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HETEROSIS AND COMBINING ABILITY STUDIES IN NEAR HOMOZYGOUS LINES OF OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH] FOR GROWTH PARAMETERS

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ABSTRACT

The present investigation was carried out with the objective of identifying good combiners and to assess the magnitude of heterosis for growth characters. Maximum heterosis was observed in the cross KO-2 × PK (48.20%) for plant height, KO-2 × AA (23.90%) for number of leaves, KO-6 × PK (-43.05%) for internodal length over the better parent and KO-6 × PK (56.07%) for plant height over commercial check, KO-2 × PK for number of leaves over the best parent (6.99%) and the commercial check (47.59%) and the crosses KO-6 × PK and KO-13 × V5 exhibited significant negative heterosis over the best parent (-10.42%) and the commercial check (-11.34%) for internodal length. The cross KO-2 × PK (19.28) for plant height, KO-2 × PK (6.31) for number of leaves, KO-5 × V5 for internodal length (-2.87) and number of branches per plant (0.60) and KO-4 × V6 (2.18) for number of nodes on the main stem were identified as good specific combiners. The parent KO-18 (13.69) for plant height, KO-6 for number of leaves (1.43), internodal length (-1.13) and number of nodes on the main stem (1.37) and KO-12 (0.34) for number of branches per plant were identified as good general combiners. Non-additive gene action was predominant for most of the traits.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a fast growing annual which has captured a prominent position among the vegetables and is commonly known as bhendi or lady's finger in India. It is being cultivated for its fibrous fruits or pods. It has multiple uses where tender fruits are used as vegetable, eaten boiled or in culinary preparations as sliced and fried pieces. It is also used in thickening of soups and gravies because of its high mucilage content. Okra fruits are sliced and sundried or canned and dehydrated for off-season use. The ripe seeds are roasted, ground and used as a substitute for coffee. The roots and stem of okra are used for cleaning the canned juice from which jaggery is prepared. Mature fruits and stems containing crude fibre are used in the paper industry.

India is the leading country in okra production but the yield potential is very low attributing to poor yielding varieties and incidence of various pests and diseases. The low cost of production and high nutritional value (Aykroyd, 1963) has enhanced the usefulness of this crop. Hybrid breeding has helped in overcoming the yield barriers by accelerating increase in productivity. Hybrid vigour in okra has been first reported by Vijayaraghavan and Warier (1946). Despite high cost of hybrid seeds, there has been an increasing concern among farmers on cultivation of hybrids because under optimum crop production and protection management, the crops raised from F_1 hybrids show higher yield due to large size and increase in the number of fruits. Besides F_1 hybrids are early maturing and uniform than varieties and thereby reducing cost in grading and harvesting. Combining ability helps in the evaluation of inbreds in terms of their genetic value, in the selection of suitable parents for hybridization and helps in the identification of superior cross combination which may be utilized for commercial exploitation of heterosis. Thus, heterosis breeding for yield and quality with disease resistance offers quantum jump in yield in short time. Hence an attempt has been made to assess the magnitude and direction of heterosis for growth parameters in near homozygous lines of okra.

MATERIALS AND METHODS

The investigation on heterosis and combining ability in okra was carried out at the Department of Vegetable Science, K.R.C. College of Horticulture, Arabhavi, Gokak Taluk, Belgavi district of Karnataka state during 2010-2011. The experimental material comprised of 18 lines which were collected from the department itself and 4 testers (Parbhani Kranti, Arka Anamika, VRO-5 and VRO-6) collected from different sources and their 72 F_1 hybrids along with one commercial check (MHY-10). Each of the 18 lines was crossed with each of the 4 testers to derive 72 F_1 hybrids. The experiment was laid out in randomized block design with two replications. Each treatment or a genotype in each replication was represented by one row each accommodating 20 plants at a row to row spacing of 60cm and 30cm from plant to plant. Five plants were randomly selected for each genotype from each replication and evaluated for the quantitative characters and the replicated mean values of various characters of parents and hybrids were subjected to line × tester (*l* × *t*) with the method suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

