of the data (Table-2a and 2b) on gca effects reveals that different parents were found to reveal desirable general combining effects for different traits. SKBS-11, Pant Bhindi, GO-2, and Arka Anamika showed desirable negative and significant gca effects in all environments and pooled over environments data for maturity traits viz; days to first flowering and days to first fruit picking. SKBS-11, Parbhani Kranti, Red Bhindi and Arka Anamika were good combiners in all environments and data pooled over environments for plant height.SKBS-11; IC-117018, Parbhani Kranti and Arka Anamika were good combiners for number of nodes per plant and internodal distance. SKBS-11 and Pant Bhindi were good combiners for pod girth while for pod girth Azad Ganga and IC-117018 showed desirable significant gca effects. GO-2 and SKBS-11 exhibited higher significant gca for average pod weight; while for number of pods per plant SKBS-11, Arka Anamika and Parbhani Kranti were good combiners. Lam-1, Red Bhindi and Arka Anamika exhibits significant gca effects for pod yield per plant. SKBS-11 and IC-117018 exhibited highly significant gca effects for number of seeds per pod while for 100 seed weight SKBS-11 and Parbhani Kranti were good general combiners. Pusa Sawani, SKBS-11 and Lam-1 were good combiners for seed yield per plant while SKBS-11 and IC-117018 were good combiners for pod yield. In most of the cases, high general combining ability for the traits was associated with their high to average *per se* performance and poor general combining ability was associated with low *per se* performance. Overall performance of the parents reveals that SKBS-11, Arka Anamika, Red bhindi and Parbhani Kranti were desirable for most of the yield and yield attributing traits. No parent had desirable gca effect for all the traits in okra. Similar results have been shown by Sanjeev and Pathania (2011) [7], Sharma and Singh (2012) [14], Ali *et al*. (2013) [16] and Sateesh *et al*. (2013) [15]. As none of the parents was a good combiner for all the traits simultaneously, the parents with desirable gca for maximum traits could be selected for use in further breeding programmes. In case of often cross-pollinated species, like okra, mass selection and progeny selection should be followed.

Specific combining ability effects

The specific combining ability of forty five crosses for different traits revealed that none of the F_1 crosses exhibited significant desirable effects for all the traits. Performance of some excellent crosses on the basis of sca and *per se* performance together with the parental performance for each trait is given in table3a and 3b. The crosses exhibiting significant desirable sca effects (pooled over environments) included IC-117018 x Arka Anamika, Lam-1 x GO-2, GO-2 x Arka Anamika, SKBS-11 x GO-2, SKBS-11 x Arka Anamika, Azad Ganga x Arka Anamika for days to first flowering; Parbhani Kranti x Arka Anamika, Azad Ganga x Arka Anamika, IC-117018 x Arka Anamika, GO-2 x Arka Anamika, Lam-1 x Arka Anamika, for days to first fruit picking; Pant bhindi x Red bhindi, Azad Ganga X Parbhani Kranti, SKBS-11 x Arka Anamika, Parbhani Kranti x Lam-1, SKBS-11 x Lam-1, GO-2 x Arka Anamika, Azad Ganga x Red Bhindi for plant height; SKBS-11 x Parbhani Kranti, SKBS-11 x Red Bhindi, SKBS-11 x IC-117018, Pant Bhindi x Pusa Sawani, IC-117018 x Arka Anamika, Parbhani Kranti x GO-2, IC-117018 x Lam-1 for number of nodes; Azad Ganga x Parbhani Kranti, SKBS-11 x Lam-1, SKBS-11 x Pant Bhindi, Pant Bhindi x Red Bhindi, Pant Bhindi x Lam-1, Pant Bhindi x IC-117018 for internodal distance; Lam-1 x GO-2, Pant Bhindi x Pusa Sawani, IC-117018 x GO-2, IC-117018 x Azad Ganga, Azad Ganga x Pusa Sawani, SKBS-11 x Azad Ganga for pod length; Pant Bhindi x Lam-1, Pant Bhindi x Pusa Sawani, IC-117018 x Azad Ganga, Lam-1 x GO-2, SKBS-11 x Pant Bhindi, SKBS-11 x IC-117018 for pod girth; Pant Bhindi x Azad Ganga, SkBS-11 x IC-117018, SKBS-11 x Parbhani Kranti, IC-117018 x Pusa Sawani, SKBS-11 x Azad Ganga, IC-117018 x Arka Anamika for average pod weight; Azad Ganga x Parbhani Kranti, Azad Ganga x Arka Anamika, IC-117018 x Azad Ganga, Red Bhindi x Pusa Sawani, SKBS-11 x Pusa Sawani, IC-117018 x Pusa Sawani, Pant Bhindi x Pusa Sawani for number of pods per plant; SKBS-11 x Azad Ganga, Pant Bhindi x Parbhani Kranti, Parbhani Kranti x GO-2, Pant Bhindi x Pusa Sawani, SKBS-11 x Parbhani Kranti, Pant Bhindi x Azad Ganga, Parbhani Kranti x Arka Anamika for pod yield per plant; SKBS-11 x Azad Ganga, Pant Bhindi x Pusa Sawani, Pant Bhindi x Azad Ganga, Azad Ganga x Pusa Sawani, SKBS-11 x Pant Bhindi, Pant Bhindi x IC-117048, SKBS-11 x Red Bhindi for number of seeds per pod; SKBS-11 x Red Bhindi, IC-117018 x Red Bhindi, SKBS-11 x IC-117018, SKBS-11 x lam-1, SKBS-11 x GO-2, IC-11708 x Red Bhindi, IC-117018 x Go-2 for 100 seed weight; SKBS-11 x Azad Ganga, SKBS-11 x Pant Bhindi, Azad Ganga x Pusa Sawani, GO-2 x Red Bhindi, Parbhani Kranti x GO-2, Pant Bhindi x Parbhani Kranti, for seed yield per plant; SKBS-11 x Parbhani Kranti, SKBS-11 x Pusa Sawani, Pant Bhindi x GO-2, SKBS-11 x IC-117018, IC-117018 x Pusa Sawani, SKBS-11 x Arka Anamika for pod yield. These desirable specific cross combinations resulted out of crosses between the parents with high x high, high x low or average x high general combining ability.

