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HETEROSIS AND INBREEDING DEPRESSION IN OKRA *ABELMOSCHUS ESCULENTUS* (L.) MOENCH

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Abstract

The experiment was conducted with 120 treatments (28 F_1s, 28F_2s, 28B_1s and 28B_2s populations) developed through diallel technique excluding reciprocals alongwith 8 parents *viz*., AB-2, AB-1, KS-312, BO-2, P-7, VRO-3, VRO-5 and PK in a randomized block design with three replications at the Research Farm of the Department of Vegetable Science, C.S. Azad University of Agriculture and Technology, Kalyanpur, Kanpur during Kharif 2006. The observation were recorded on 20 randomly selected plants for 10 quantitative traits namely, days to flowering, height of plant (cm), number of branches per plant, number of first fruiting node, number of nodes per plant, length of internode (cm), length of fruit (cm), width of fruit (cm), number of fruits per plant and yield per plant (g). The study was revealed that the high magnitude of heterosis over better parent and economic parent were observed in crosses AB-2 x AB-1, VRO-3 x PK and AB-1 x PK found desirable for yield per plant. These crosses also showed reasonable amount of inbreeding depression in F_2 population.

Key words: Okra, heterosis, inbreeding depression, diallel cross, dominance, epistasis.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop of India. It belongs to the family Malvaceae and having chromosome number 2n = 130. It behave as often cross pollinated crop although it is potential self pollinated crop, 8.75 to 9.61 per cent out crossing (Purewal and Randhawa, 1947). Okra is an important fruit vegetable crop of the tropical and subtropical regions of the world. It is grown successfully in plains and hills. It is a crop of warm wet season in the northern India, but it is also taken as winter crop in the frost free areas of Central and South India, particularly Gujarat, Maharashtra. It is a good source of Vitamin A, B and C, protein and mineral elements. In recent years heterosis breeding has been extensively exploited and utilized for boosting up yield. The estimation of the extent of heterosis over standard parent/check variety under commercial cultivation (Economic heterosis) would by most desirable for hetersis breeding. Hence in the heterosis over standard parent for yield and ten related attributes.

Materials and Methods

The experiment was conducted with 120 treatments (28 F_1s, 28F_2s, 28B_1s and 28B_2s populations) developed through diallel technique excluding reciprocals alongwith 8 parents viz., AB-2, AB-1, KS-312, BO-2, P-7, VRO-3, VRO-5 and PK in a randomized block design with three replications at the Research Farm of the Department of Vegetable Science, C.S. Azad University of Agriculture and Technology, Kalyanpur, Kanpur during Kharif 2006. The observation were recorded on 20 randomly selected plants for 10 quantitative traits namely, days to flowering, height of plant (cm), number of branches per plant, number of first fruiting node, number of nodes per plant, length of inter node (cm), length of fruit (cm), width of fruit (cm), number of fruits per plant and yield per plant (g). Parents were sown in single row with ten plants and F_1s, F_2s, B_1s and B_2s grown in double rows with ten plants in each row. The plant to plant and row to row spacing were maintained at 45 cm apart. Heterobeltiosis and inbreeding depression from F_1 and F_2 were calculated as suggested by Lal *et al.* (1975).

Results and Discussion

The pre-requisites for the exploitation of heterosis on commercial scale the extent of heterosis (F_1 over the better economic parents). Heterosis and inbreeding are important aspects for studying the nature of gene action in F_1 and F_2 generation. It is of considerable interest to get the cause of heterosis for hybrid seed production. There can not be any gene system for yield *per se* as the yield is the end product of the multiplicative interaction between yield components (Grafius, 1959). This automatically follows that

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heterobeltiosis in individual yield components in the present investigation. Heterosis had been marked out over better parent and inbreeding depression in F_2 generation (Table 1). Hybrid vigour in self pollinated crops to be economically advantageous must yield 25% more than the best commercial variety. The days to flowering are an important character and desirable parent with early flowering in the case of high cross heterobeltiosis with low inbreeding depression is useful for exploitation of heterosis for the purpose of developing the high yield pure line variety.

