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Research Article

Heterobeltiosis, inbreeding depression and heritability study in okra(*Abelmoschus esculentus* (L.) Moench)

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Abstract:

P_1, P_2, F_1, F_2, BC_1 and BC_2 generations of six crosses *viz.,* HRB-55 x AOL-05-4, VRO-5 x Red Long, VRO-6 x AOL-05-3, GO-2 x AOL-04-3, Arka Anamika x AOL-03-1 and Parbhani Kranti x AOL-03-6 were used to study heterobeltiosis, inbreeding depression and heritability for days to first flowering, days to first picking, plant height, primary branches per plant, stem girth, fruit length, fruit girth, fruit weight, fruits per plant and fruit yield per plant in okra (*A. esculentus* (L.) Moench). HRB-55 x AOL-05-4 showed heterobeltiosis in desirable direction for almost all the fruit yield and its contributing characters particularly, 94.06 per cent for fruit yield per plant and 86.12 per cent fruits per plant. Moderate to high narrow sense heritability was observed for primary branches per plant in the crosses HRB-55 x AOL-05-4 (E_1), VRO-6 x AOL-05-3 (E_1) and Parbhani Kranti x AOL-03-6 (E_2); fruit girth in the crosses VRO-5 x Red Long (E_1), VRO-6 x AOL-05-3 (E_1), GO-2 x AOL-04-3 (E_1) and Arka Anamika x AOL-03-1 (E_1); fruit weight in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red Long (E_1) and GO-2 x AOL-04-3 (E_2). The highest heritability identified 99.35 per cent for fruit length in the cross HRB-55 x AOL-05-4. The results of heterosbeltiosis revealed that the cross HRB-55 x AOL-05-4 may be exploited for fruit yield and its component traits. The positive and significant inbreeding depression observed for days to first flowering in cross, GO-2 x AOL-04-3 (E_1 and E_2) and for days to first picking in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red Long (E_2), GO-2 x AOL-04-3 (E_2) and Parbhani Kranti x AOL-03-6 (E_2). This indicates to obtain desirable segregants for earliness in subsequent segregating generations. The negative and significant inbreeding depression which is desirable for okra crop improvement also observed for different traits across the environments *viz*., twelve cases each in the crosses HRB-55 x AOL-05-4 and VRO-5 x Red Long; four cases in cross VRO-6 x AOL-05-3; eight cases in cross GO-2 x AOL-04-3; seven cases in cross Arka Anamika x AOL-03-6 and six cases in cross Parbhani Kranti x AOL-03-6. These findings would be useful for the improvement of fruit yield and its quality traits while handling the segregating generation for the development of improved varieties.

Key words: Heterobeltiosis **,** heritability and inbreeding depression

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), an important vegetable crop is grown in the tropical, sub-tropical low altitude regions of Asia, Africa, America and temperate regions of the Mediterranean basin. In India, okra is commercially grown in the states of Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana and Punjab in *kharif* and summer season. In India, it is cultivated in 3.76 lakh hectares with the annual production of 36.84 lakh tonnes, and average productivity 9.80 tonnes per hectare (Anonymous, 2006). While in Gujarat, its area, production and productivity is 0.43 lakh hectares, 3.66 lakh tonnes and 8.51 tonnes per hectare, respectively (Anonymous, 2006).

Okra is a self-pollinated crop even though it has a suitable mechanism to produce hybrid seed at a commercial scale. Hence, heterosis *per se* is commercially useful. However, heterosis that has superiority over better parent (heterobeltiosis) is useful in deciding the direction of future hybrid breeding programme. It also identifies the cross combinations which are promising in conventional breeding programme. Heterosis leads to increase in yield, reproductive ability,

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adaptability, biotic and abiotic resistance, general vigour and quality.

Inbreeding depression defines to decrease in fitness and vigour due to inbreeding effect. It increases homozygosity in the genotype by continuous selfing. It results due to fixation of undesirable recessive genes in F_2. While in case of heterosis, favourable dominant genes of one parent are masking the effect of recessive genes of other parent. Estimation of heritability serves as a useful guide to the breeder. The breeder is able to appreciate the production of variation that is due to genotypic (broad sense heritability) or additive (narrow sense heritability) effects. If heritability of a character is very high, selection for the character should be fairly easy. This is because there would be a close correspondence between the genotype and phenotype due to relatively smaller contribution of the environment to phenotype. But for a character with low heritability, selection may be considerably difficult or virtually impractical due to the masking effect of the environment on genotypic effects. Thus, estimates of heritability are useful in predicting the transmission of characters from the parents to their offspring. Heritability in narrow sense may helps more in the selection of elite types from the mixed parental populations or segregating populations.