The overall ranking of genotypes based on their general combining ability, specific combining ability and *per se* performance of the parents and crosses revealed that the genotypes `SKBS-11, Arka Anamika and Parbhani Kranti were good general combiners for most of the traits and these could be used for the development of improved varieties in Okra. Based on overall sca performances, the cross combinations viz., SKBS-11 x Parbhani Kranti, SKBS-11x Pusa Sawani and SKBS-11x Azad Ganga were found to be desirable for most of the traits.

Table 1a: Analysis of variance for combining ability and estimates of components of variance for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench)(Pooled analysis)

Source of variation	d.f	Days to first flowering	Days to first pod picking	Plant height	Number of nodes	Internodal distance	Pod length	Pod girth
Environments	**2**	**21557.53**	**32004.93****	**531.38****	**16.54****	**14.13****	**41.62****	**3.46****
gca	9	6.95**	5.59**	1722.16**	48.02**	2.59**	4.21**	0.65**
Sca	45	8.83**	7.86**	377.52**	9.09**	1.57**	1.04**	0.45**
gca x environments	18	7.73**	6.94**	48.64**	0.17**	0.32**	1.05**	0.004*
sca x environments	90	9.21**	8.16	22.55**	0.08**	0.16*	0.45**	0.004*
Error	154	--	--	--	--	-	--	--
Pooled	324	0.51	1.27	14.13	0.25	0.01	0.04	0.017
$\hat{\sigma}^2 g$	-	0.74	1.51	47.44	1.32	0.07	0.11	0.017
$\hat{\sigma}^2 s$	-	1.67	6.51	121.12	2.94	0.52	0.45	0.14
$\hat{\sigma}^2 A$	-	2.83	3.03	94.89	2.65	0.14	0.23	0.035
$\hat{\sigma}^2 D$	-	7.82	6.51	121.12	2.94	0.52	0.45	0.14
$\hat{\sigma}^2 A / \hat{\sigma}^2 D$		0.32	0.47	0.78	0.91	0.27	0.51	0.25

Table 1b: Analysis of variance for combining ability and estimates of components of variance for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench) (Pooled analysis)