Heterosis for days to flowering ranged from -17.38 (AB-2 x AB-1) to 9.50 (AB-2 x PK) percent and from -22.55 (BO-2 x PK) to 17.10 (P-7 x PK) percent over better parent and economic parents, respectively. Crosses AB-2 x AB-1, AB-2 x KS-312, AB-1 x KS-312 and KS-312 x VRO-3 were found to be early in flowering over better parent in order of merit. Crosses BO-2 x PK, AB-2 x AB-1, AB-2 x KS-312, AB-1 x KS-312 and AB-2 x VRO-3 showed early flowering over economic parent "AB-1". The inbreeding depression ranged from -13.79 (AB-1 x VRO-3) to 7.46 (BO-2 x P-7) percent over F_1. Crosses AB-1 x VRO-3, KS-312 x VRO-3, BO-2 x VRO-5, AB-1 x VRO-5 and AB-2 x KS-312 showed early flowering in F_2 population in order of merit. Similar results were reported by Singh and Singh (1972) and Thanker *et al.* (1982). The crosses indicate positive heterosis for height of plant. Hybrid vigour ranged from -6.79 (BO-2 x VRO-3) to 21.46 (BO-2 x PK) percent over better parent and from -4.88 (AB-2 x VRO-5) to 39.43 (BO-2 x PK) percent over economic parent. Crosses BO-2 x PK, AB-1 x PK, AB-1 x P-7, VRO-5 x PK and AB-2 x PK were found to be tallest for height of plant over better parent in order of merit. Crosses BO-2 x PK, VRO-5 x PK, AB-1 x PK, AB-2 x PK and VRO-3 x PK were tallest over economic parent. Inbreeding depression in F_2 ranged from -11.87 (VRO-3 x VRO-5) to 11.89 (AB-1 x P-7) percent over F_1. Crosses VRO-3 x VRO-5, BO-2 x VRO-5, KS-312 x PK, AB-2 x BO-2 and AB-2 x AB-1 showed significant increase height of plant in F_2 population. These findings supported by Thanker *et al.* (1982). The heterosis ranged from -14.46 (AB-1 x KS-312) to 50.21 (AB-1 x VRO-3) percent over better parent and from -14.58 (AB-1 x KS-312) to 74.17 (VRO-5 x PK) percent over economic parent. Cross combination AB-1 x KS-312, P-7 x VRO-3, AB-2 x KS-312, AB-2 x AB-1 and BO-2 x P-7 exhibited maximum heterosis for less number of branches per plant over better parent. Crosses AB-1 x KS-312, AB-2 x AB-1, AB-1 x BO-2 and AB-2 x KS-312 showed maximum heterosis in order of merit for less number of branches per plant. Inbreeding depression ranged from -72.06 (AB-1 x BO-2) to 31.71 (VRO-3 x PK) percent over F_1. Crosses AB-1 x BO-2, AB-2 x VRO-3, AB-1 x KS-312, AB-2 x AB-1 and KS-312 x BO-2 showed significant increase in number of branches per plant in F_2 population. These studies are in agreement with those of Sharma and Mahajan (1978); Deshmukh and Bhapkar (1982).

The heterosis for number of first fruiting node ranged from -24.34 (VRO-5 x PK) to 50.98 (KS-312 x PK) percent over better parent and from -50.56 (AB-1 x KS-312) to 62.96 (BO-2 x VRO-3) percent over economic parent, respectively. Crosses VRO-5 x PK, P-7 x VRO-3, VRO-3 x VRO-5, BO-2 x VRO-5 and AB-2 x AB-1 were found having minimum number of first fruiting node over better parent in order of merit. Crosses AB-1 x KS-312, AB-2 x AB-1, KS-312 x VRO-3 and P-7 x VRO-3 showed minimum number of first fruiting node over economic parent. The inbreeding depression ranged from -45.10 (AB-1 x KS-312) to 22.54 (P-7 x PK) percent over F_1. Crosses P-7 x PK, KS-312 x PK, AB-1 x P-7, BO-2 x VRO-5 and AB-2 x VRO-5 showed minimum number of first fruiting node in F_2 populations.