Materials and Methods

The six generations *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 were developed from each six female lines *viz.,* HRB-55, VRO-5, VRO-6, GO-2, Arka Anamika and Parbhani Kranti and male lines, AOL-05-04, Red Long, AOL-05-3, AOL-04-3, AOL-03-1 and AOL-03-6. Selfed seeds of parental lines used to make six crosses *viz.*; HRB-55 x AOL-05-4, VRO-5 x Red Long, VRO-6 x AOL-05-4, GO-2 x AOL-04-3, Arka Anamika x AOL-03-1 and Parbhani Kranti x AOL-03-6. F_1, F_2 and BC_1 and BC_2 were developed by selfing and backcrossing. These six generations of each of six crosses were grown in compact family block design with three replications at the Main Vegetable Research Station, Anand Agricultural University, Anand in *kharif* 2005 (E_1) and summer 2006 (E_2) seasons. Each plot had one row for parents and F_1s, two rows for each of the BC_1 and BC_2 and four rows for each F_2 population. Each row consisted of 10 plants. The spacing between rows and plants within row were followed 60 and 30 cm, respectively. Five plants from each of parents and F_1s, 10 plants in each of backcrosses and 20 plants in each of F_2s randomly selected to record observation.

Heterosis expressed as per cent increase or decrease of F_1 hybrid over its better parent was computed for all the characters in individual environment. The narrow sense heritability (h^2_{ns}) from the estimates of basic generations was calculated by the formula suggested by Warner (1952). The above heritability estimate is based on the assumption that epistasis is absent.

Results and discussion

Heterobeltiosis

The earliness traits like days to first flowering and days to first picking significant and desirable heterobeltiosis manifested by the crosses Arka Anamika x AOL-03-1, VRO-5 x Red Long, GO-2 x AOL-04-3 and Parbhani Kranti x AOL-03-6 in E_1 and HRB-55 x AOL-05-4 in E_2. Both these traits were important in crops like okra because early picking of fruits may help to get higher price in the market. Therefore, both these traits may be exploited through heterosis breeding. Present investigation akin with those obtained earlier by Partap and Dhankhar (1981), Elangovan *et al*. (1981), Sivakumar *et al*. (1995) and Ahlawat (2004).

The morphological traits like plant height and primary branches per plant, positive and significant heterosis was observed in the crosses HRB-55 x AOL-05-4 and VRO-5 x Red Long in E_2. Whereas in the cross Parbhani Kranti x AOL-03-6, it was significant and positive for plant height in E_1 and primary branches per plant in E_2. The significant and positive heterobeltiosis exhibited by cross Arka Anamika x AOL-03-1 for plant height in E_2. Lal *et al*., (1975), Partap and Dhankhar (1980), Elangovan *et al.* (1981), Pawar *et al.* (1999), and Ahlawat (2004) also found similar results for these traits. The stem girth is also important character in okra as it provides strong strength to the plant withstand in the field. The desirable heterosis was observed for this trait in the crosses HRB-55 x AOL-05-4 (E_2), Arka Anamika x AOL-03-1 (E_1), GO-2 x AOL-04-3 (E_2) and Parbhani Kranti x AOL-03-6 (E_1)

The traits that contribute in marketable fruit yield like fruit length, fruit girth and fruit weight are more important for okra heterosis breeding.

The present investigation revealed that heterotic effects found significant for fruit length and fruit girth in the crosses HRB-55 x AOL-05-4 and Parbhani Kranti x AOL-03-6 as well as fruit length in the crosses VRO-6 x AOL-05-3 and VRO-5 x Red Long in both E_1 and E_2 environments. This kind of heterosis also identified for fruit weight in the crosses VRO-6 x AOL-05-3 (E_2), Arka Anamika x AOL-03-1 (E_1) and Parbhani Kranti x AOL-03-6 (E_2). Patel *et al*., (1990), reported positive and significant heterotic effects for fruit length. Further, both negative and positive heterosis over better parent also quoted for the this character by Lal *et al.,* (1975), Partap and Dhankhar (1980), Elangovan *et al.* (1981), Thaker *et al.* (1981), Poshiya and Shukla (1986), Pawar *et al.* (1999) and Ahlawat (2004).