Source of variation	d.f	Average pod weight	Number of pods plant^{-1}	Pod yield plant^{-1}	Number of seeds pod $^{-1}$	100 seed weight	Seed yield plant^{-1}	Pod yield
Environments	2	11.36**	15.67**	1212.99**	147.97**	10.52**	1015.84**	30.99**
gca	9	1.39**	48.38**	1494.98**	517.38**	1.21**	325.80**	13.68**
Sca	45	1.96**	8.07**	1145.27**	134.97**	0.22**	215.33**	10.11**
gca x environments	18	0.021**	0.31**	32.28*	0.20*	0.02*	13.54*	0.177**
sca x environments	90	0.011**	0.26**	27.96*	0.22**	0.01*	13.53*	0.153**
Error	154	--	--	--	--	--	--	--
Pooled	324	0.006	0.51	8.41	0.67	0.003	1.67	0.045
$\hat{\sigma}^2 g$	-	0.038	1.33	69.07	14.35	0.033	27.86	0.37
$\hat{\sigma}^2 s$	-	0.65	2.64	612.28	44.76	0.072	171.21	3.35
$\hat{\sigma}^2 A$	-	0.07	2.67	138.14	28.71	0.066	55.72	0.75
$\hat{\sigma}^2 D$	-	0.65	2.64	612.28	44.76	0.072	171.21	3.35
$\hat{\sigma}^2 A / \hat{\sigma}^2 D$	-	0.11	1.01	0.23	0.64	0.92	0.32	0.22

*** Significant at 5 and 1 per cent levels, respectively

Table 2a: General combining ability effects for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench)(Pooled analysis)

Parents	Days to first flowering	Days to first pod picking	Plant height (cm)	Number of nodes	Internodal distance	Pod length	Pod girth
SKBS-11	-1.03**	0.38*	-8.31**	2.19**	-0.46**	-5.58**	-0.05*
Pant Bhindi	-0.41**	-1.16**	0.76**	-0.39*	0.12**	-0.66**	0.12**
IC-117018	2.04**	1.78**	8.38**	0.99**	-0.09**	-0.22**	-0.16**
Azad Ganga	0.94**	0.85**	3.19**	-0.47*	0.33**	0.31**	-0.20**
Parbhani Kranti	0.92**	1.40**	-3.89**	1.21**	-0.25**	-0.16**	0.07**
Lam-1	0.43**	0.39*	3.34**	-0.92**	0.33**	-0.22**	0.05**
GO-2	-0.84**	-1.03**	2.21**	-0.36*	0.16**	0.10**	0.06**
Red Bhindi	0.59**	0.92**	-7.14**	0.78**	-0.09**	0.13**	0.24**
Arka Anamika	-2.13**	-2.33**	-4.13**	1.51**	-0.28**	-0.14**	0.06**
Pusa Sawani	0.34*	0.34*	6.25**	-0.74**	0.46**	0.58*	-0.11**
SE± (g)	0.13	0.16	0.07	0.16	0.01	0.03	0.02
SE±(g_i-g_j)	4	4	4	5	5	6	4s

Table 2b: General combining ability effects for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench) (Pooled analysis)

Parents	Average pod weight	Number of pods plant^{-1}	Pod yield plant^{-1}	Number of seeds pod^{-1}	100 seed weight	Seed yield plant^{-1}	Pod yield
SKBS-11	0.17**	2.43**	2.77	8.56**	0.46**	4.96**	1.46**
PANT BHINDI	0.10**	-0.36**	2.61**	-9.44**	0.09**	2.40**	1.04**
IC-117018	-0.31**	0.87**	-3.45**	5.16**	-0.09**	-2.20**	-2.03**
Azad Ganga	-0.08**	-0.58**	-6.41**	-1.19**	-0.02*	-2.99**	-0.47**
Parbhani Kranti	0.13**	1.04**	-6.04**	1.25**	0.16**	2.97**	-0.44**
Lam-1	0.02*	-0.93**	7.96**	-1.29**	0.12**	3.63**	0.59**
GO-2	0.32**	-0.16*	3.23**	1.21**	0.05**	2.02**	0.46**
Red Bhindhi	0.11**	0.78**	4.06**	-1.25**	0.12**	2.54**	0.30**
Arka Anamika	0.27**	1.29**	3.47**	1.75**	-0.08**	-0.82**	0.25**
Pusa Sawani	0.04**	-0.82**	-4.83**	0.39**	-0.05**	5.78**	-0.36**
SE± (g)	0.01	0.06	0.45	0.13	0.01	0.20	0.03
SE±(g_i-g_j)	6	5	5	6	6	6	6