The heterosis for number of nodes per plant ranged from -10.33 (AB-2 x VRO-5) to 15.96 (AB-2 x KS-312) percent over better parent and from -13.86 (BO-2 x P-7) to 30.20 (AB-2 x PK) percent over economic parent. Cross combinations AB-2 x KS-312, AB-2 x PK, AB-2 x AB-1, BO-2 x VRO-3 and KS-312 x VRO-3 exhibited maximum heterosis for more number of nodes per plant over better parent. Crosses AB-2 x PK, AB-1 x PK, AB-2 x KS-312, AB-2 x AB-1 and BO-2 x PK showed maximum heterosis in order of merit for more number of nodes per plant over economic parent. Inbreeding depression ranged from -21.77 (KS-312 x PK) to 28.74 (AB-2 x KS-312) percent over F_1. Cross combinations KS-312 x PK, P-7 x VRO-3, AB-2 x VRO-3, BO-2 x P-7, AB-2 x BO-2 and BO-2 x VRO-3 exhibited more number of nodes per plant in F_2 populations.

The heterosis for length of inter node ranged from -13.36 (AB-1 x VRO-3) to 48.75 (KS-312 x P-7) percent over better parent and from -28.15 (AB-2 x KS-312) to 17.50 (AB-1 x PK) percent over economic parent. Crosses AB-1 x VRO-3, BO-2 x VRO-3 and P-7 x VRO-3 showed shortest length of inter node over better parent in order of merit. Crosses AB-2 x KS-312, BO-2 x VRO-3, KS-312 x VRO-3, AB-1 x KS-312 and BO-2 x P-7 showed shortest length of inter node over economic parent. Inbreeding depression ranged from -32.73 (KS-312 x PK) to 34.12 (AB-2 x KS-312) percent over F_1. Cross combinations KS-312 x PK, BO-2 x P-7, KS-312 x VRO-3, P-7 x VRO-3 and VRO-3 x VRO-5 showed shortest length of inter node in F_2 populations.

The heterosis for length of fruit ranged from -12.39 (AB-1 x KS-312) to 39.08 (AB-2 x P-7) percent and from -12.36 (AB-1 x KS-312) to 31.12 (BO-2 x PK) percent over better and economic parents, respectively. Maximum heterosis was observed for length of fruit in the cross combinations AB-2 x P-7, KS-312 x BO-2, P-7 x VRO-3, AB-2 x VRO-5 and P-7 x VRO-5 over better parents. Crosses BO-2 x PK, AB-2 x P-7, VRO-3 x PK, AB-1 x PK and AB-2 x PK over economic parents in order of merit for more length of fruit. Inbreeding depression ranged from -22.87 (KS-312 x P-7) to 19.62 (BO-2 x PK) percent over F_1. Cross combinations, KS-312 x P-7, P-7 x PK, BO-2 x VRO-3, BO-2 x VRO-5 and AB-2 x VRO-5 exhibited more length of fruit in F_2 populations.

The heterosis for width of fruit ranged from -35.51 (KS-312 x PK) to 51.43 (AB-1 x PK) percent over better parent and from -12.79 (AB-2 X AB-1) to 54.07 (AB-2 x PK) percent over economic parent. Crosses AB-2 x AB-1, AB-1 x PK, AB-2 x VRO-3, AB-2 x AB-1 and AB-1 x VRO-3 were found to be good response for width of fruit over better parent. Crosses AB-2 x PK, VRO-3 x PK, VRO-5 x PK, P-7 x PK and AB-1 x PK showed good response for width of fruit over economic parent. Inbreeding depression ranged from -26.47 (KS-312 x VRO-5) to 20.00 (AB-2 x PK) percent over F_1. Crosses AB-2 x PK, AB-1 x PK, VRO-3 x PK, VRO-3 x VRO-5 showed thickness of fruit in F_2 populations in order of merit.