Heterosis for growth parameters is an indication of heterosis for yield as growth and yield parameters are strongly associated (Jaiprakashnarayan, 2003). Significant and high magnitude of heterosis over better parent and the commercial check was observed in the desirable direction for plant height and number of branches per plant. For number of leaves, internodal length and number of nodes on the main stem significant and high magnitude of heterosis was observed in the desirable direction over better parent, the best parent and the commercial check. For plant height six crosses showed positively significant heterosis over better parent and 24 crosses over the commercial check and the maximum heterosis was observed in the cross KO-2 × PK (48.20%) over better parent and the cross KO-6 × PK (56.07%) over the commercial check (Table 1). The parent KO-6 involved in the cross KO-6 × PK showed positive and significant gca effects (Table 2) and the cross KO-2 × PK also exhibited positive and significant sca effects (Table 3) for plant height .Heterosis over better parent and the commercial check was also reported by Thippeswamy, 2001 and Hosamani *et al*., 2008 for plant height.

Among the crosses, 12 crosses over better parent, one cross over the best parent and 29 crosses over the commercial check exhibited positive and significant heterosis for number of leaves. The maximum positive and significant heterosis over better parent was observed in the cross KO-2 × AA (23.90%), and the cross KO-2 × PK exhibited maximum heterosis over the best parent (6.99%) and the commercial check (47.59%)(Table 1).The parent KO-2 involved in the crosses KO-2 × AA and KO-2 × PK showed positive and significant gca effects(Table 2) for number of leaves and the cross KO-2 × PK also showed positive and significant sca effects (Table 3). Similar work has been reported by Sood and Kalia, 2001.

For internodal length, 32 crosses showed negative and significant heterosis over better parent, two crosses each exhibited significant negative heterosis over the best parent and over the commercial check (Table 1) and the maximum negative and significant heterosis was observed in the cross KO-6 × PK (-43.05%) over better parent and the crosses KO-6 × PK and KO-13 × V5 exhibited significant negative heterosis over the best parent (-10.42%) and the commercial check (-11.34%). The parents involved in the above crosses KO-6, KO-13 and PK showed negative and significant gca effects (Table 2) and the cross KO-13 × V5 showed negative and significant sca effects (Table 3). Similar observations were also made by Weerasekara (2006). Maximum and significant positive heterosis was observed in the cross KO-2 × V5 (112.50%) over better parent and in the crosses KO-12 × PK and KO-12 × V5 (61.54%) over the commercial check for number of branches per plant. Out of the 72 crosses, 30 crosses over better parent and 48 crosses over the commercial check exhibited positive and significant heterosis for number of branches of per plant. The parent KO-12 exhibited positive and significant gca effects (Table 2) and the cross KO-2 × V5 also showed significant and positive sca effects (Table 3).

Table 1: Heterosis (%) over better parent, the best parent and the commercial check for growth parameters in okra