*, ** Significant at 5 and 1 per cent levels, respectively

Table 3a: Specific combining ability effects for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench) (Pooled analysis)

Crosses	Days to first flowering	Days to first pod picking	Plant height	Number of nodes	Internodal distance	Pod length	Pod girth
SKBS-11 x Pant Bhindi	-1.24*	-1.12*	-8.33**	1.22**	-0.89**	-0.76**	-0.57**
SKBS -11 x IC 117018	1.45*	1.95**	-7.83**	2.06**	-0.50**	-0.63**	-0.56**
SKBS -11 x Azad Ganga	-0.14	-0.67	-5.46**	1.24**	-0.50**	-1.28**	-0.47**
SKBS -11 x P. Kranti	-0.51	-1.24*	-9.40**	2.61**	-0.53**	-0.59**	-0.02
SKBS -11 x Lam I	-1.51**	-1.94**	-10.40**	1.61**	-0.92**	-1.05**	-0.39**
SKBS -11 x GO-2	-2.38**	-1.97**	-4.49**	0.69	-0.35*	-0.44*	-0.42**
SKBS -11 x Red Bhindi	-0.85	-1.59**	-9.90**	2.40**	-0.26*	-0.36*	-0.29*
SKBS -11 x A. Anamika	-2.08**	-2.19**	-11.50**	1.90**	-0.53**	-0.30	-0.13
SKBS -11 x Pusa Sawani	1.30**	2.64**	10.40**	-0.08	-0.47**	-0.13	-0.49**
P. Bhindi x IC 117018	2.26**	1.67**	-2.48**	1.19**	-0.80**	-0.55**	-0.42**
P. Bhindi x Azad Ganga	1.28**	3.59**	-4.22**	-0.20	0.44**	-0.86*	0.11
P. Bhindi x P. Kranti	1.34*	1.08*	-4.88**	1.14**	-0.27*	-0.77**	0.05
P. Bhindi x Lam I	-0.68	-0.75	-6.67**	0.72*	-0.81**	-0.76**	-0.89**
P. Bhindi x GO-2	-2.51**	-3.16**	-5.05**	-1.25**	0.19	-0.47*	-0.45**
P. Bhindi x Red Bhindi	-0.56	-0.16	-12.82**	0.09	-0.83**	-0.29	0.34*
P. Bhindi x Arka Anamika	-2.54**	-2.54**	-8.64**	1.87**	-0.61**	-0.79**	0.49**
P. Bhindi x Pusa Sawani	1.19*	0.62	4.02**	2.08**	1.06**	-1.32**	-0.81**
IC 117018 x Azad Ganga	1.29*	0.41	2.44**	-0.55	0.14	-1.26**	-0.74**
IC 117018 x P.Kranti	1.53**	0.68	-10.08**	1.91**	-1.03**	-0.82**	0.34*
IC 117018 x Lam I	0.16	0.67	-2.81**	1.93**	-0.58**	-0.69**	-0.43**
IC 117018 x GO-2	2.19**	1.94**	2.81**	-0.59	-0.39**	-1.30**	0.50**
IC 117018 x Red Bhindi	1.42**	1.61**	-5.63**	1.73**	-0.40**	-0.38*	-0.09
IC 117018 x A. Anamika	-4.32**	-3.26**	-8.30**	1.54**	-0.35*	-0.37*	-0.19
IC 117018 x Pusa Sawani	-0.62	-0.09	-0.09	2.06**	0.63**	-0.59**	-0.45**
Azad Ganga x P.Kranti	2.78**	1.14*	-12.69**	0.13	-1.15**	-0.46*	-0.17
Azad Ganga x Lam I	3.19**	2.46**	11.66**	0.30	-0.39**	0.29	-0.09
Azad Ganga x GO-2	0.13	0.57	4.15**	-0.57	0.67**	-0.85**	-0.29*
Azad Ganga x Red Bhindi	0.18	0.67	-9.50**	0.68	-0.25*	-0.65**	0.02
Azad Ganga x A.Anamika	-2.16**	-2.67**	-7.85**	0.24	-015	0.28	-0.09
Azad Ganga x P.Sawani	4.34**	2.24**	4.35**	0.46	0.53**	-1.22**	-0.39*