The heterosis for number of fruits per plant ranged from -9.44 (AB-2 x P-7) to 33.33 (AB-2 x AB-1) percent and from -20.35 (KS-312 x P-7) to 39.53 (AB-2 x AB-1) percent over better and economic parents, respectively. Maximum heterosis in descending order was observed in the cross combinations AB-2 x AB-1, BO-2 x PK, VRO-3 x VRO-5, AB-2 x BO-2 and BO-2 x P-7 over better parent and cross combinations AB-2 x AB-1, AB-2 x BO-2, BO-2 x PK, KS-

312 x P-7 and AB-2 x PK showed heterosis over economic parent for more number of fruits per plant. Inbreeding depression ranged from -20.62 (P-7 x PK) to 24.73 (AB-2 x VRO-3) percent over F_1. Cross combinations AB-2 x VRO-3, AB-1 x BO-2, AB-1 x KS-312. AB-2 x BO-2 and AB-1 x PK exhibited maximum significant positive inbreeding depression for less number of fruits per plant, Mahajan *et al.* (2017).

The heterosis for yield per plant ranged from -6.39 (KS-312 x PK) to 30.00 (AB-2 x AB-1) percent over better parent and from -18.21 (KS-312 x P-7) to 36.84 (AB-2 x AB-1) percent over economic parent. Maximum yield per plant was observed for the crosses AB-2 x AB-1, VRO-3 x PK, BO-2 x P-7, AB-1 x PK and BO-2 x VRO-3 over better parent and crosses AB-2 x AB-1, AB-2 x BO-2, AB-1 x PK and AB-2 x VRO-3 over economic parent. Inbreeding depression ranged from -16.92 (P-7 x PK) to 30.04 (AB-2 x VRO-3) percent over F_1. Crosses AB-2 x VRO-3, AB-1 x BO-2, AB-2 x KS-312, AB-2 x BO-2 and AB-2 x AB-1 showed maximum significant positive inbreeding depression for low yield per plant. It was further revealed that some crosses also showed significant and high heterosis with significant positive inbreeding depression which might be due to non allelic gene interactions, Kurere *et al*. (2019).

Conclusion

On the basis of better parent heterosis cross combination AB-2 x AB-1, VRO-3 x PK, BO-2 x P-7, AB-1 x PK and BO-2 x VRO-3 showed more than 20% heterosis for yield per plant. On the basis of economic parent (AB-1) heterosis cross combinations AB-2 x AB-1, AB-2 x BO-2, AB-1 x PK, AB-2 x VRO-3 and VRO-3 x PK showed more than 20% for yield per plant and superiority over AB-1.

At the last cross combination AB-2 x AB-1, VRO-3 x PK and AB-1 x PK were common cross combination showed heterotic response over better and economic parent on the basis of range from 25.26% to 36.84%. These crosses also showed reasonable amount of inbreeding depression in F_2 population.

References

Lal, S.; Shekhar, C, and Srivastava, J.P. (1975). Genetic studies in Bhindi (*Abelmoschus esculentus* (L.) Moench] gene effect and heterosis. *Indian J. Hort.,* **34(1):** 49-50.

Kulkarni, R.S. and Virupakshppa, K. (1977). Heterosis and inbreeding depression in Okra. *Indian J. Agric. Sci.,* **47(11):** 552-555.

Purewal, S.S. and Randhawa, S. (1947). Chromosome and pollination in Okra. *Indian J. Agric. Sci.,* **17:** 129-136.

Sharma, S.S. and Mahajan, Y.P. (1978). Analysis of combining ability and heterosis for some economic characters in okra. *Scientia Hort.* **9(2):** 111-118.

Yadav, J.R.; Bhargava, L.; Kumar, S.; Mishra, G.; Yadav, Alok; Parihar, N.S. and Singh, S.P. (2007). Useful heterosis for yield and its components in okra [*Abelmoschus esculentus* (L.) Moench]. *Prog. Agric.,* **7(1/2):** 5-7.

