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Maternal Effects and Heterosis Breeding for Fruit Yield Traits in Okra (*L.*)

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ABSTRACT

A 7 x 7 full diallele cross was effected in okra. The reciprocal differences were quite obvious. The mean of the direct crosses differed significantly from that of their reciprocal crosses for almost all the traits in many cross combinations. Such differences were also deserved at reciprocal effects and heterotic level. Reciprocal difference may be due to the confounded effect of cytoplasm and maternal genotypes. Existence of reciprocal difference due to the presence of over dominance, the best scheme to develop hybrids would be the reciprocal recurrent selection. Standard heterosis upto the tune of 55.96 per cent was recorded by the cross Pusa A4 x Punjab Padmini followed by the cross Punjab Padmini x Varsha Uphar (51.38 per cent) for fruit yield per plant. The cross combinations Pusa A4 x Punjab Padmini, Punjab Padmini x Varsha Uphar and Parbhani Kranti x Punjab Padmini can be utilised for heterosis breeding in okra, which showed high mean ,significant *sca* effects and high economic heterosis for fruit yield and other traits of interest.

Key Words: Heterosis, Maternal effects, Okra, *Sca*.

The magnitude of heterosis provide a basis for genetic diversity and a guide for the choice of developing superior F_1 hybrids so as to exploit hybrid vigour and / or for building gene pools to be employed in breeding programme. Heterosis breeding technique is well established in cross pollinated crops. Efforts are being strengthened to make the hybrid technology fruitful in self pollinated crops also. Now a days heterosis has been considered as a key to boost up the per unit yield and to bring desired quality improvement in the crops. Okra is one of the indiegenous (Zeven and Zhukovsku, 1975) and important self pollinating tropical and sub tropical vegetable crop. Presence of confounded effect of cytoplasm and maternal genotype was earlier reported in the expression of yield and yield components. The proper choice of male and female parents need to be considered through contribution of cytoplasm to obtain better hybrid combination So studies on reciprocal difference and hybrid breeding in okra stand for merit consideration.

MATERIAL AND METHODS

Seven diverse genotypes of okra *viz.,*Varsha Uphar (VU), Pusa A4, Parbhani Kranti (PK) , PB 266, Punjab Padmini (PP), Gujarat Bhindi (GB) and EMS 8 were crossed in full diallele fashion during 2008.The resulting 42 hybrids (21 direct and 21 reciprocals) were sown in the field during January, 2009,following RBD with three replications at Plant Breeding Farm, Faculty of Agriculture, Annamalai University, Tamilnadu. All the entries were sown in a single row plot of 3m size with a spacing of 45 x 30 cm. All the crop management and plant protection operations were carried out as per recommended package of practices. The observations were recorded on five randomly selected competitive plants for the characteristics *viz.,* for days to first fruit harvest, number of fruits per plant, single fruit weight (g) and fruit yield per plant (g).The data were analyzed for combining ability effects and reciprocal effects using standard procedure outlined by Griffing (1956).The differences among the mean performance of the direct and reciprocal crosses were compared using simple't' test. Such a test was also performed to find out the difference at heterotic level.

RESULTS AND DISCUSSION

The *per se* performance, specific combining ability effects and heterosis of the 21 direct crosses were compared with per se performance, reciprocal effects and heterosis of their reciprocal crosses for the traits days to first fruit harvest, number of fruits per plant, single fruit weight (g) and fruit yield per plant (g) (Table 1,2,3). It was found out that six and twelve out of 21 crosses showed significant mean difference and reciprocal effects, respectively between direct and reciprocal crosses for days to first fruit harvest, where as at heterotic level five crosses showed significant differences. For the trait number of fruit per plant, ten and eleven crosses

