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# Heterosis studies in okra [*Abelmoschus esculentus* (L.) Moench]

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## ABSTRACT

**Heterosis for pod yield and its components was studied in a set of line x tester crosses of 8 lines and 4 testers. The analysis of variance revealed highly significant differences among genotypes, parents and hybrids for all the characters indicating substantial amount of genetic variability present in the material studied. The magnitude of heterosis varied from cross to cross for all the characters studied. Mean squares due to parents vs hybrids were significant for days to 50 % flowering, days to first picking, internodal length, plant height, fruit girth, number of fruits per plant and fruit yield per plant indicating considerable heterosis for these characters. The pronounced heterotic effects were observed for number of nodes per plant, internodal length, plant height, number of branches per plant, number of fruits per plant and fruit yield per plant. While, moderate heterotic effects were recorded for fruit length and fruit girth. While, days to 50 % flowering and days to first picking depicted low heterotic effects. Out of 32 crosses studied, two and twenty eight crosses manifested significant and positive heterobeltiosis and standard heterosis for fruit yield per plant, respectively. The hybrid BO-13 x GO-2 exhibited highest heterobeltiosis (15.72 %), whereas the hybrid Pant Bhindi x JOL-1 showed the maximum standard heterosis (60.18 %) for fruit yield per plant. Which could be further exploited in okra breeding.**

**Key words :** Heterobeltiosis, Standard heterosis, Line x tester and okra

## INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is one of the most important vegetable crops grown extensively throughout the country during both summer and rainy seasons for its green tender fruits. It is a good source of vitamin A, B, and C, protein and mineral elements. Its fast growth, short duration and photoinsensitive nature, genetical study can be completed in short span of time. Moreover, its large flower and monadelphous nature of the stamens make emasculation and pollination process easier. With the ease in fruit set and good number of seeds per pod, okra can be well exploited for hybrid vigour.

Choice of the parents for a breeding programme is important to improve quantitative characters like fruit yield and its components. Exploitation of hybrid vigour is an important tool for making genetical improvement of yield and its attributing characters in okra. The magnitude of heterosis for fruit yield and its components provides a basis for determining genetic diversity and also serves as a guide for the choice of desirable parents for developing superior $F_1$ hybrids to exploit hybrid vigour and for building gene pools to be employed in breeding programme. Keeping this in view, the present investigation was carried out to know the extent of heterobeltiosis and standard heterosis for fruit yield and its components in okra crosses obtained from 8 lines x 4 testers mating method.

## MATERIALS AND METHODS

The experimental materials comprised of eight lines of diverse origin namely; Chhodawadi, HRB-108-2, D-1-87-5, KS-404, Pant Bhindi, BO-13, EC-329372 and IC-990049; four testers *viz*., JOL-1, GO-2, Parbhani Kranti and HRB-55 as well as their 32 $F_1$'s obtained through line x tester crosses. Thus, 12 parental lines and 32 hybrids along with a standard check (GO-2) were evaluated in a Randomized Block Design with three replications during *kharif* season of 2005 at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh. Each entry consisted of a single row plot of ten plants for each parent and $F_1$, spaced at 45 cm x 30 cm. All the recommended agronomic practices and plant need based protection measures were followed to raise the good crop of okra. The observations were recorded on five randomly selected competitive plants of each parent and $F_1$ from each replication for 10 various characters (Table 1). The heterotic effects were computed as the percentage increase (+) or decrease (-) of $F_1$ mean values over better parent (heterobeltiosis) and standard check variety GO-2 (economic heterosis) for all the characters and crosses, following the standard formula.

## RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied indicating the presence of sufficient variability in the experimental material (Table 1). Further, partitioning of mean sum of squares for parents and hybrids were also found significant for all the characters studied suggesting considerable amount of variability among the

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**Table 1 : Analysis of variance for the experimental design in respect of ten characters in okra**

| Source | df | Days to 50 % flowering | | Days to first picking | | No. of nodes per plant | | Internodal Length (cm) | | Plant height (cm) | | No. of branches per plant | | Fruit length (cm) | | Fruit girth (cm) | | No. of fruits per plant | | Fruit yield per plant (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Replications | 2 | 1.008 | | 1.008 | | 0.660 | | 0.114 | * | 517.179 | * | 0.354 | | 2.332 | ** | 0.102 | * | 1.411 | | 1476.758 | |
| Genotypes | 43 | 32.921 | ** | 32.921 | ** | 25.947 | ** | 0.815 | ** | 461.925 | ** | 0.371 | ** | 1.419 | ** | 0.337 | ** | 16.566 | ** | 5613.516 | ** |
| Parents (P) | 11 | 105.462 | ** | 105.462 | ** | 20.072 | ** | 0.536 | ** | 545.918 | ** | 0.264 | * | 2.202 | ** | 0.646 | ** | 16.599 | ** | 5375.899 | ** |
| Hybrids (H) | 31 | 6.966 | ** | 6.966 | ** | 28.795 | ** | 0.902 | ** | 343.391 | ** | 0.421 | ** | 1.160 | ** | 0.171 | ** | 16.858 | ** | 5644.504 | ** |
| P vs H | 1 | 39.557 | ** | 39.557 | ** | 2.249 | | 1.182 | ** | 3212.556 | ** | 0.007 | | 0.834 | | 2.084 | ** | 7.168 | | 7266.668 | ** |
| Error | 86 | 1.240 | | 1.240 | | 1.239 | | 0.028 | | 116.646 | | 0.133 | | 0.246 | | 0.032 | | 1.757 | | 584.78 | |

* and ** indicates significance values against error mean square at P=0.05 and 0.01, respectively.

parents and hybrids for various traits. Significance of mean squares due to parents *vs* hybrids for all the characters except number of nodes per plant, number of branches per plant and fruit length indicated that performance of parents was different than that of hybrids as well as presence of overall heterosis.

The experimental results indicated that the magnitude of heterosis over better parent as well as standard check varied from cross to cross and character to character. This depicted the existence of potential heterosis in okra. The range of heterosis by hybrids over their better parent and standard check variety GO-2, number of crosses showing significant and desirable heterosis over better parent and standard check variety and hybrid showing highest heterosis in desired direction over better parent and standard check are presented in Table 2.

The early flowering at a lower internodal level is helpful in increasing the number of fruits per plant and therefore, the hybrids exhibiting negative heterosis are considered favourable for the first fruiting node.

For days to flowering and days to first picking, none of the crosses displayed significant and desired (negative) heterobeltiosis, whereas,16 crosses were found significantly earlier over standard check. The cross KS-404 x Parbhani Kranti was found earliest to standard check for days to 50 % flowering (-9.63 %) and days to first picking (-8.84 %). Heterosis for earliness was also reported by Singh and Syamal (2006) and Yadav *et al*. (2007). Lateness was observed by Partap *et al*. (1981).

With respect to number of nodes per plant, 3 crosses over better parent and 19 crosses over standard check showed positive and significant heterosis. For this trait, the highest desirable positive heterobeltiosis and standard heterosis was found in the cross HRB-108-2 x GO-2 (11.29%) and Pant Bhindi x JOL-1 (47.11%), respectively. In okra, only one fruit is borne at each axil. Therefore, more number of fruiting nodes on main stem with shorter distance would be helpful in increasing the number of fruits per plant which in turn gives more yield per plant. Positive heterosis for this character in okra was reported by Singh and Syamal (2006), Yadav *et al.* (2007) and Pandey *et al*. (2008).