S. No.	Crosses	Plant height BP	BTP	CC	Number of leaves BP	BTP	CC	Internodal length BP	BTP	CC
1	KO-2×PK	48.20**	2.60	46.01**	11.87**	6.99**	47.59**	3.57**	20.83**	19.59**
2	KO-2×AA	31.74*	-17.15	17.90	23.90**	-13.97**	18.67**	64.29**	91.67**	89.69**
3	KO-2×V5	-30.05*	-38.77**	-12.87	-28.42**	-42.79**	-21.08**	-5.13**	15.63**	14.43**
4	KO-2×V6	-19.96	-20.37	13.31	-17.28**	-31.00**	-4.82**	-9.23**	22.92**	21.65**
5	KO-3×PK	13.78	-9.04	29.44*	-31.96**	-34.93**	-10.24**	19.01**	50.00**	48.45**
6	KO-3×AA	8.97	-12.89	23.96	6.67**	-16.16**	15.66**	14.05**	43.75**	42.27**
7	KO-3×V5	-10.21	-21.41	11.83	12.02**	-10.48**	23.49**	20.66**	52.08**	50.52**
8	KO-3×V6	-16.72	-17.15	17.90	-10.99**	-25.76**	2.41	4.62**	41.67**	40.21**
9	KO-6×PK	22.25	9.67	56.07**	-7.42**	-7.42**	27.71**	-43.05**	-10.42**	-11.34**
10	KO-6×AA	3.71	-6.96	32.40*	-14.85**	-14.85**	17.47**	-19.21**	27.08**	25.77**
11	KO-6×V5	-6.72	-16.32	19.08	-31.88**	-31.88**	-6.02**	-25.17**	17.71**	16.49**
12	KO-6×V6	-13.38	-13.83	22.63	-21.40**	-21.40**	8.43**	-21.19**	23.96**	22.68**
13	KO-12×PK	10.95	-22.04	10.95	-20.09**	-23.58**	5.42**	22.02**	38.54**	37.11**
14	KO-12×AA	-0.44	-30.04**	-0.44	-20.86**	-35.37**	-10.84**	13.86**	19.79**	18.56**
15	KO-12×V5	-11.05	-22.14	10.80	1.60	-17.03**	14.46**	-5.13**	15.63**	14.43**
16	KO-12×V6	2.09	1.56	44.53**	6.28**	-11.35**	22.29**	-6.15**	27.08**	25.77**
17	KO-13×PK	1.33	-12.99	23.82	-29.22**	-32.31**	-6.63**	26.32**	50.00**	48.45**
18	KO-13×AA	8.23	-7.07	32.25**	-2.52	-32.31**	-6.63**	15.61**	37.29**	35.88**
19	KO-13×V5	-33.37**	-41.68**	-17.01	-9.29**	-27.51**	0.00	-26.50**	-10.42**	-11.34**
20	KO-13×V6	-13.27	-13.72	22.78	-20.42**	-33.62**	-8.43**	-13.85**	16.67**	15.46**
21	KO-16×PK	-21.11	-21.52	11.69	5.76**	-11.79**	21.69**	-5.00**	38.54**	37.11**
22	KO-16×AA	16.24	-10.71	27.07*	-2.74**	-6.99**	28.31**	-0.85	21.88**	20.62**
23	KO-16×V5	9.74	-15.70	19.97	-6.29**	-34.93**	-10.24**	-6.78**	14.58**	13.40**
24	KO-16×V6	17.93	3.22	46.89**	7.65**	-13.97**	18.67**	35.59**	66.67**	64.95**
25	KO-18×PK	6.06	5.51	50.15**	0.00	-16.59**	15.06**	6.21**	60.42**	58.76**
26	KO-18×AA	8.72	8.72	8.72	1.10	1.10	1.10	0.54	0.54	0.54
27	KO-18×V5	24.52	24.52	24.52	3.09	3.09	3.09	1.51	1.51	1.51
28	KO-18×V6	32.50	32.50	32.50	4.10	4.10	4.10	2.01	2.01	2.01
	SEm±	36.26**	-4.68	35.65**	-22.83**	-26.20**	1.81	13.93**	44.79**	43.30**
	CD at 5%	18.57	-17.05	18.05	-5.29**	-29.69**	-3.01	44.26**	83.33**	81.44**
	CD at 1%	-1.19	-13.51	23.08	-12.02**	-29.69**	-3.01	5.74**	34.38**	32.99**

Table 1: Cont......