The positive and significant heterobeltiosis detected for fruits per plant in the crosses HRB-55 x AOL-05-4 (E_2) and Arka Anamika x AOL-03-1 (E_2), VRO-5 x Red Long (E_1) and Parbhani Kranti x AOL-03-6 (E_1). For fruit yield per plant, the heterotic effect was observed to be significant only in the cross HRB-55 x AOL-05-4. This might be due to low heterotic contribution of yield component traits toward yield. This type of heterosis also reported for these traits by Lal *et al.* (1975), Singh and Singh (1979, Vijay and Manohar (1986), Patel *et al.,* (1990), whereas, negative and positive heterotic effects were also reported for these traits by Partap and Dhankhar (1980), Elangovan *et al.* (1981), Thaker *et al.* (1982), Poshiya and Shukla (1986), Sivakumar *et al.* (1997), Pawar *et al* (1999), and Ahlawat (2004).

The desirable heterobeltiosis was identified in 53.33 per cent cases (48 out of 90) for the traits under study. The highest magnitude of heterotic effect was obtained for fruit yield per plant (94.06 %) followed by fruits per plant (86.12 %) in cross HRB-55 x AOL-05-4 under E_2. This cross also exhibited desirable heterotic effects for most of the traits in E_2. The heterotic effect in desirable direction was also observed for days to first flowering and days to first picking in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red Long (E_1), GO-2 x AOL-04-3 (E_1), Arka Anamika x AOL-03-1 (E_1) and Parbhani Kranti x AOL-03-6 (E_1).

The fruit yield contributing characters like fruit length, fruit girth and fruit weight also exhibited heterobeltiosis in desirable direction *viz*., fruit length (E_1 and E_2) and fruit girth (E_1) in cross VRO-5 x Red Long; fruit length (E_1 and E_2), fruit girth (E_1) and fruit weight (E_2) in cross VRO-6 x AOL-05-3; fruit length (E_2) in cross GO-2 x AOL-04-3; fruit length (E_1), fruit girth (E_1 and E_2) and fruit weight (E_1) in cross Arka Anamika x AOL-03-1 and fruit length (E_1 and E_2) fruit girth (E_1 and E_2) and fruit weight (E_2) in cross Parbhani Kranti x AOL-03-6.

On the basis of heterosis results, the cross HRB-55 x AOL-05-4 found promising for fruit yield and its component traits as well as earliness and quality traits under summer season (E_2). Whereas, the crosses Arka Anamika x AOL-03-1, VRO-5 x Red long, GO-2 x AOL-04-3 and Parbhani Kranti x AOL-03-6 were observed to be superior for earliness along with some of the yield component traits in *kharif* season (E_1). The results of heterosbeltiosis revealed that the cross HRB-55 x AOL-05-4 found most promising for fruit yield, earliness, fruit yield component and quality traits in E_2.

Inbreeding depression

The positive and significant inbreeding depression was observed for days to first flowering in cross GO-2 x AOL-04-3 (E_1 and E_2) and for days to first picking in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red Long (E_2), GO-2 x AOL-04-3 (E_2) and Parbhani Kranti x AOL-03-6 (E_2). This indicates to obtain desirable segregants for earliness in subsequent segregating generations of these crosses.

The negative and significant inbreeding depression which is desirable for okra crop improvement was also observed for different traits across the environments *viz*., twelve cases each in the crosses HRB-55 x AOL-05-4 and VRO-5 x Red Long; four cases in cross VRO-6 x AOL-05-3; eight cases in cross GO-2 x AOL-04-3; seven cases in cross Arka Anamika x AOL-03-6 and six cases in cross Parbhani Kranti x AOL-03-6. These findings would be useful for the improvement of fruit yield and its quality traits while handling the segregating generation for the development of improved varieties.

The inbreeding depression is also one of the important components for heterosis breeding

programme in crop improvement. The results of inbreeding depression were also presented for different characters of various crosses under E_1 and E_2 environments (Table 1). The positive and significant inbreeding depression was found for days to first flowering in GO-2 x AOL-04-3 (E_1 and E_2) and days to first picking in HRB-55 x AOL-05-4 (E_2), VRO-5 x Red long (E_2), GO-2 x AOL-04-3 (E_2) and Parbhani Kranti x AOL-03-6 (E_2) crosses. It predicts better chances to obtain desirable segregants for earliness in the subsequent filial generations of these crosses. On the contrary, the negative and significant inbreeding depression, which is undesirable for okra breeding programme, was also found in the present study. Lal *et al.* (1975) also cited positive inbreeding depression for days to first flowering.