Verma, R.S.; Gautam, N.C.; Singh, V.B.; Singh, B.M. and Pandey, Vivek (2009). Studies on heterobeltiosis and inbreeding depression in okra [*Abelmoschus esculentus* (L.) Moench]. Ist Indian Agricultural Scientists and Farmers Congress on Technological Innovations for Enhancing Agriculture Production, C.C.S.U., Meerut, Oct. 3-4 (130) p-278.

Aware, S.S., Deshmukh, D.T., Thakre, S.V. and Zambre, S.M. (2014). Heterosis and inbreeding depression studies in okra [*Abelmoschus esculentus* (L.) Moench] *International J. Curr. Microbiol. App. Sci*., **39(12):** 733-747.

Neetu, Singh, A.K., Kumar, R. and Pal, M. (2015). Heterosis and inbreeding depression in okra [*Abelmoschus esculentus* (L.) Moench]. *International J. Scientific Innovative Res*., **3(2):** 15-24.

Tonde, N.G., Kale, V.S., Nagre, P.K. and Lajurker, V.G. (2016). Heterosis and inbreeding depression in okra [*Abelmoschus esculentus* (L.) Moench]. *The bioscan,* **11(3):** 1979-1984.

Mahajan, R.C., Sonawane, D.J., and Yamgar, S.V. (2017). Estimation of heterosis, inbreeding depression and heritabillty for fruit yield and its attributing traits in okra [*Abelmoschus esculentus* (L.) Moench]. *J. Pharmaco. Phytochem*., **6(6):** 2174-2177.

Kurere, P., Pitchaimuthu, M. Srinivasa, V. and Venugopalan, R. (2019). Heterosis and inbreeding depression in okra [*Abelmoschus esculentus* (L.) Moench]. *International J. Curr. Microbiol. App. Sci.,* **8(1):** 353-367.

Table 1: Estimates of heterosis over better parent, over economic parent (Azad Bhindi-1) and inbreeding depression in percent for ten characters in okra