S. . No	Crosses	Number of branches per plant BP	BTP	CC	Number of nodes on main stem BP	BTP	CC
1	KO-2×PK	0.00	-19.05**	30.77**	0.00	-14.71**	0.00
2	KO-2×AA	0.00	-38.10**	0.00	6.25**	-18.75**	-4.74**
3	KO-2×V5	112.50**	-19.05**	30.77**	-24.26**	-24.26**	-11.21**
4	KO-2×V6	7.69**	-33.33**	7.69**	-12.99**	-18.75**	-4.74**
5	KO-3×PK	-23.53**	-38.10*	0.00	-8.19**	-21.69**	-8.19**
6	KO-3×AA	15.38**	-28.57**	15.38**	18.97**	1.47	18.97**
7	KO-3×V5	88.89**	-19.05**	30.77**	-11.76**	-11.76**	3.45**
8	KO-3×V6	25.38**	-28.57**	15.38**	-1.57	-8.09**	7.76**
9	KO-6×PK	-28.57**	-28.57**	15.38**	30.17**	11.03**	30.17**
10	KO-6×AA	-33.33**	-33.33**	7.69**	35.21**	5.88**	24.14**
11	KO-6×V5	-52.38**	-52.38**	-23.08**	-17.28**	-17.28**	-3.02*
12	KO-6×V6	-9.52**	-9.52**	46.15**	-11.42**	-17.28**	-3.02*
13	KO-12×PK	16.67**	0.00	61.54**	8.55**	-6.62**	-14.66**
14	KO-12×AA	-16.67**	-28.57**	15.38**	-9.40**	-22.06**	0.86
15	KO-12×V5	16.67**	0.00	61.54**	-7.35**	-7.35**	-3.45**
16	KO-12×V6	-16.67**	-28.57**	15.38**	2.36*	-4.41**	9.48**
17	KO-13×PK	-23.53**	-38.10**	0.00	-1.72	-15.81**	9.48**
18	KO-13×AA	15.38**	-28.57**	15.38**	0.00	-14.34**	-8.62**
19	KO-13×V5	30.77**	-19.05**	30.77**	-20.59**	-20.59**	8.62**
20	KO-13×V6	7.69**	-33.33**	7.69**	-12.60**	-18.38**	12.07**
21	KO-16×PK	6.67**	-23.81**	23.08**	-7.63**	-11.03**	4.31**
22	KO-16×AA	-23.53**	-38.10**	0.00	5.74**	-5.15**	11.21**
23	KO-16×V5	0.00	-38.10**	0.00	-0.82	-11.03**	4.31**
24	KO-16×V6	0.00	-47.62**	-15.38**	2.21	2.21	19.83**
25	KO-18×PK	-7.14**	-38.10**	0.00	-16.14**	-21.69**	-8.19**
26	KO-18×AA	0.18	0.18	0.18	0.82	0.82	0.82
27	KO-18×V5	0.50	0.50	0.50	2.30	2.30	2.30
28	KO-18×V6	0.67	0.67	0.67	3.05	3.05	3.05
	SEm±	-35.29**	-47.62**	-15.38**	2.05	-8.46**	7.33**
	CD at 5%	7.69**	-33.33**	7.69**	-17.62**	-26.10**	-13.36**
	CD at 1%	-58.33**	-76.19**	-61.54**	-7.35**	-7.35**	8.62**

* and ** indicate significance of values at p = 0.05 and p = 0.01, respectively.

BP - Heterosis over better parent, BTP - Heterosis over the best parent, CC- Heterosis over the commercial check (MHY-10), PK - Parbhani Kranti, AA - Arka Anamika, V5 - VRO-5 and V6 - VRO-6.

Table 2: General combining ability effects for growth parameters in okra

Sl. No Lines	Parent	Plant height	Number of leaves	Internodallength	Number of branches per plant	Number of nodes on main stem
1.	KO-1	-2.43	-0.72	-0.55*	0.11	0.44
2.	KO-2	-1.58	1.13*	-0.01	0.06	-0.63
3.	KO-3	1.59	0.76	0.42	0.04	0.63
4.	KO-4	0.34	1.16*	0.69*	-0.09	-0.60
5.	KO-5	1.99	-1.89**	0.92	-0.04	-0.75
6.	KO-6	9.54*	1.43**	-1.13*	-0.01	1.37**
7.	KO-7	6.52	-0.34	1.54**	-0.09	0.09
8.	KO-8	5.54	-0.84	-0.31	-0.14	0.21
9.	KO-9	3.72	0.18	-0.03	-0.11	0.11
10.	KO-10	-7.83	0.06	0.10	0.06	-0.20
11.	KO-11	-7.23	-1.77**	-0.98*	0.04	-0.25
12.	KO-12	-1.33	0.76	-0.61*	0.34**	0.60
13.	KO-13	-2.01	-1.44**	-0.70*	0.01	-0.38
14.	KO-14	-7.91	0.01	-0.25	0.19*	0.15
15.	KO-15	-2.63	-0.32	0.34	-0.29**	-0.20
16.	KO-16	-16.01**	0.61	0.15	0.11	-1.15**
17.	KO-17	6.02	1.33*	-0.56*	-0.06	1.32**
18.	KO-18	13.69**	-0.07	0.97*	-0.16	-0.74
	SEm ±	4.36	0.54	0.26	0.09	0.41
	CD at 5%	8.67	1.07	0.51	0.17	0.81
	CD at 1%	11.49	1.42	1.34	0.23	1.08
Testers						
1.	PK	0.95	-0.09	-0.39**	0.04	0.13
2.	AA	1.29	0.03	0.36**	-0.02	0.04
3.	V5	-2.43	-0.60*	0.37**	-0.13**	-0.17
4.	V6	0.19	0.66**	-0.34**	0.10**	0.00
	SEm ±	2.05	0.25	0.12	0.04	0.19
	CD at 5%	NS	0.49	0.23	0.07	NS
	CD at 1%	NS	0.65	0.31	0.10	NS

