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Studies on combining ability in okra [*Abelmoschus esculentus* (L.) Moench] through Line X Tester analysis for productivity and quality traits

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Abstract
Thirty three hybrids were developed by crossing seven lines and three testers in L x T fashion for twenty six parameters for productivity and quality traits. The variance due to parents vs. hybrids was also significant for all traits except plant height at 45 DAS, internodal length 45 DAS, days to first flowering, fruit diameter and seed yield per plant. The lines L7, L1 and L3 may be utilized as parent stocks for breeding for, growth parameters, earliness, yield and quality traits *etc.*, among the hybrids L3 x T2, L7 X T2, L3 x T3, L1 x T3 and L7 x T2 showed specific combiner for almost characters as per results due to its an F_5 generation which attain homozygosity so, selection is effective for quality traits of fruits. The information presented here about quality traits of okra showed the potential nutritional importance of okra and it has role in improved nutrition.

Keywords: Genetic combining ability, specific combining ability, okra, variance, growth, yield and quality

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] is an annual herbaceous plant, native of tropical Africa commonly known as bhendi or lady's finger in India. It belongs to the family *Malvaceae* under the order *Malvales*, having a somatic chromosome number of cultivated species 2n=82-130 and is considered to be an amphidiploid. The recent trend in okra breeding has been towards development of hybrids to meet the specific uses coupled with high yield as it may be difficult to develop a hybrid having all the characters. The line x tester analysis developed by Kempthorne (1957) has been used in the present study to assess the genetic potentialities of the parents in hybrid combination (Griffing, 1956). Combining ability studies are more reliable as they provide useful information for the selection of parents in terms of performance of the hybrids and elucidate the nature and magnitude of various types of gene actions involved in the expression of quantitative traits. Therefore the present investigation was undertaken to study the association among different components and their direct and indirect contribution for productivity and quality in okra.

Methods and Material
Present investigation on Studies on performance of newly developed okra hybrids and its parents (*Abelmoschus esculentus* L.) for Productivity & Quality Traits for yield and yield attributing traits in okra was undertaken at Division at Biotechnology and crop improvement, COH, Bagalkot during 2016-17. Thirty Three hybrids were developed by crossing seven lines and three testers in Line x Tester fashion. All the crosses were evaluated along with the parents in randomized block design with two replications with the objective of assessing the performance of newly developed okra hybrids for productivity and quality traits. Statistical analysis were done using Window Stat software version 9.32.

Result and Discussion
Studies on combining ability revealed that the lines, L7, L1 and L3 were the good general combiners for total yield per plant in order of merit. Similarly, the line L7 for days to first flowering, early harvesting, plant height fruit length, fruit diameter and total number of fruits. L2 days to first flowering, L7 for internodal length at 95 DAS, number of nodes at 95 DAS, number of branches at 45 DAS were the good general combiners.

Same findings were reported by Singh *et al.* (2012) [3] Thippeswamy, (2001) [5] and Singh *et al.* (2006) [4] Hosamani *et al.* (2008) [1] and Jindal *et al.* (2009) [2].

The crosses L3 x T2 and L4 X T1 were identified as the good specific combiner for marketable yield per plot in order of merit. The crosses L2 x T3 for days to first flowering, L5 X T1 for days to 50 per cent flowering, L2 X T2 total number of fruits per plant, L7 X T2, L3 x T3 and L6 X T1 for total yield per plant,L5 x T3 for average fruit weight, L1 X T3 for fruit yield per plot, L1 XT1, L2 x T2 and IIHR-L1 x T3 for number of branches per plant at 45 DAS, L7 xT1 for internodal length, L3 x T2,L7 X T3 and L6x T1 for number of nodes at 45 DAS, L2 x T1 and L1 X T2 for number of ridges,L1 x T3 and L4 x T1 for number of seeds per fruit and L5 x T2 for 100 seed weight. Comprehensive assessment of parents by considering gca effects of 25 characters studied has resulted into identification of lines, *viz*., L7, L3, and L1 and the testers T2 and T3 as good combiner over all characters which can be used in future breeding programme. Same findings were reported by Salesh kumar *et.al*. (2015) Thippeswamy, (2001) [5] and Singh *et al.* (2006) [4] Hosamani *et al.* (2008) [1] and Jindal *et al.* (2009) [2].