Crosses	Days to flowering			Height of plant (cm)			Number of branches per plant			Number of first fruiting node		
	Over BP	Over EP	ID	Over BP	Over EP	ID	Over BP	Over EP	ID	Over BP	Over EP	ID
AB-2 x AB-1	-17.38**	-19.11**	-6.55**	-5.84	-4.06	-5.80*	-8.21**	-8.33**	-36.36**	-7.22**	-7.22**	-1.80**
AB-2 x KS-312	-15.01**	-16.78**	-8.23**	0.66	2.56	7.30**	-11.52**	-2.92**	14.16**	-4.09**	0.00	7.41**
AB-2 x BO-2	-7.10**	-9.03**	-1.94*	-3.19	1.30	-7.16**	10.76**	21.67**	-16.44**	8.62**	16.67**	-30.95**
AB-2 x P-7	-2.35**	-4.36**	-1.54	1.67	3.58	5.18*	15.82**	27.08**	-21.31**	18.10**	26.85**	1.46**
AB-2 x VRO-3	-9.74**	-11.60**	-8.22**	-1.19	0.68	1.84	-5.06**	4.17**	-64.00**	-3.10**	4.26**	-26.33**
AB-2 x VRO-5	0.47	-1.60	-1.90*	-6.64*	-4.88	10.63**	-1.27**	8.33**	-15.38**	16.09**	24.63**	3.42**
AB-2 x PK	9.50**	7.24**	-1.96*	11.01**	27.44**	10.11**	18.48**	3.00**	-15.38**	27.93**	37.41**	-2.43**
AB-1 x KS-312	-13.05**	-13.05**	-7.52**	0.03	0.03	10.05**	-14.46**	-14.58**	-56.10**	-5.56**	-50.56**	-45.10**
AB-1 x BO-2	-6.54**	-6.54**	-6.76**	4.50	9.35**	11.08**	-5.42**	-5.42**	-72.06**	27.78**	27.78**	-0.72
AB-1 x P-7	0.87	0.87	-1.20	14.41**	14.41**	11.89**	9.74**	9.58**	-33.08**	21.30**	21.30**	8.40**
AB-1 x VRO-3	-6.56**	-6.56**	-13.79**	1.97	1.97	1.72	50.21**	50.00**	-16.67**	1.85**	1.85**	-16.36**
AB-1 x VRO-5	-0.51	-0.51	-8.33**	4.91	4.91	6.99**	23.64**	23.33**	-4.73**	28.70**	28.70**	-25.18**
AB-1 x PK	5.55**	5.55**	6.61**	17.51**	34.89**	7.16**	40.19**	40.00**	-27.35**	12.04**	12.04**	-30.58**
KS-312 x BO-2	-7.78**	-5.04**	-5.33**	1.34	6.04*	7.65**	1.06**	18.75**	-35.09**	27.00**	32.41**	-9.09**
KS-312 x P-7	-4.56**	-1.72*	-7.20**	5.48	1.07	4.39	13.48**	33.33**	-14.06**	34.10**	39.81**	-11.04**
KS-312 x VRO-3	-10.51**	-7.85**	-10.64**	5.31	0.96	-3.88	20.57**	41.67**	-16.18**	-6.22**	-2.22**	-4.17**
KS-312 x VRO-5	-6.59**	-3.80**	1.64*	-0.20	-0.03	-4.47*	6.38**	25.00**	-25.00**	29.07**	34.63**	-10.09**
KS-312 x PK	6.44**	9.61**	2.19**	-6.30*	7.57*	-8.95*	17.02**	37.50**	-33.33**	50.98**	57.41**	17.65**
BO-2 x P-7	5.48**	13.32**	7.46**	6.98*	11.94**	4.29	-6.61**	29.58**	-32.48**	19.61**	13.89**	-16.26**
BO-2 x VRO-3	-5.76**	1.24	-2.63**	-6.79*	2.46	-4.78*	17.12**	62.50**	-17.95**	27.17**	62.96**	-7.95**
BO-2 x VRO-5	-8.38**	-1.31	-9.13**	-0.29	4.33	9.66**	9.01**	51.25**	22.87**	-16.34**	18.52**	4.69**
BO-2 x PK	4.76**	-22.55**	-3.66**	21.46**	39.43**	10.39**	24.62**	72.92**	19.28**	-6.93**	31.85**	-4.63**
P-7 x VRO-3	-3.72**	1.48	-4.42**	3.03	-1.28	-2.57	-12.50**	31.25**	-9.52**	-22.54**	-0.74**	-29.66**
P-7 x VRO-5	-8.11**	1.84**	0.71	6.41*	3.19	-2.41	-3.89**	44.17**	-2.60**	3.97**	45.37**	-1.66**
P-7 x PK	4.36**	17.10**	3.68**	2.66	17.86**	10.97**	12.50**	68.75**	1.23**	14.57**	60.19**	22.54**
VRO-3 x VRO-5	-5.26**	-0.15	-5.31**	2.26	-0.84	-11.87**	-5.44**	66.67**	-4.25**	-19.36**	3.33**	-31.72**
VRO-3 x PK	1.56	7.05**	-7.29**	8.77**	24.87**	6.86**	5.13**	70.83**	31.71**	4.05**	33.33**	-25.00**
VRO-5 x PK	-0.74	10.00**	2.31**	12.67**	39.35**	7.56**	7.18**	74.17**	-19.62**	-24.34**	11.11**	-43.33**
SE ±	0.84	0.84	0.81	3.16	3.04	2.26	0.27	0.28	0.32	0.50	0.49	0.42

Contd....