*and** indicate significance of values at p = 0.05 and p = 0.01, respectively. NS: Not significant. PK = Parbhani Kranti, AA = Arka Anamika, V5 = VRO-5 and V6 = VRO-6

Table 3: Specific combining ability effects for growth parameters in okra

Sl.No	Cross	Plant height	Number of branches	Internodallength	Number of branches per plant	Number of nodes on main stem
1	KO-2×PK	19.28*	6.31**	-0.42	0.13	0.47
2	KO-2×AA	-0.07	1.39	2.22**	-0.21	0.01
3	KO-2×V5	-17.14	-4.58**	-1.43**	0.30	-0.53
4	KO-2×V6	-2.07	-3.13**	-0.37	-0.23	0.05
5	KO-3×PK	4.90	-2.91**	0.54	-0.24	-1.72*
6	KO-3×AA	0.86	1.27	-0.51	0.02	1.52
7	KO-3×V5	-3.62	3.20**	-0.12	0.33	-0.06
8	KO-3×V6	-2.14	-1.56	0.09	-0.10	0.26
9	KO-4×PK	-17.35*	-2.51*	-0.82	0.08	-1.56
10	KO-4×AA	0.21	1.87	-0.03	0.14	-0.42
11	KO-4×V5	-0.37	-1.50	2.22**	-0.15	-0.20
12	KO-4×V6	17.51*	2.14	-1.37*	-0.08	2.18**
13	KO-5×PK	-8.50	2.14	-1.81**	-0.27	1.09
14	KO-5×AA	7.36	-1.98	1.69**	-0.51**	-1.07
15	KO-5×V5	-12.42	-0.35	-2.87**	0.60**	1.20
16	KO-5×V6	13.56	0.19	2.99**	0.17	-1.22
17	KO-6×PK	14.95	2.71*	-0.81	0.01	1.97*
18	KO-6×AA	-1.39	0.89	0.24	-0.03	1.36
19	KO-6×V5	-6.67	-2.38*	-0.22	-0.32	-1.58
20	KO-6×V6	-6.89	-1.23	0.79	0.35	-1.75*
21	KO-9×PK	6.38	-0.14	1.14*	0.11	0.33
22	KO-9×AA	1.93	-3.06**	-0.96	0.07	-0.73
23	KO-9×V5	8.96	2.67*	0.63	-0.22	0.44
24	KO-9×V6	-17.27	0.52	-0.81	0.05	-0.04
25	KO-10×PK	5.53	-0.71	-0.18	0.13	0.64
26	KO-10×AA	-15.92	-0.83	-2.19**	-0.01	-1.07
27	KO-10×V5	15.61	2.90**	2.30**	0.30	0.85
28	KO-10×V6	-5.22	-1.36	0.07	-0.43*	-0.42
29	KO-12×PK	-4.67	-0.31	1.03	0.26	0.34
30	KO-12×AA	-12.72	-3.13**	-0.63	-0.28	-1.67*
31	KO-12×V5	-1.39	1.70	-0.83	0.43*	0.55
32	KO-12×V6	18.78*	1.74	0.43	-0.40*	0.78
33	KO-13×PK	4.70	-0.11	1.67**	-0.22	0.07
34	KO-13×AA	10.06	-0.23	0.30	0.04	0.36
35	KO-13×V5	-19.52*	1.50	-1.99**	0.35	-0.28
36	KO-13×V6	4.76	-1.16	0.02	-0.18	-0.15
37	KO-18×PK	-14.10	-1.29	-1.31*	0.16	0.58
38	KO-18×AA	5.96	-0.01	-0.56	-0.08	0.52
39	KO-18×V5	0.58	-0.08	1.43**	0.03	-0.86
40	KO-18×V6	7.56	1.37	0.44	-0.10	-0.24
	SEm ±	8.72	1.09	0.53	0.19	0.82
	CD at 5%	17.34	2.16	1.05	0.37	1.63
	CD at 1%	NS	2.87	1.39	0.50	2.16

*and** indicate significance of values at p=0.05 and p=0.01, respectively

Table 4: Variance due to general and specific combining ability for growth parameters in okra