Study on combining ability variance revealed that non-additive gene action was predominant for number of fruits per plant, internodal length, plant height, number of branches per plant and fruit length. These traits can be improved for combining ability through recurrent selection schemes or heterosis breeding. Non-additive genetic component was higher than additive component for most of the characters like days to first flowering, days to first harvest, plant height, internodal length, number of branches per plant, final stem girth, fruit weight, number of fruits per plant, total yield per plant, marketable yield per plant, marketable yield per hectare, fruit length, fruit girth and number of ridges per fruit and these traits can be improved through recurrent selection schemes and also through heterosis breeding. Non-additive component of genetic variance was slightly higher than additive component for all the traits these can be improved through direct selection or recurrent selection schemes.

Variations and interrelationships were observed in the crosses and lines of okra. Variability in the various traits studied gives ample scope for manipulation of okra and its components for higher economic returns. The lines L7, L1 and L3 may be utilized as parent stocks for breeding for, growth parameters, earliness, yield and quality traits *etc*., among the hybrids L3 x T2, L7 X T2, L3 x T3, L1 x T3 and L7 x T2 showed specific combiner for almost characters as per results due to its an F_5 generation which attain homozygosity so, selection is effective for quality traits of fruits. The information presented here about quality traits of okra showed the potential nutritional importance of okra and it has role in improved nutrition.

Table 1: Estimation of general combining ability effects for growth parameters in okra

SL. NO		Plant height		Number of branches		No. of leaves		Intermodal length		Number of nodes	
		45 DAS	90DAS	40DAS	90DAS	45DAS	90DAS	45DAS	90DAS	45DAS	95DAS
Parents											
1	L1	0.8	-1.17	-0.47	-0.20	0.40	-0.22	0.03	-0.38*	0.08	1.11**
2	L2	-5.2**	-8.72**	-1.45**	-0.06	-1.42**	-0.71*	0.11	-0.12	-0.75**	-0.74*
3	L3	1.3*	2.34	0.79*	0.29*	0.83*	-1.5**	0.19	0.09	0.82**	0.91**
4	L4	-0.61	-1.88	-0.17*	-0.08	0.53	-1.12**	0.06	-0.08	-0.04	-1.48**
5	L5	0.01	0.39	-0.57	0.06	-0.19	-0.7*	0.20*	0.07	-0.41*	-0.58*
6	L6	1.1*	2.26	-0.38	-0.06	-0.54	-0.01	-0.02	0.07	0.13	-0.51*
7	L7	2.54**	6.7**	2.26**	0.064	0.38	4.39**	-0.59**	0.34**	0.17	1.28**
SEm±		0.81	2.26	0.37	0.11	0.47	0.35	0.13	0.10	0.21	0.28
CD at 5%		1.70	4.71	0.79	0.24	0.99	0.73	0.28	0.221	0.45	0.58
CD at 1%		2.31	6.43	1.07	0.33	1.35	1.00	0.38	0.30	0.62	0.79
Testers											
1	T1	-0.42	0.33	-0.15	-0.03	-0.71*	0.02	0.92**	-0.03	-0.13	0.07
2	T2	1.79*	-0.97	-0.15	0.00	-0.25	-0.23	0.40**	0.69**	-0.11	0.39*
3	T3	0.50	3.63*	0.30	0.36*	0.97*	0.21	-0.132	-0.31**	0.25*	-0.46*
SEm±		0.533	0.65	0.248	0.76*	0.31	0.23	0.08	0.069	0.143	0.183
CD at 5%		1.11	3.09	0.51	0.16	0.64	0.48	0.18	0.14	0.30	0.38
CD at 1%		1.51	0.95	0.70	0.21	0.88	0.65	0.25	0.19	0.4090	0.52

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant, DAS: Days after sowing.