The negative and significant inbreeding depression for plant height is desirable for okra hybrid breeding programme which was observed in the crosses HRB-55 x AOL-05-4 (E_1), VRO-5 x Red long (E_2), Arka Anamika x AOL-03-1 (E_1) and Parbhani Kranti x AOL-03-6 (E_2). Whereas, it was observed for primary branches per plant in the crosses HRB-55 x AOL-05-4 (E_1), VRO-5 x Red long (E_1), VRO-6 x AOL-05-3 (E_1) and Arka Anamika x AOL-03-1 (E_1). For stem girth, the same trend of inbreeding depression was found in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red long (E_1 and E_2), VRO-6 x AOL-05-3 (E_1) and Arka Anamika x AOL-03-1 (E_1). The desirable segregants may be obtained from segregating generations of these crosses which exhibited negative and significant inbreeding depression for plant height, primary branches per plant and stem girth. The negative inbreeding depression was also reported for plant height and primary branches per plant by Lal *et al.* (1975). The characters like fruit length, fruit girth and fruit weight are considered to be most important fruit yield contributers. The negative and significant inbreeding depression is considered to be beneficial to get the better segregants. This type of results were obtained for fruit length in the cross HRB-55 x AOL-05-4 (E_2); for fruit girth in the crosses HRB-55 x AOL-05-4 (E_2), VRO-5 x Red long (E_1 and E_2), VRO-6 x AOL-05-3 (E_2), GO-2 x AOL-04-3 (E_1) and Arka Anamika x AOL-03-1 (E_2); and for fruit weight in the crosses HRB-55 x AOL-05-4 (E_1 and E_2), VRO-5 x Red long (E_1), GO-2 x AOL-04-3 (E_1 and E_2), Arka Anamika x AOL-03-1 (E_2). On the contrary, positive and significant heterosis, which is not desirable for these traits, was also observed in the present study.

The negative and positive inbreeding depression estimates were also reported for fruit length and fruit weight by Thaker *et al.* (1982);, the positive inbreeding depression was also cited for fruit length and fruit girth by Lal *et al.* (1975). All these investigations are supportive to the present findings.

The traits fruits per plant and fruit yield per plant are considered to be most important in okra crop. The negative and significant inbreeding depression that is useful for okra crop improvement programme was observed for fruits per plant in the crosses HRB-55 x AOL-05-4 (E_1), VRO-5 x Red long (E_2), GO-2 x AOL-04-3 (E_1 and E_2) and Arka Anamika x AOL-03-1 (E_1). The desirable inbreeding depression that is negative in direction was also cited for fruits per plant by Lal *et al.* (1975). While, positive inbreeding depression was reported by Thaker *et al.* (1982). Many investigators reported absence of inbreeding depression for fruit yield per plant as cited in the review of literature in the present study.

Heritability

The moderate heritability was accounted for days to first flowering in the crosses VRO-5 x Red Long (20.67 % in E_2) and in the cross Parbhani Kranti x AOL-03-6 (21.14 % in E_1); for days to first picking in the cross Arka Anamika x AOL-03-1 (49.87 % in E_2); for plant height in the cross Parbhani Kranti x AOL-03-6 (30.53% in E_2); for primary branches per plant in the crosses HRB-55 x AOL-05-4 (38.21 % in E_1) and Parbhani Kranti x AOL-03-6 (47.87 % in E_2); for stem girth in the crosses VRO-6 x AOL-05-3 (43.01 % in E_1) and GO-2 x AOL-04-3 (45.45 % in E_1); for fruit girth in the crosses VRO-5 x Red Long (48.22 % in E_1) and VRO-6 x AOL-05-3 (35.07 % in E_1); for fruit weight in the cross VRO-5 x Red Long (39.59 % in E_1); for fruits per plant in the cross VRO-6 x AOL-05-3 (34.19 % in E_2); for fruit yield per plant in the crosses VRO-6 x AOL-05-3 (25.11 % in E_1) and Parbhani Kranti x AOL-03-6 (41.78 % in E_1) and for moisture content in fruits in the cross VRO-5 x Red Long (30.00 % in E_2).