Table 1. Reciprocal difference at mean performance level for fruit yield traits

S. No.	Crosses	Days to first fruit harvest			Number of fruits per plant			Single fruit weight (g)			Fruit yield per plant (g)		
		D	R	Difference	D	R	Difference	D	R	Difference	D	R	Difference
1	VU x PUSA4	47.20	47.07	0.13	29.13	30.73	1.60**	16.73	16.25	0.48	487.51	499.42	11.91*
2	VU x PK	48.33	47.07	1.26**	26.27	26.00	0.27	14.57	14.80	0.27	382.73	385.83	3.10
3	VU x PB266	52.80	53.60	0.80*	22.47	21.93	0.54	14.07	14.27	0.20	315.39	312.92	2.47
4	VU x PP	47.13	47.80	0.67	29.73	29.67	0.06	16.93	17.87	0.94**	503.50	530.16	26.66**
5	VU x GB	54.07	54.00	0.07	20.80	19.33	1.47**	13.91	14.28	0.37	289.37	276.09	13.28*
6	VU x EMS8	48.33	47.87	0.46	27.80	28.33	1.08**	14.97	15.33	0.36	416.08	434.45	18.37*
7	$PUSA_4$ x PK	43.73	44.00	0.27	32.00	30.93	1.07**	15.60	16.12	0.52**	499.53	498.63	0.90
8	PUSA x PB266	48.93	50.67	1.74**	22.93	24.13	1.20**	15.52	15.07	0.45	356.02	363.69	7.67
9	$PUSA_4$ x PP	45.53	46.07	0.54	30.20	30.13	0.07	18.09	17.81	2.50**	546.20	537.87	8.33
10	$PUSA_4$ x GB	51.07	50.67	0.40	23.40	23.73	0.33	15.35	14.81	1.16**	359.19	351.56	7.57
11	$PUSA_4$ x EMS8	44.53	44.27	0.26	31.73	32.13	0.40	15.97	15.67	0.30	506.87	503.41	3.46
12	PK x PB266	50.87	55.27	4.40**	21.73	18.87	2.86**	15.12	17.05	1.93**	328.64	321.26	7.38
13	PK x PP	44.07	44.13	0.06	28.00	26.60	1.40**	18.39	18.43	0.04	514.78	490.25	24.53**
14	PK x GB	53.67	53.07	0.60	20.13	20.07	0.06	15.09	15.42	0.33	303.88	309.40	5.52
15	PK x EMS8	44.27	44.07	0.20	29.40	27.93	1.47**	16.12	15.82	0.30	473.82	442.02	31.80**
16	PB266 x PP	48.80	48.80	0.00	25.47	23.80	1.67**	16.49	15.80	0.68*	419.84	376.05	43.79**
17	PB266 x GB	57.40	55.80	1.60**	18.87	18.87	0.00	14.12	15.74	1.64**	266.32	296.97	30.65**
18	PB266 x EMS8	47.07	47.60	0.53	26.40	26.13	0.27	15.30	15.17	0.12	403.82	396.52	7.30
19	PP x GB	49.80	51.33	1.53**	25.07	24.80	0.27	15.50	16.20	0.70*	388.43	401.73	13.30*
20	PP x EMS8	47.20	46.60	0.60	27.07	28.07	1.00**	15.21	14.38	0.83*	411.79	403.61	8.18
21	GB x EMS8	47.33	46.87	0.46	24.73	24.93	0.20	15.12	15.05	0.04	373.88	375.28	1.40

* - Significant at 5 per cent level ** - Significant at 1 per cent level. D – Direct Crosses, R – Reciprocal Crosses.