Table 2: Estimation of general combining ability effects for earliness and yield parameters in okra

S. No		Nods at first flowering	Days to first flowering	Days to 50% flowering	Days to first fruit picking	Total no. of fruits per plant	Total fruit yield per plant (g)	Marketable yield per plant (g)	Average fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Marketable yield per plot (kg/plant)	fruit yield per plot(kg)
Parents													
1	L1	-0.09	-1.13	1.35	2.40*	1.19*	34.6**	48.84**	0.29	0.81	0.31	0.45**	0.27**
2	L2	-0.15	-2.40**	0.02	-3.52**	-1.97**	-69.04**	-46.71	-0.90**	-0.66	-1.06**	-0.58**	-0.62**
3	L3	-0.07	3.97**	1.52	1.07	1.19*	26.14**	16.10*	0.86**	-1.1*	0.35	0.32**	0.39**
4	L4	0.17**	0.09	1.72	-0.79	-1.47*	-18.38*	-19.70	0.39	-0.29	-1.08**	-0.21*	-0.14
5	L5	0.07**	0.61	-7.34**	-1.91*	-1.64*	-23.57**	-39.77	-0.92**	-0.44	-0.05	-0.29*	-0.42**
6	L6	0.12**	-2.3**	1.25	0.94	0.52	12.68	3.47	-0.07	-0.36	-0.23	-0.24*	-0.05
7	L7	-0.057**	1.22**	1.45	1.80*	2.19**	37.56**	37.84**	0.33	2.06**	1.76**	0.57**	0.57**
SEm±		0.079	0.80	1.17	0.901	0.59	7.379	6.87	0.27	0.51	0.27	0.08	0.072
CD at 5%		0.16	1.68	2.45	1.88	1.23	15.39	14.33	0.57	1.07	0.58	0.18	0.15
CD at 1%		0.52	2.30	3.34	2.56	1.68	20.99	19.55	0.78	1.46	0.79	0.24	0.20
Testers													
1	T1	-0.36**	0.04	0.68	0.30	-0.35	-15.04*	-3.20	-0.21	-0.11	-0.29	-0.16*	-0.11**

2	T2	-0.02	-0.33	0.42	0.11	0.35	8.64	8.54*	0.23	-0.03	0.16	0.32**	0.18*
3	T3	0.64**	0.29	-1.11*	-0.41	0.00	6.40	-5.34	-0.01	0.15	0.12	-0.16*	-0.06
SEm±		0.22	0.529	0.77	0.590	0.386	4.83	4.49	0.18	0.336	0.181	0.05	0.04
CD at 5%		0.10	1.10	1.6	1.23	0.80	10.07	9.38	0.37	0.70	0.37	0.11	0.09
CD at 1%		0.14	1.50	2.19	1.67	1.100	20.99	12.7	0.51	0.95	0.51	0.16	0.13

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant.

Table 3: Estimation of general combining ability effects for quality and seed parameters in okra