S. No.	Character	GCA	SCA	GCA:SCA
1	Plant height	2.7990	81.7093	0.0342
2	Number of leaves	0.0497	3.8743	0.0128
3	Internodal length	0.0803	1.4857	0.0540
4	Number of branches per plant	0.0037	0.0456	0.0811
5	Number of nodes on main stem	0.0270	0.7204	0.0374

GCA - Variance due to General combining ability, SCA - Variance due to Specific combining ability

Thippeswamy, 2001, Rewale *et al*., 2003, Eswaran *et al*., 2007 and Hosamani *et al*., 2008 reported same studies for number of branches. For number of nodes on the main stem 15 crosses over better parent, two crosses over the best parent and 31 crosses over the commercial check exhibited significant and positive heterosis and the maximum positive and significant heterosis over better parent was observed in the cross KO-6 × AA (35.21%) and the cross KO-6 × PK exhibited significant and maximum positive heterosis over the best parent (11.03%) and the commercial check (30.17%). The parent KO-6 involved in the above crosses exhibited positive and significant gca effects (Table 2) and the cross KO-6 × PK also showed significant and positive sca effects (Table 3). Similar finding were observed by Shoba and Mariappan, 2005 and Desai *et al*., 2007.

Ratio of general combining ability variance (GCA) to specific combining ability (SCA) is an indication of predominance of additive or non-additive genetic variance. GCA to SCA ratio (Table 4) was very low for number of leaves indicating preponderance of non-additive gene action and hence these traits can be improved through recurrent selection for specific combining ability or heterosis breeding. Non-additive component of genetic variance was higher than additive component for plant height, number of nodes on main stem, internodal length and number of branches per plant. Hence, these characters can be improved through recurrent selection schemes. There is great scope for heterosis breeding to exploit the non-additive genetic variance.

REFERENCES

Aykroyd, W.R. 1963. *ICMR Special Report*. Series No. 42.

Desai, S. S., Bendale, V. W., Bhave, S. G. and Jadhav, B. B. 2007. Heterosis for yield and yield components in okra (*Abelmoschus esculentus*(L.) Moench). *J. Maharashtra Agric. Univ.* **32(1):** 41-44.

Eswaran, R., Thirugnanakumar, S., Sampathkumar, C. P., Anandan, A. and Padmanaban, C. 2007. Studies on the genetic causes of heterosis in okra [*Abelmoschus esculentus* (L.) Moench]. *Plant Archives*. **7(2):** 721-724.

Hosamani, R. M., Ajjappalavara, P. S., Patil, B. C., Smitha, R. P. and Ukkund, K. C. 2008. Heterosis for yield and yield components in okra. *Karnataka J. Agric. Sci*. **21(3):** 473-475.

Jaiprakashnarayan, R. P. 2003. Studies on genetic variance and heterosis in okra. M.Sc. Thesis, Univ. Agric. Sci., Dharwad.

Kempthorne, O. 1957. An introduction to genetic statistics. John Wiley and Sons, New York. pp. 408-711.

Rewale, V. S., Bendale, V. W., Bhave, S. G., Madav, R. R. and Jadhav, B. B. 2003. Combining ability of yield and yield components in okra. *J. Maharashtra Agric. Univ*. **28(3):** 244-246.

Shoba, K. and Mariappan, S. 2005. Studies on heterosis for growth, flowering, fruit charactes in okra (*Abelmoschus esculentus*(L.) Moench).*South Indian Hort*. **53(1-6):** 303-305.

Sood, S. and Kalia, P. 2001. Heterosis and combining ability studies for some quantitative traits in okra (*Abelmoschus esculentus* (L.) Moench). *Haryana J. Hort. Sci*. **30(1&2):** 92-94.

Thippeswamy, S. 2001. Line × tester analysis for heterosis and combining ability using male sterile lines in okra. M.Sc. Thesis, Univ. Agric. Sci., Bangalore.

Vijayaraghavan, C. and Warier, U. A. 1946. Evaluation of high yielding bhendi (*Hibiscus esculentus*). Proc. 33rd Indian Science Congress, **33**: 165.

Weerasekara, D. 2006. Genetic analysis of yield and quality parameters in okra (*Abelmoschus esculentus*(L.) Moench). M.Sc. Thesis, Univ. Agric. Sci., Dharwad.