The high heritability was identified for days to first flowering in the crosses HRB-55 xAOL-05-

4 (50.20 % in E_1) and Parbhani Kranti x AOL-03-6 (51.92 % in E_2); for days to first picking in the crosses HRB-55 x AOL-05-4 (51.68 % in E_1 and 87.47 % in E_2) and VRO-6 x AOL-05-3 (57.80 % in E_1); for plant height in the crosses VRO-5 x Red Long (82.87 % in E_2), Arka Anamika x AOL-03-1 (63.18 % in E_1 and 96.52 % in E_2) and Parbhani Kranti x AOL-03-6 (68.92 % in E_1); for primary branches per plant in the cross VRO-6 x AOL-05-3 (73.90 % in E_1); for stem girth in the cross Arka Anamika x AOL-03-1 (87.72 % in E_1); for fruit length in the cross HRB-55 x AOL-05-4 (99.35 % in E_2) and VRO-6 x AOL-05-3 (89.87 % in E_1 and 64.70 % in E_2); for fruit girth in the crosses GO-2 x AOL-04-3 (70.60 % in E_1) and Arka Anamika x AOL-03-1 (56.33 % in E_1); for fruit weight in the crosses HRB-55 x AOL-05-4 (54.61 % in E_2) and GO-2 x AOL-04-3 (94.55 % in E_2); for fruits per plant in Arka Anamika x AOL-03-1 (76.72 % in E_1); for fruit yield per plant in the crosses HRB-55 x AOL-05-4 (81.42 % in E_1), VRO-5 x Red Long (93.12 % in E_2), Arka Anamika X AOL-03-1 (67.32 % in E_1) and Parbhani Kranti x AOL-03-6 (82.52 % in E_2).

Patel *et al.* (1990), reported moderate to high heritability for plant height. Further, they also reported moderate heritability for fruits per plant. Moderate and high heritability estimates were observed in 32.61 and 46.00 per cent cases for almost all the characters in various crosses under both the environments, respectively. The higher values of narrow sense heritability for a particular character indicated that it is controlled largely by genes acting in an additive fashion. Thus, if heritability is high for a trait, the plant breeder can go for selection of individuals or group of individuals. In crops like okra high narrow sense heritability estimates may be helpful for the development of improved varieties.

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Table 1.1 Magnitude of heterobeltiosis (%), inbreeding depression (%) and heritability in narrow sense (%) for different characters in six crosses of okra over environments

Days to first flowering Crosses	Heterobeltiosis (%)		Inbreeding Depression (%)		Narrow sense heritability (h^2_{ns})	
	E_1	E_2	E_1	E_2	E_1	E_2
HRB-55 x AOL-05-4	4.12**±0.24	-12.39**±1.73	- 0.49±0.86	- 8.39**±. 60	50.20	-
VRO-5 x Red Long	- 2.57**±0.41	14.78**±0.79	0.17±0.76	0.17±1.05	-	20.67
VRO-6 x AOL-05-3	3.15**±0.49	6.41**±1.39	- 0.62±1.05	0.49±1.32	-	-
GO-2 x AOL-04-3	- 5.62**±0.23	11.90**±1.90	4.81**±0.82	4.52**±1.55	-	15.39
Arka Anamika x AOL-03-1	- 6.27**±0.40	2.58±1.70	- 5.23**±0.87	- 3.37**±1.12	-	-
Parbhani Kranti x AOL-03-6	-7.27**±0.21	- 2.01±1.77	- 8.25**±0.80	- 4.41**±1.12	21.14	51.92
Days to first picking						
HRB-55 x AOL-05-4	1.86**±0.40	-12.73**±2.61	0.29±0.83	12.11**±0.84	51.68	87.47
VRO-5 x Red Long	- 1.85**±0.32	17.83**±1.21	- 3.38**±0.61	4.75**±1.26	-	-
VRO-6 x AOL-05-3	- 0.65±0.41	5.97**±1.63	- 5.54**±0.93	0.97±1.68	57.80	18.41
GO-2 x AOL-04-3	- 3.26**±0.21	10.89**±1.59	1.57±0.82	5.83**±1.60	-	-
Arka Anamika x AOL-03-1	- 5.53**±0.22	1.60±2.27	- 4.08**±0.71	- 2.54*±1.13	-	49.87
Parbhani Kranti x AOL-03-6	- 7.98**±0.22	- 4.43±2.43	- 7.91**±0.59	7.44**±1.40	-	-

*, ** Significant at 5% and 1% levels, respectively. **E_1** = *kharif* 2005, **E_2** = Summer 2006

Table 1.2 Contd.