SL. No		Rind thickness (cm)	Flesh thickness (mm)	Number of ridges on fruit surface	Number of seed per fruit	Seed yield per fruit (g)	100 seed weight
Parents							
1	L1	0.03	0.73*	0.14	1.54	0.11	0.04
2	L2	0.22**	0.45	0.47	-0.95	-0.09	-0.08
3	L3	0.29**	1.15*	0.14	2.21*	0.08	-0.04
4	L4	-0.08	-0.06	0.47	-0.95	0.05	-0.17
5	L5	-0.23**	-0.81*	-0.19	-1.61	-0.13*	0.20
6	L6	-0.02	-0.82*	-0.52	-0.78	0.04	0.11
7	L7	-0.18**	-0.63	-0.52	0.54	-0.03	-0.06
SEm±		0.10	0.379	0.33	1.18	0.05	0.23
CD at 5%		0.20	0.79	0.70	2.4	0.12	0.48
CD at 1%		0.28	1.08	0.95	3.37	0.16	0.66
Tester							
1	T1	0.14*	-0.16	0.40*	0.11	0.08	0.08
2	T2	-0.11	0.25	0.04	0.19	-0.07	-0.07
3	T3	-0.03	-0.08	-0.45*	-0.31	-0.01	-0.01
SEm±		0.06	0.248	0.22	0.77	0.038	0.15
CD at 5%		0.13	0.511	0.46	1.62	0.07	0.31
CD at 1%		0.18	0.70	0.62	2.20	0.10	0.43

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant.

Table 4: Estimation of specific combining ability effects for growth parameters in okra

SL. No.	Hybrids	Plant height		Number of branches		No. of leaves		Intermodal length		Number of nodes	
		45 DAS	90DAS	40DAS	90DAS	45DAS	90DAS	45DAS	90DAS	45DAS	90DAS
1	L1XT1	-1.24	4.67	4.67	-0.39	-0.94	-0.22	-0.27	-0.41 *	-0.38	0.02
2	L1XT2	0.61	-7.85	-7.85	0.16	0.28	-0.31	0.23	0.38	-0.30	0.61
3	L1XT3	0.63	3.17	3.17	0.23	0.66	0.54	0.04	0.03	0.68	-0.63
4	L2XT1	0.00	-1.87	-1.87	-0.03	0.08	0.21	-0.10	0.12	-0.13	0.09
5	L2XT2	-1.38	2.19	2.19	-0.06	0.52	0.06	-0.05	-0.23	0.04	0.07
6	L2XT3	1.38	-0.32	-0.32	0.09	-0.60	-0.2	0.16	0.11	0.09	-0.16
7	L3XT1	0.02	-2.48	-2.48	0.20	-0.68	-0.45	-0.14	0.06	0.23	-1.3*
8	L3XT2	-1.72	0.57	0.57	-0.13	-0.14	-0.40	-0.14	0.19	-0.43	2.2**
9	L3XT3	1.70	1.91	1.91	-0.06	0.82	0.85	0.28	-0.25	0.19	-0.83
10	L4XT1	0.25	3.09	3.09	0.18	0.11	1.02	-0.11	0.33	0.40	0.42
11	L4XT2	0.81	0.71	0.71	0.10	-0.54	0.83	-0.05	-0.06	0.03	-0.19
12	L4XT3	-1.06	-3.80	-3.80	-0.28	0.42	-1.86 **	0.16	-0.26	-0.43	-0.23
13	L5XT1	0.82	0.36	0.36	-0.06	0.95	0.17	-0.09	-0.08	-0.13	0.02
14	L5XT2	0.57	1.07	1.07	0.000	0.18	0.33	0.000	-0.03	-0.10	-0.69
15	L5XT3	-1.40	-1.43	-1.43	0.06	-1.14*	-0.51	0.09	0.11	0.23	0.66
16	L6XT1	0.05	-1.75	-1.75	0.06	0.30	0.36	-0.16	-0.03	0.170	1.5**
17	L6XT2	-0.48	-0.29	-0.29	-0.16	0.33	-0.98	0.05	-0.08	0.34	-0.75
18	L6XT3	0.43	2.04	2.04	0.098	-0.64	0.62	0.10	0.11	-0.52	-0.80
19	L7XT1	0.08	-2.02	-2.02	0.036	0.16	-1.09	0.90*	0.00	-0.16	-0.74
20	L7XT2	1.59	3.59	3.59	0.100	-0.64	0.46	-0.04	-0.15	0.41	-1.25*
21	L7XT3	-1.68	-1.57	-1.57	-0.13	0.47	0.62	-0.86**	0.14	-0.24	2.0**
SEm±		1.41	3.91	0.37	0.20	0.82	0.61	0.236	0.18	0.38	0.48
CD at 5%		2.94	8.17	8.17	0.42	1.71	1.27	0.49	0.38	0.79	1.01
CD at 1%		4.01	11.14	1.07	0.57	2.3	1.74	0.67	0.52	1.08	1.38