Table 2. Reciprocal effect of *sca* for fruit yield traits

S. No.	Crosses	Days to first fruit harvest		Number of fruits per plant		Single fruit weight (g)		Fruit yield per plant (g)	
		sca	RE	*sca*	RE	*sca*	RE	*sca*	RE
1	VU x PUSA4	-0.67**	0.07	1.15**	-0.80**	0.96**	0.24**	42.17**	-5.96*
2	VU x PK	-0.39**	0.63**	-0.06	0.13	-0.79**	-0.13	-23.66**	-1.55
3	VU x PB266	0.53**	-0.40**	-0.91**	0.27*	-0.55**	-0.12	-25.95**	1.24
4	VU x PP	-1.31**	-0.33**	2.44**	0.03	1.09**	-0.47**	70.20**	-13.33**
5	VU x GB	1.00**	0.03	-2.36**	0.73**	-0.47**	-0.19*	-44.38**	6.64**
6	VU x EMS8	0.66**	0.23*	0.40**	-0.27*	0.46**	0.18*	15.05**	-9.19**
7	$PUSA_4$ x PK	-1.73**	-0.13	3.29**	0.53**	-0.60**	-0.26*	35.98**	0.45
8	PUSA x PB266	-0.38**	-0.87**	-1.56**	-0.60**	-0.36**	0.23*	-35.42**	-3.83
9	$PUSA_4$ x PP	-0.48**	-0.27**	0.92**	0.03	0.70**	0.12	40.32**	4.16
10	$PUSA_4$ x GB	0.32**	0.20	-0.85**	-0.17	-0.44**	0.27**	-26.90**	3.81
11	$PUSA_4$ x EMS8	-0.55**	0.13	2.28**	-0.20	0.17*	0.15	39.76**	1.73
12	PK x PB266	2.60**	-2.20	-2.21**	1.43**	0.46**	-0.96**	-26.96**	3.69
13	PK x PP	-2.47**	-0.03	0.64**	0.70**	0.17*	-0.02	44.16**	12.27**
14	PK x GB	2.54**	0.30**	-1.73**	0.03	-0.24**	-0.16	-32.28**	-2.76
15	PK x EMS8	-1.07**	0.10	1.60**	0.73**	0.36**	-0.15	35.89**	15.90**
16	PB266 x PP	-2.35**	0.01	1.05**	0.83**	-0.29**	0.34**	7.42**	21.90**
17	PB266 x GB	1.19**	0.80**	0.12	0.01	0.23**	-0.81**	10.56**	-15.33**
18	PB266 x EMS8	-2.48**	-0.27*	2.28**	0.13	0.42**	0.61	45.98**	3.65
19	PP x GB	-0.85**	-0.87**	2.04**	0.13	-0.46**	-0.35**	17.56**	-6.65**
20	PP x EMS8	0.98**	0.30**	-0.56**	-0.50**	-1.63**	0.42**	-52.93**	4.09
21	GB x EMS8	-3.08**	0.23*	1.53**	-0.10	-0.40	0.03	33.38**	-0.70

* - Significant at 5 per cent level ** - Significant at 1 per cent level. D – Direct Crosses, R – Reciprocal Crosses.

Table 3. Reciprocal difference at heterotic level for fruit yield traits and standard heterosis for fruit yield per plant