Crosses	Number of nodes per plant			Length internode (cm)			Length of fruit (cm)			Width of fruit (cm)		
	Over BP	Over EP	ID	Over BP	Over EP	ID	Over BP	Over EP	ID	Over BP	Over EP	ID
AB-2 x AB-1	14.55**	20.79**	23.36**	13.55**	2.70**	-4.12**	23.24**	23.24**	17.85**	-12.96**	-12.79**	-25.33**
AB-2 x KS-312	15.96**	22.28**	28.74**	6.25**	-28.15**	34.12**	7.43	0.00	14.52**	-7.43**	-5.81**	-8.02**
AB-2 x BO-2	3.29	8.91**	-11.36**	7.19**	15.13**	-16.73**	12.33**	4.56**	4.76**	-2.86**	-1.16**	-8.82**
AB-2 x P-7	0.78	6.29**	9.46**	9.35**	-1.10	11.97**	39.08**	29.46**	17.31**	-0.57**	1.16**	-17.82**
AB-2 x VRO-3	-10.33**	-5.45**	-16.23**	18.22**	6.93**	14.62**	19.02**	10.79**	9.36**	13.14**	15.11**	-13.64**
AB-2 x VRO-5	0.47	5.94**	9.81**	1.87**	-7.86**	-16.82**	26.75**	18.01**	-4.08**	-5.71**	-4.07**	-6.06**
AB-2 x PK	15.01**	30.20**	17.87**	25.70**	13.69**	15.24**	11.94**	24.48**	17.67**	51.43**	54.07**	20.00**
AB-1 x KS-312	9.41**	9.41**	8.82**	17.50**	-20.54**	5.32**	-12.39**	-12.36**	0.57**	-3.29**	-2.91**	-8.00**
AB-1 x BO-2	7.93**	7.43**	12.90**	18.78**	-5.92**	5.63**	2.07**	2.07**	5.69**	3.29**	3.49**	-9.55**
AB-1 x P-7	10.89**	10.89**	15.63**	5.60**	3.55**	8.57**	13.28**	13.28**	7.33**	10.25**	10.47**	-5.26**
AB-1 x VRO-3	5.69**	5.69**	4.92**	-13.36**	-13.36**	2.93**	16.18**	16.18**	6.79**	12.57**	12.79**	-8.25**
AB-1 x VRO-5	-3.47*	-3.47**	10.26**	2.56**	-5.07**	2.91**	2.49**	2.49**	-0.40	9.09**	9.30**	-1.06**
AB-1 x PK	10.20**	24.75**	22.22**	17.48**	17.50**	17.39**	14.18**	26.97**	15.03**	21.86**	22.09**	12.86**
KS-312 x BO-2	7.39**	-4.31**	19.81**	33.75**	-9.55**	-0.93	32.73**	11.62**	15.99**	-9.19**	-2.33**	-17.26**
KS-312 x P-7	1.08	-6.93**	13.83**	48.75**	0.59	15.97**	7.14**	12.86**	-22.87**	-5.41**	1.74**	2.86**
KS-312 x VRO-3	13.41**	0.50	11.82**	13.75**	-23.08**	-32.42**	21.36**	6.22**	8.83**	3.78**	11.63**	2.60**
KS-312 x VRO-5	-1.34**	-9.16**	18.26**	32.71**	10.23**	-6.44**	8.63**	-0.41	7.08**	-8.11**	-1.16**	-26.47**
KS-312 x PK	-8.60**	3.47*	-21.77**	37.50**	-7.02**	-32.73**	4.23**	15.93**	13.03**	-13.51**	-6.98**	-23.75**
BO-2 x P-7	-6.45**	-13.86*	-14.37**	2.99**	-18.43**	-32.64**	19.41**	0.41	7.02**	0.00	10.47**	-14.74**
BO-2 x VRO-3	14.44**	1.98*	-11.17**	-3.95**	-23.92**	-16.67**	17.54**	2.90**	-8.87**	-5.26**	4.65**	-15.00**
BO-2 x VRO-5	12.90**	3.96**	0.63	16.86**	-7.44**	-11.87**	19.46**	9.54**	-8.33**	-7.89**	1.74**	-10.29**
BO-2 x PK	5.17**	19.06**	3.81**	28.81**	2.03**	-12.64**	17.91**	31.12**	19.62**	5.26**	16.28**	-1.50**
P-7 x VRO-3	1.61	-6.44**	-16.93**	-3.45**	-5.33**	-25.00**	27.96**	12.03**	-2.22**	-1.33**	14.53**	1.69**
P-7 x VRO-5	1.08	-6.93**	-2.13*	22.37**	13.27**	-2.61**	26.18**	15.68**	8.54**	1.33**	18.02**	-13.49**
P-7 x PK	4.08**	17.82**	11.55**	8.62**	6.51**	14.68**	2.61**	14.11**	-10.55**	6.00**	23.26**	-13.21**
VRO-3 x VRO-5	2.06	-6.04**	-9.04**	7.31**	-0.68**	-18.30**	15.38**	5.81**	14.12**	-1.60**	19.19**	6.34**
VRO-3 x PK	-1.82	11.14**	4.23**	4.95**	11.16**	-15.59**	15.67**	28.63**	5.16**	4.55**	33.72**	9.13**
VRO-5 x PK	-8.16**	3.96**	-6.03**	44.29**	3.56**	15.44**	5.97**	17.84**	7.75**	3.20**	25.00**	-2.33*
SE ±	1.75	1.47	1.04	0.67	0.65	0.51	0.62	0.68	0.61	0.15	0.13	0.15