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant, DAS: Days after sowing

Table 5: Estimation of specific combining ability effects for early and yield parameters in okra

Hybrids	Nods at first flowering	Days to first flowering	Days to 50% flowering	Days to first fruit picking	Total number of fruits per plant	Total fruit yield per plant (g)	Marketable yield per plant (g)	Average fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Marketable yield per plot (kg/plant)	Fruit yield per plot (kg)
L1XT1	0.16	0.73	-1.48	0.90	0.52	14.03	-10.99	0.08	-1.06	-0.48	-0.08	-0.05
L1XT2	-0.13	-1.08	-0.82	-1.21	-1.69	-13.85	13.05	-0.03	-0.34	0.29	0.12	-0.44**
L1XT3	-0.03	0.34	2.3	0.31	1.16	-0.18	-2.05	-0.05	1.41	0.19	-0.03	0.50**
L2XT1	0.03	1.65**	1.54	1.03	-1.81	6.37	6.58	-0.63	0.01	0.69	-0.09	0.04
L2XT2	-0.17	0.42	2.50	-0.28	2.97**	-3.30	-6.40	0.61	0.73	-1.81**	0.11	0.05
L2XT3	0.13	-2.0**	-4.05	-0.75	-1.16	-3.07	-0.17	0.02	-0.75	1.12*	-0.01	-0.09
L3XT1	0.05	0.17	-0.55	-1.56	1.52	-33.37	-10.71	0.14	0.11	-0.37	-0.15	0.07
L3XT2	-0.05	0.40	-0.99	1.31	-1.69	-8.67	32.34**	-0.12	0.13	0.21	0.60**	0.23
L3XT3	0.00	-0.57	1.54	0.24	0.16	42.04**	-21.62	-0.01	-0.25	0.15	-0.45*	-0.31*
L4XT1	0.00	0.60	-1.65	2.00	-0.81	-16.16	6.95	-0.26	0.64	0.01	0.32*	0.11
L4XT2	0.14	-0.06	0.20	-0.51	-1.02	-4.81	-4.94	0.10	-0.21	0.69	-0.30	0.01
L4XT3	-0.14	-0.54	1.44	-1.48	1.83	20.98	-2.00	0.15	-0.36	-0.71	-0.01	-0.13
L5XT1	-0.14	-1.11	3.91*	-0.88	0.85	14.32	-4.33	-0.27	0.84	0.12	0.16	0.04
L5XT2	0.19	-0.53	-2.72	-0.99	-0.35	-12.77	-18.22	-1.11*	-0.93	0.66	-0.37*	-0.24
L5XT3	-0.04	1.64	-1.18	1.88	-0.50	-1.55	22.56**	1.38*	0.08	-0.73	0.21	0.20
L6XT1	-0.04	-0.57	-1.48	0.26	0.19	26.34*	21.81*	0.87	0.21	-0.28	0.16	-0.12
L6XT2	-0.00	-0.24	2.47	-0.64	0.47	-0.83	-32.47	-0.14	0.68	0.24	-0.32*	0.28*
L6XT3	0.05	0.82	-0.98	0.38	-0.66	-25.5	10.66	-0.72	-0.90	0.04	0.16	-0.16
L7XT1	-0.06	-1.47	-0.28	-1.75	-0.47	-11.54	-9.30	0.07	-0.76	0.31	-0.30	-0.10
L7XT2	0.02	1.10	-0.62	2.33	1.31	44.25**	16.65*	0.69	0.00	-0.30	0.15	0.10
L7XT3	0.03	0.37	0.91	-0.58	-0.83	-32.71*	-7.35	-0.77	0.76	-0.01	0.14	0.00
SEm±	0.13	1.40	2.038	1.561	1.02	12.78	11.90	0.89	0.89	0.48	0.14	0.12
CD at 5%	0.28	2.92	3.25	3.25	2.13	26.6	24.82	1.85	1.85	1.00	0.31	0.26
CD at 1%	0.39	3.98	5.80	4.44	2.91	36.37	33.86	2.53	2.53	1.36	0.42	0.35