Plant height Crosses	Heterobeltiosis (%)		Inbreeding Depression (%)		Narrow sense heritability (h^2_{ns})	
	E_1	E_2	E_1	E_2	E_1	E_2
HRB-55 x AOL-05-4	-23.23±16.04	18.66**±0.93	-38.90**±12.20	12.86**±3.54	-	-
VRO-5 x Red Long	4.78±9.98	7.09**±1.32	4.36±12.20	-10.92*±5.54	-	82.87
VRO-6 x AOL-05-3	-10.78±7.18	-4.92**±1.18	-18.04±12.55	12.22**±2.42	-	-
GO-2 x AOL-04-3	-0.65±13.23	-13.13**±1.66	-7.66±12.98	4.32±2.89	4.57	-
Arka Anamika x AOL-03-1	-23.73**±8.25	10.98**±2.09	-22.14*±9.92	24.34**±0.42	63.18	96.52
Parbhani Kranti x AOL-03-6	20.00**±6.44	-15.14**±0.61	2.04±12.09	-6.00*±2.74	68.92	30.53
			Primary branches per plant			
HRB-55 x AOL-05-4	-26.81**±2.00	76.92**±3.16	-16.32**±0.45	14.57**±0.59	38.21	-
VRO-5 x Red Long	-25.30**±2.00	10.68**±2.52	-22.72**±0.47	3.08**±0.43	-	-
VRO-6 x AOL-05-3	-36.25**±1.57	4.35±2.65	-46.25**±0.72	20.83**±0.51	73.90	-
GO-2 x AOL-04-3	-25.80**±1.35	-13.78**±4.22	0.46±0.42	24.41**±0.63	-	-
Arka Anamika x AOL-03-1	-15.00**±2.81	-14.99**±3.44	-10.44**±0.47	12.76**±0.81	-	-
Parbhani Kranti x AOL-03-6	-9.64**±2.48	20.81**±4.88	9.73**±0.47	1.85**±0.48	-	47.87

*, ** Significant at 5% and 1% levels, respectively. E_1 = *kharif* 2005, E_2 = Summer 2006

Table 1.3 Contd.

Stem girth Crosses	Heterobeltiosis (%)		Inbreeding Depression (%)		Narrow sense heritability (h^2_{ns})	
	E_1	E_2	E_1	E_2	E_1	E_2
HRB-55 x AOL-05-4	-2.74**±0.29	23.81**±0.30	- 0.42± 0.31	-5.58**±0.43	-	-
VRO-5 x Red Long	-2.04**±0.47	-15.71**±0.34	-2.48**±0.27	-3.03**±0.39	-	9.61
VRO-6 x AOL-05-3	-7.22**±0.21	-11.63**±0.39	-2.46**±0.21	8.63**±0.72	43.01	-
GO-2 x AOL-04-3	7.78**±0.45	-18.74**±0.34	7.09**±0.35	10.71**±0.75	45.45	-
Arka Anamika x AOL-03-1	1.38**±0.34	-9.72**±0.25	-1.63**±0.24	4.00**±0.67	87.72	-
Parbhani Kranti x AOL-03-6	6.79**±0.26	-3.42**±0.24	7.56**±0.26	-0.46±0.50	-	-
			Fruit length			
HRB-55 x AOL-05-4	22.07**±0.42	3.41**±0.49	11.65**±1.00	-1.32*±0.45	-	99.35
VRO-5 x Red Long	9.31**±0.39	5.75**±0.75	6.78**±0.82	21.81**±0.80	-	-
VRO-6 x AOL-05-3	14.71**±0.35	12.09**±0.63	22.74**±0.92	4.96**±0.73	89.87	64.70
GO-2 x AOL-04-3	-6.37**±0.70	14.18**±0.49	1.19±0.61	22.61**±1.20	-	-
Arka Anamika x AOL-03-1	5.13**±0.55	-5.28**±0.23	7.75**±0.72	5.16**±0.67	-	-
Parbhani Kranti x AOL-03-6	9.42**±0.44	26.04**±0.20	5.48**±0.70	24.93**±0.91	-	-

*, ** Significant at 5% and 1% levels, respectively. **E_1** = *kharif* 2005, **E_2** = Summer 2006

Table 1.4 Contd.