Contd....

Crosses	Number of fruits per plant			Yield per plant		
	Over BP	Over EP	ID	Over BP	Over EP	ID
AB-2 x AB-1	33.33**	39.53**	15.83**	30.00**	36.84**	19.23*
AB-2 x KS-312	-2.78	1.74	18.29**	5.00	10.53	22.29*
AB-2 x BO-2	20.56**	26.16**	19.82**	20.15*	26.47**	20.93*
AB-2 x P-7	-9.44**	-5.23**	5.52**	1.50	6.84	16.26
AB-2 x VRO-3	1.11	5.81**	24.73**	15.00	21.05*	30.04**
AB-2 x VRO-5	0.00	4.65**	1.11	12.50	18.42	11.11
AB-2 x PK	11.11**	16.28**	17.00**	10.17	15.96	18.03
AB-1 x KS-312	-3.49**	-3.49**	20.48**	-2.37	-2.37	14.56
AB-1 x BO-2	13.95**	13.95**	24.49**	16.16	16.16	22.86*
AB-1 x P-7	-2.33	-2.33	5.36**	1.05	1.05	3.39
AB-1 x VRO-3	10.47**	10.47**	7.37**	18.33	18.33	10.91
AB-1 x VRO-5	8.14**	8.14**	2.15**	20.21*	20.21*	5.60
AB-1 x PK	12.21**	12.21**	19.17*	25.26**	25.26**	19.22*
KS-312 x BO-2	1.31	-9.88**	12.90**	1.20	-6.53	12.50
KS-312 x P-7	2.24	-20.35**	-8.76**	-5.42	-18.21	-6.50
KS-312 x VRO-3	4.08**	-11.05**	-12.42**	7.75	-9.26	-13.46
KS-312 x VRO-5	6.79**	-13.08	-7.69**	5.18	-5.89	-5.34
KS-312 x PK	-0.63	-7.56**	12.58**	-6.39	-11.32	11.93
BO-2 x P-7	16.34**	3.49**	11.80**	26.50**	16.84	16.35
BO-2 x VRO-3	14.60**	1.92	-11.51**	22.62**	13.26	-7.16
BO-2 x VRO-5	2.61	-8.72**	-3.50**	2.93	-4.92	-7.00
BO-2 x PK	29.69**	20.64**	12.29**	15.28	9.21	10.55
P-7 x VRO-3	7.48**	-8.14**	10.13**	10.93	-4.08	6.34
P-7 x VRO-5	-6.43**	-13.37**	-18.79**	9.76	-1.79	-8.47
P-7 x PK	1.56	-5.52**	-20.62**	3.87	-1.59	-16.92
VRO-3 x VRO-5	25.85**	7.56**	17.30**	2.49	8.30	12.59
VRO-3 x PK	10.00**	2.33**	-17.90**	27.13**	20.44*	-2.91
VRO-5 x PK	4.37**	-2.91**	-9.58**	2.44	-2.95	-10.49
SE ±	1.20	1.29	1.05	9.41	10.12	9.52

BP = Better parent, EP = Economic parent (Azad Bhindi-1) and ID = Inbreeding depression
* Significant at 5 per cent level, ** Significant at 1 per cent level