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant

Table 6: Estimation of specific combining ability effects for quality and seed parameters in okra

S. No.	Hybrids	Rind thickness (cm)	Flesh thickness (mm)	Number of ridges on fruit surface	Number of seed per fruit	Seed yield per fruit (g)	100 seed weight
1	L1XT1	0.34*	0.02	-1.07	0.38	-0.01	0.02
2	L1XT2	-0.31	0.69	1.28**	-3.69	0.07	-0.28*
3	L1XT3	-0.02	-0.72	-0.21	3.31**	-0.06	0.26
4	L2XT1	0.06	0.34	2.09**	-2.11**	-0.10	-0.16
5	L2XT2	0.11	-0.83	-1.04	0.31	0.00	0.02
6	L2XT3	-0.17	0.48	-1.04	1.81**	0.09	0.14
7	L3XT1	0.39*	0.14	-0.57	1.71**	-0.02	-0.00
8	L3XT2	-0.21	-0.50	0.28	-0.35	0.17	0.09
9	L3XT3	-0.17	0.36	0.28	-1.35**	-0.15	-0.09
10	L4XT1	-0.25	-0.14	0.09	2.38**	-0.00	-0.09
11	L4XT2	0.14	0.18	-0.04	0.81	0.00	-0.11
12	L4XT3	0.11	-0.03	-0.04	-3.19	-0.00	0.20
13	L5XT1	-0.43*	-0.28	0.26	-1.45**	0.11	-0.21
14	L5XT2	0.08	0.40	-0.38	0.47	-0.16	0.34*
15	L5XT3	0.34	-0.11	0.11	0.97	0.05	-0.13
16	L6XT1	-0.02	-0.36	-0.40	-0.28	0.05	0.25
17	L6XT2	0.04	0.62	-0.04	1.14*	0.12	-0.12
18	L6XT3	-0.02	-0.26	0.45	-0.85	-0.18	-0.13
19	L7XT1	-0.08	0.27	-0.40	-0.61	-0.03	0.19
20	L7XT2	0.14	-0.56	-0.04	1.31*	-0.21*	0.05
21	L7XT3	-0.05	0.29	0.45	-0.69	0.24*	-0.25*
SEm±		0.173	0.657	0.58	2.05	2.05	0.10
CD at 5%		0.36	1.37	1.21	4.28	0.58	0.21
CD at 1%		0.493	1.87	1.65	5.84	1.24	0.28

*and** indicate significance of values at p=0.05 and p=0.01, respectively. NS: Not significant.

Table 7: Analysis of variance (Mean sum of Squares) of line x tester analysis for various characters in Okra