S. No.	Crosses	Days to first fruit harvest			Number of fruits per plant			Single fruit weight (g)			Fruit yield per plant (g)				
														Standard Heterosis	
		D	R	Difference	D	R	Difference	D	R	Difference	D	R	Difference	D	R
1	VU x PUSA4	-4.90**	-5.17**	0.27	12.77**	18.97**	6.20**	11.68**	8.45**	3.23	26.11**	29.19**	3.08*	39.21**	42.61**
2	VU x PK	-0.21**	-2.82**	2.61*	4.65**	3.59**	1.06	-2.70	-0.92	1.78	2.17*	2.99**	0.82	9.29*	10.17**
3	VU x PB266	-0.75	0.75	0.00	-3.99**	-6.27**	2.28	-2.59	-0.99	1.60	-6.00**	-6.74**	0.74	-9.94*	-10.65**
4	VU x PP	-9.53**	-8.25**	1.28	25.63**	25.35**	0.28	7.97**	13.96**	5.99**	37.42**	44.70**	7.28**	43.77**	51.38**
5	VU x GB	2.85**	2.73**	0.12	-8.50**	-14.96**	6.46**	-5.41**	-2.89**	2.52	-12.68**	-16.69**	4.01**	-17.37**	-21.16**
6	VU x EMS8	-3.91**	-4.84**	0.93	17.96**	20.23**	2.27	4.98**	7.55**	2.57	24.24**	29.73**	5.49**	18.81**	24.05**
7	$PUSA_4$ x PK	-8.12**	-7.56**	0.56	29.03**	24.73**	4.30**	-2.93	0.30	2.63	25.33**	25.10**	0.23	42.64**	42.38**
8	PUSA x PB266	-6.56**	-3.25**	3.31**	-0.72*	4.47*	3.75	0.13	-2.80	2.67	-0.97	1.17	0.20	1.66	3.85
9	$PUSA_4$ x PP	-11.18**	-10.14**	1.04	29.24**	28.96**	0.28	7.81**	6.40**	1.41	39.93**	37.79**	2.14	55.96*8	53.59**
10	$PUSA_4$ x GB	-1.29**	-2.06**	0.77	4.31**	5.79**	1.48	-2.86**	-6.25**	3.39**	1.08	-1.07	0.01	2.56	0.39
11	$PUSA_4$ x EMS8	-9.97**	-10.51**	0.54	36.39**	38.11**	1.72	4.06**	2.06**	2.00	41.25**	40.28**	0.97	44.73**	43.75**
12	PK x PB266	-0.59**	8.01**	7.42**	-2.83**	-15.65**	12.82**	-2.42**	10.01**	7.59**	-5.44**	-7.56**	2.12	-6.16	-8.27*
13	PK x PP	-11.98**	-11.85**	0.13	23.71**	17.53**	6.18*	9.63**	9.89**	0.26	36.05**	29.56**	6.49**	46.99**	39.99**
14	PK x GB	6.20**	5.01**	1.19	-7.22**	-7.53**	0.31	-4.45**	-2.38**	2.07	-11.51**	-9.90**	1.61	-13.23**	-11.65**
15	PK x EMS8	-8.29**	-8.70**	0.41	30.47**	23.96**	6.51**	5.03**	3.12**	1.91	36.59**	27.42**	9.17**	35.30**	26.22**
16	PB266 x PP	-11.00**	-11.00**	0.00	21.66**	13.69**	7.97**	1.75	-2.49	0.74	23.74**	10.83**	12.91**	19.88**	7.38
17	PB266 x GB	3.80**	0.90**	2.90*	-5.67**	-5.67**	0.00	-7.30**	3.36	3.94**	-12.48**	-2.41**	10.07**	-23.95**	-15.20**
18	PB266 x EMS8	-11.25**	-10.25**	1.00	26.72**	25.44**	1.28	3.52**	2.68**	0.84	31.19**	28.82**	2.37	15.31**	13.22**
19	PP x GB	-8.12**	-4.92**	3.20*	23.68**	22.37**	1.31	-6.09**	-1.83**	4.26**	15.90**	19.87**	3.97**	10.91**	14.71**
20	PP x EMS8	-9.11**	-10.27**	1.16	28.28**	33.02**	4.74**	-5.21**	-10.40**	5.19**	21.60**	19.18**	2.42	17.58**	15.25**
21	GB x EMS8	-9.67**	-10.56**	0.89	22.64**	23.64**	1.00	0.28	-0.14	0.14	23.12**	23.58**	0.46	6.76	7.16

* - Significant at 5 per cent level ** - Significant at 1 per cent level. D – Direct Crosses, R – Reciprocal Crosses.

showed significant mean difference and reciprocal effects respectively and eight crosses recorded significant differences at heterotic level. Nine and twelve out of 21 crosses were registered significant mean difference and reciprocal effects respectively for the trait single fruit weight. While six crosses recorded significant difference at heterotic level. Nine crosses out of 21 crosses registered significant mean difference, reciprocal effects and relative heteroris for the trait fruit yield per plant.