P. Kranti x Lam I	2.54**	2.94**	-11.07**	1.72**	-0.19	-0.68**	0.13
P. Kranti x GO-2	-0.35	-0.54	-6.13**	2.05**	-0.43**	-0.86**	0.11
P. Kranti x Red Bhindi	5.53**	3.34**	-4.96**	1.70**	-0.44**	-0.43*	0.07
P.Kranti x A. Anamika	-2.18**	-3.64**	-4.14**	1.56**	-0.71**	-0.43*	-0.38*
P. Kranti x P Sawani	2.38**	1.27*	7.04**	0.43	0.06	1.58**	-0.43**
Lam I x GO-2	-3.45**	-1.52**	-5.37**	1.22**	-0.69**	-0.71**	-0.66**
Lam I x Red Bhindi	2.37**	2.46**	-4.51**	0.90*	0.10	-1.58**	0.12
Lam I x Arka Anamika	-3.67**	-3.21**	-3.69**	0.44	-0.33*	-0.73**	0.20
Lam 1 x Pusa Sawani	-0.56	-0.50	-6.18**	1.35**	-0.16	0.30	-0.30*
GO-2 x Red Bhindi	5.46**	2.25**	-7.06**	-0.80*	0.27*	-0.40*	0.19
GO-2 x Arka Anamika	-3.79**	-3.54**	-10.15**	1.09**	-0.45**	0.39*	0.37*
GO-2 x Pusa Sawani	6.09**	5.31**	5.43**	0.49	-0.59**	0.53*	-0.36*
Red Bhindi x A. Anamika	-2.63**	-2.19**	-5.71**	1.29**	-0.29*	0.46*	0.21
Red Bhindi x Pusa Sawani	-0.93	-0.11	-5.44**	0.72*	-0.32*	0.27	-0.29*
A. Anamika x P.Sawani	-2.49**	-1.15*	-9.45**	0.07	-0.45**	1.83**	-0.22
SE± (S_{ij})	0.47	0.43	0.45	0.35	0.13	0.183	0.14

*, ** Significant at 5 and 1 per cent levels, respectively

Table 3 b: Specific combining ability effects for maturity and yield attributing traits in Okra (*Abelmoschus esculentus* (L.) Moench) (Pooled analysis)