Sl. No.	Replication	Genotypes	Parents	Crosses	Parents Vs .Cross	Line	Testers	Line x Testers	Error
DF	1	33	9	21	1	7	3	21	35
1	16.41	12.05**	8.85*	14.09**	0.002	38.41**	3.03	3.77	3.98
2	1.36	61.36*	44.38	59.05	260.48**	137.72**	10.31	27.84	30.71
3	11.56	2.57*	1.48	2.90*	5.670*	3.68*	10.72**	1.20*	1.35
4	0.04	7.41**	3.61**	8.35**	22.85**	24.08***	069	1.76*	0.75
5	0.99	2.84**	0.53	3.57**	9.20**	8.59**	0.99	1.49	0.86
6	0.07	0.20**	2.32*	0.10	2.12**	0.15	0.01	0.08	0.08
7	0.90	0.58*	0.16	0.72*	1.61*	1.47*	0.67	0.35	0.29
8	1.71	3.65**	2.33**	4.31**	2.21*	7.10	2.63	3.20**	0.47
9	0.005	0.07*	0.11*	0.05	0.002	0.09	0.04	0.03	0.03
10	0.18	0.44**	0.64**	0.35**	0.358	0.45	0.19	0.31**	0.11
B Earliness Parameters									
11	0.20	0.24**	0.33**	0.17**	0.67**	0.31	0.49	0.13	0.06
12	411.87	21.64**	5.43	28.42**	32.01	64.75**	13.26	12.77	8.31
13	34.38	8.17*	0.28	11.16**	19.20*	30.40**	1.38	3.18	3.92
C. Yield Parameters									
14	3.16	9.64**	13.33**	8.45**	0.27	16.69*	1.786	5.452*	2.095
15	5941.74	3296.02**	2374.00**	3874.75**	13.88	9114.06**	2395.0	1501.65**	326.77
16	250.80	9.92*	7.46	11.49*	0.52	30.40**	1.38	3.181	3.92
17	0.883	1.35**	1.02*	1.55*	0.28	2.76	0.710	1.097*	0.46
18	70.47	2.94*	2.07	3.06	9.31*	7.05*	0.258	1.533	1.58
19	0.001	3.38**	3.60**	2.61**	16.89**	5.71*	0.922	1.340**	0.46
20	0.082	0.53**	0.44**	0.59**	0.064	1.17**	1.109*	0.227**	0.04
21	0.005	0.39**	0.25**	0.47**	0.007	1.15**	0.350	0.152**	0.03
22	2.606	2744.7	2249.35	3053.72	1024.9	8249.14	782.33	834.574	283.311

Significance at 5% -*, and 1%- **

Analysis of variance (Mean sum of Squares) of line x tester analysis for various characters in Okra

Sl. No.	Replication	Genotypes	Parents	Crosses	Parents Vs .Cross	Line	Testers	Line x Testers	Error
DF	1	33	9	21	1	7	3	21	35
D. Quality parameters									
22	0.04	0.199**	0.078	0.189**	1.492**	0.23	0.23*	0.15*	0.060
23	1.67	1.584**	1.236	1.598	4.427*	3.825*	0.68	0.63	0.865
24	0.581	1.240**	1.368	1.674*	3.717*	1.079*	2.59	1.817*	0.681
E. Seed parameters									
25	343.80	17.73*	34.68**	10.09	17.99	12.65	1.02	10.32	8.440
26	0.32	0.040*	0.01	0.053**	0.017	0.05	0.08	0.04	0.020
27	0.022	0.328**	0.55	0.176	1.302	0.785*	0.11	0.32	0.322

A	Growth Parameter	B	Early Parameter	C	Yield Parameter	D	Quality Parameter
1	Plant height at 45 days	11	Nods at first flower	14	Total number of fruits / plant	21	Rind thickness (cm)
2	Plant height at 95 days	12	Days to first flowering	15	Total fruit yield per plant (g)	22	Flesh thickness (mm)
3	Number of leaves at 45 DAS	13	Days to 50% flowering	16	Days to first fruit picking	23	No.of ridges on fruit surface
4	Number of leaves at 95 DAS			17	Average fruit weight (g)		
5	Number of branches 45 DAS			18	Fruit length (cm)	E	**Seed quality parameter**
6	Number of branches 95 DAS			19	Fruit diameter (cm)	24	Number of seeds per fruit
7	Number of nodes 45 DAS			20	Marketable yield / plot (kg/plt)	25	Seed yield per fruit (g)
8	Number of nodes 95 DAS		21		Marketable yield /plant	26	100-seed weight (test weight)
9	Inter nodal length 45 at DAS						
10	Inter nodal length at 95 DAS						

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