Fruit girth Crosses	Heterobeltiosis (%)		Inbreeding Depression (%)		Narrow sense heritability (h^2_{ns})	
	E_1	E_2	E_1	E_2	E_1	E_2
HRB-55 x AOL-05-4	2.67**±0.28	1.55**±0.18	0.46*±0.22	-2.44**±0.34	-	-
VRO-5 x Red Long	2.41**±0.22	-8.15**±0.23	-2.20**±0.22	-7.40**±0.26	48.28	-
VRO-6 x AOL-05-3	1.96**±0.14	-10.93**±0.36	4.48**±0.22	-1.47**±0.22	35.07	-
GO-2 x AOL-04-3	-0.69**±0.23	0.16±0.25	-3.81**±0.25	1.41**±0.28	70.60	-
Arka Anamika x AOL-03-1	7.46**±0.19	1.41**±0.19	3.31**±0.17	-5.73**±0.21	56.33	-
Parbhani Kranti x AOL-03-6	1.17**±0.21	8.30**±0.16	1.99**±0.14	12.55**±0.22	-	-
			Fruit weight			
HRB-55 x AOL-05-4	-18.93**±3.06	-5.81**±0.67	-23.87**±1.28	-19.59**±1.36	-	54.61
VRO-5 x Red Long	-3.28*±1.51	-7.06**±2.40	-4.03*±1.80	4.62*±1.86	39.59	-
VRO-6 x AOL-05-3	-12.21**±1.16	5.07*±2.47	2.24*±1.11	10.88**±1.43	-	-
GO-2 x AOL-04-3	4.30±2.33	0.55±1.49	-5.21*±2.57	-7.17**±2.19	-	94.55
Arka Anamika x AOL-03-1	7.73*±3.07	-10.55**±1.97	5.11*±2.22	-2.66*±1.15	-	-
Parbhani Kranti x AOL-03-6	-1.75±1.88	15.43**±1.77	-0.53±1.68	12.49**±2.15	-	-

*, ** Significant at 5% and 1% levels, respectively. **E_1** = *kharif* 2005; **E_2** = Summer 2006

Table 1.5 Contd.

Fruits per plant Crosses	Heterobeltiosis (%)		Inbreeding Depression (%)		Narrow sense heritability (h^2_{ns})	
	E_1	E_2	E_1	E_2	E_1	E_2
HRB-55 x AOL-05-4	-13.82**± 0.78	86.12**± 0.52	-15.78**± 2.03	36.17**±1.37	-	6.06
VRO-5 x Red Long	22.16**± 0.99	-4.67**± 0.54	21.42**±2.08	-12.5**±0.89	-	-
VRO-6 x AOL-05-3	0.91± 0.88	-7.09**± 0.82	16.86**± 1.76	16.77**± 1.07	-	34.19
GO-2 x AOL-04-3	15.50**± 1.21	-30.31**±0.54	-9.22**± 1.61	-4.76**± 0.98	8.32	-
Arka Anamika x AOL-03-1	-9.98**± 0.86	25.39**± 0.40	-4.77**± 1.79	13.21**± 1.53	76.72	-
Parbhani Kranti x AOL-03-6	-10.19**± 0.43	6.72**± 0.66	17.63**±1.19	14.48**±1.47	-	-
			Fruit yield per plant			
HRB-55 x AOL-05-4	4.60± 15.47	94.06**± 8.57	-13.25±40.08	29.64± 25.02	81.42	-
VRO-5 x Red Long	37.95± 23.04	-15.82*± 6.18	18.33± 47.18	-26.13±24.41	-	93.12
VRO-6 x AOL-05-3	-1.26± 12.76	10.12± 8.14	23.60± 40.72	22.01±19.19	25.11	8.41
GO-2 x AOL-04-3	43.0± 24.30	-0.47± 6.97	0.20± 38.01	2.91±23.57	-	-
Arka Anamika x AOL-03-1	-13.90± 7.93	9.30± 7.44	10.18± 35.08	16.78±25.84	67.32	-
Parbhani Kranti x AOL-03-6	7.42± 15.09	0.93± 6.70	18.93± 31.15	3.74± 27.23	41.78	82.52

*, ** Significant at 5% and 1% levels, respectively. **E_1** = *kharif* 2005; **E_2** = Summer 2006