Crosses	Average pod weight	Number of pods plant^{-1}	Pod yield plant^{-1}	Number of seeds pod^{-1}	100 seed weight	Seed yield plant^{-1}	Pod yield
SKBS-11x Pant Bhindi	0.32**	1.49**	8.40*	4.35**	0.24**	6.90**	2.62**
SKBS -11 x IC 117018	1.70**	1.29**	8.06*	1.82*	1.21**	5.08**	3.33**
SKBS -11 x Azad Ganga	1.10**	1.27**	12.66**	6.03**	0.33**	6.97**	1.94**
SKBS -11 x P. Kranti	1.49**	1.05**	11.49**	2.15*	0.14**	4.43**	3.59**
SKBS -11 x Lam I	0.43**	1.03*	6.06*	2.98**	1.16**	-2.48	1.34**
SKBS -11 x GO-2	0.44**	1.63**	6.36*	1.42	1.15**	4.66**	1.32**
SKBS -11 x Red Bhindi	0.53**	1.37**	8.32*	4.01**	2.30**	6.87**	2.61**
SKBS -11 x A. Anamika	0.13*	0.82*	9.78**	1.68*	-0.61**	5.55**	3.20**
SKBS -11 x Pusa Sawani	0.56**	1.85**	7.97*	1.66*	-0.34**	2.71*	3.55**
P. Bhindi x IC 117018	-0.12*	1.48**	10.62**	4.28**	0.21**	5.30**	1.52**
P. Bhindi x Azad Ganga	1.93**	1.06**	10.84**	4.70**	-0.14**	4.27**	2.94**
P. Bhindi x P. Kranti	0.97**	1.19**	11.87**	3.32**	0.17**	6.68**	2.87**
P. Bhindi x Lam I	0.20**	0.72*	9.28**	0.78	0.13**	-3.77*	2.68**
P. Bhindi x GO-2	0.14*	1.04**	5.21*	2.66**	0.39**	4.39**	3.38**
P. Bhindi x Red Bhindi	0.36**	0.14	5.21*	2.46**	0.29**	3.14*	2.16**
P. Bhindi x Arka Anamika	0.84**	1.73**	5.18*	3.80**	0.21**	4.82**	3.22**
P. Bhindi x Pusa Sawani	0.92**	1.71**	11.42**	5.19**	-0.11*	2.65*	2.99**
IC 117018 x Azad Ganga	-0.24**	1.94**	8.62*	3.25**	1.30**	4.24**	2.86**
IC 117018 x P.Kranti	-0.17*	1.11**	9.96**	1.66*	0.09*	4.01**	1.88**
IC 117018 x Lam I	0.42**	1.21**	6.33*	3.88**	0.09*	-3.43*	2.69**
IC 117018 x GO-2	0.33**	1.19**	6.26*	1.50*	1.03**	4.15**	2.46**
IC 117018 x Red Bhindi	0.09	1.20**	6.64*	3.64**	1.07**	6.04**	1.30**
IC 117018 x A. Anamika	1.02**	0.76*	10.42**	2.53**	0.56**	4.57**	1.66**
IC 117018 x Pusa Sawani	1.41**	1.75**	10.27**	3.73**	-0.11*	7.93**	3.27**
Azad Ganga x P.Kranti	0.47**	2.14**	9.82**	-1.48*	0.26**	4.58**	1.72**
Azad Ganga x Lam I	-0.14*	1.10**	7.30*	1.25	0.09*	-2.88*	1.17**
Azad Ganga x GO-2	0.66**	1.73**	9.30**	1.47*	0.18**	3.40*	1.10**
Azad Ganga x Red Bhindi	0.23**	1.82**	10.52**	1.92*	0.13**	1.30	1.78**
Azad Ganga x A. Anamika	0.21**	2.03**	10.69**	-2.89**	0.13**	2.67*	1.05**
Azad Ganga x P. Sawani	0.34**	1.27**	9.41**	4.54**	0.13**	6.88**	0.70**
P. Kranti x Lam I	0.46**	1.56**	9.46**	2.67**	0.20**	-4.97**	1.73**
P. Kranti x GO-2	0.49**	1.17**	11.49**	1.49*	0.19**	6.77**	1.22**
P. Kranti x Red Bhindi	0.33**	1.07**	7.87*	2.05*	0.14**	5.00**	1.33**
P. Kranti x A. Anamika	0.24**	1.18**	10.94**	3.16**	0.09*	5.35**	0.48*
P. Kranti x P Sawani	0.26**	1.73**	9.61**	4.10**	-0.06	4.23**	2.19**
Lam I x GO-2	0.68**	1.61**	10.76**	-1.44	0.08*	-3.55*	1.68**
Lam I x Red Bhindi	0.58**	1.15**	5.80*	1.58*	0.13**	-3.54*	1.13**
Lam I x Arka Anamika	0.07	1.25**	8.46**	1.69*	-0.15**	1.26	1.25**
Lam 1 x Pusa Sawani	0.27**	0.70	5.90*	-1.49	0.07	-2.62*	1.57**
GO-2 x Red Bhindi	0.21**	1.35**	5.73*	2.45**	0.17**	6.82**	0.42*
GO-2 x Arka Anamika	0.08	1.83**	6.87*	3.85**	-0.16**	5.18**	0.58*
GO-2 x Pusa Sawani	0.04	1.53**	8.81**	1.42	0.31**	6.34**	0.49*
Red Bhindi x A. Anamika	0.19**	1.33**	9.47**	2.64**	0.02	2.64*	0.69**
Red Bhindi x Pusa Sawani	0.21**	1.86**	10.63**	3.45**	0.25**	4.10**	0.59*
A. Anamika xP.Sawani	0.24**	0.75*	6.48*	2.11*	0.60**	2.61*	0.47*
SE± (S_{ij})	0.06	0.36	2.59	0.73	0.04	1.30	0.20

*, ** Significant at 5 and 1 per cent levels, respectively

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