Among the 21 direct and 21 reciprocal cross combinations, the crosses namely pusa A4 X PP (546.20, 537.87), VU x PP (503.50, 530.16), Pusa A4 x EMS8 (506.87, 503.41), PK x PP (514.78, 490.25), Pusa A4 x PK (499.53, 498.63) and VU x Pusa A4 (487.51, 499.42) recorded the maximum fruit yield per plant. Among the above six cross combinations, three cross combinations namely VU x PP, PK x PP and VU x Pusa A4 exhibited significant mean difference, reciprocal effects and relative heterosis. The parents namely PP, PK, and Pusa A4 contributed more while using as female parents from the above three combinations. Significant reciprocal effects of *sca* imply that a proper choice of male and female parent must be made to obtain a better *sca* in the selected crosses.

None of the hybrids recorded significant reciprocal effects for all the four traits studied except the hybrid Pusa A4 x EMS 8. Such a difference among the direct and reciprocal crosses at mean, reciprocal effects and heterotic level may indicate the presence of the confounded effect of cytoplasm and maternal genotype (Thirugnana Kumar *et,al*., 1999 and Senthilkumar *et,al*., 2007).These reciprocal effects shown by almost all the cross combinations for one or more character arises due to the zygote of cytoplasmic determinance for which all the practical purpose only came from female gamete. The combinations identified for favourable combining ability effects revealed that the choice of male and female parents need to be considered for the introgression of fruit yield traits and to obtain better *sca* in selected crosses, where crosses showed reciprocal effects. Thus these large heterotic effects may be utilized for the development of desirable segregants through hybridization and selection for high fruit yield. Senthilkumar and Anandan(2006), Adeniji and Kehinde (2003) and Liou *et,al*., (2002) have reported over dominance and reciprocal difference in the estimates of reciprocal effects of *sca* for fruit yield traits in okra. In the presence of over dominance and reciprocal difference, the best scheme to develop elite lines would be reciprocal recurrent selection.

Among 21 direct and 21 reciprocal cross combinations studied, the crosses namely Pusa A4 x PP (55.96%, 53.59%), PusaA4 x EMS8 (44.73%, 43.75%), VU x PP (43.77%, 51.38%), PK x PP (46.99%, 39.99%), Pusa A4 x PK (42.64%, 42.38%) and VU x Pusa A4 (39.21%,42.60%) registered maximum significant standard heterosis in the range of 39.21 to 55.96 per cent for fruit yield per plant (Table 3). These cross combinations also showed favourable standard heterosis for other traits studied. The crosses viz., Pusa A4 x PP, PP x Pusa A4, PP x VU and PK x PP which portrayed high commercial heterosis were also endowed with high mean performance and significant *sca* effects. Hence these above cross combinations are suggested to develop hybrid breeding in okra.

LITERATURE CITED

Adeniji O T and Kehinde O B 2003. Diallele analysis of pod yield in western okra (*Abelmoschus esculentus* (L.) Moench). Journal of Genet and Breeding. 57(3): 291-94.

Griffing B 1956. A generalized treatment of the use of diallele crosses in quantitative inheritance. Heridity. 10: 31-50.

PLiou-MinLi, Guo-Jiewei and Wu-ShuTu. 2002. Diallele analysis of quantitative characters in okra. Journal of Agriculture and Forestry. 51(3): 57-66.

Senthil Kumar N and Anandan A 2006. Combining ability and heterosis for fruit yield characters in okra (*Abelmoschus esculentus* (L.) Moench). Indian Journal of Plant Science 1(1): 88-91.

Senthilkumar N, Suguna V and Thirugnanakumar S 2007. Reciprocal difference and heterosis breeding for fruioot yield traits in okra (*Abelmoschus esculentus* (L.) Moench). Advance in Plant Science 20(1): 77-79.

Thirugnanakumar S, Thangavelu S and Sree Rengasamy S R 1999. Maternal effects and cytoplasmic inheritance of seed size characters in sesame (*Sesamum indicum* L.). Sesame Safflower Newslett ., 14: 19-25.

Zeven A C and Zhukovsku P M 1975. Discovery of cultivated plants and their centers of diversity.Centre for Agricultural Publishing and Documentation, Wageningen , Netherland .219.

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