In case of internodal length, only 3 and 2 hybrids exhibited significant and desirable (negative) heterobeltiosis and economic heterosis for this character, respectively. The hybrid KS-404 x JOL-1 (-10.91 %) depicted maximum significant and negative heterobeltiosis followed by D-1-87-5 x JOL-1 (-5.96 %) and Pant Bhindi x Parbhani Kranti (-1.59 %) for this trait. The negative and significant highest economic heterosis showed by the hybrid BO-13 x JOL-1 (-7.86 %) and KS-404 x JOL-1 (-6.57 %) for internodal length. Heterosis for shorter internodal length in okra was earlier reported by Borgaonkar *et al*. (2005) and Yadav *et al*. (2007).

For plant height, out of 32 crosses, 2 and 14 crosses depicted positive and significant heterosis over better parent and standard check, respectively. The highest desirable heterosis over better parent was recorded by the cross KS-404 x Parbhani Kranti (30.69 %) followed by BO-13 x Parbhani Kranti (27.72 %). The highest desirable heterosis over standard check variety (GO-2) was recoded by the cross Chhodawadi x HRB-55 (49.20 %). Tall plant with shorter internodes plays an important role in increasing the yield as fruiting takes place at each node. Heterosis for plant height in okra was also reported by Singh and Syamal (2006), Shoba and Mariappan (2007) and Pandey *et al*. (2008).

As regards to number of branches per plant, only the crosses Pant Bhindi x GO-2 showed significant desirable (positive) heterobeltiosis (40.74 %) and

**Table 2 : Range of heterosis, number of hybrids showing significant heterobeltiosis (HB) and standard heterosis (SH) and hybrids showing highest heterosis in desired direction over better parent (BP) and standard check (SH) for ten characters in okra**

| Sr. No. | Characters | Range of heterosis (%) | | No. of hybrids showing significant and desirable heterosis | | Hybrids showing highest heterosis in desired direction over | |
|---|---|---|---|---|---|---|---|
| | | HB | SH | HB | SH | HB | SH |
| 1. | Days to 50 % flowering | -2.40 to 10.48 | -9.63 to 1.48 | 0 | 16 | None | KS-404 X P.K. |
| 2. | Days to first picking | -2.19 to 9.56 | -8.84 to 1.36 | 0 | 16 | None | KS-404 X P.K. |
| 3. | No. of nodes per plant | -34.52 to 11.29 | -13.36 to 47.11 | 3 | 19 | HRB-55 x GO-2 | Pant Bhindi x JOL-1 |
| 4. | Internodal length (cm) | -10.91 to 35.59 | -7.86 to 22.89 | 3 | 2 | KS-404 x JOL-1 | BO-13 x JOL-1 |
| 5. | Plant height (cm) | -13.93 to 30.69 | 4.18 to 49.20 | 2 | 14 | KS-404 x P.K. | Chhodawadi x HRB-55 |
| 6. | No. of branches per plant | -44.00 to 40.74 | -39.18 to 65.22 | 1 | 1 | Pant Bhindi x GO-2 | Pant Bhindi x GO-2 |
| 7. | Fruit length (cm) | -22.94 to 17.61 | -9.77 to 22.21 | 2 | 2 | D-1-87-5 X P.K. | D-1-87-5 X P.K. |
| 8. | Fruit girth (cm) | -9.43 to 12.22 | -9.44 to 11.14 | 2 | 3 | EC-329372 x HRB-55 | EC-329372 X HRB-55 |
| 9. | No. of fruits per plant | -32.62 to 14.81 | -3.23 to 55.76 | 2 | 24 | Chhodawadi x GO-2 | Pant Bhindi x JOL-1 |
| 10. | Fruit yield per plant (g) | -26.59 to 15.72 | 1.83 to 60.18 | 2 | 28 | BO-13 x GO-2 | Pant Bhindi x JOL-1 |

P.K. = Parbhani Kranti.

**Table 3: Best five standard heterotic crosses for fruit yield and its component characters in okra**

| Best heterotic crosses | Fruit yield per plant (g) | Days to 50 % flowering | Days to first picking | No. of nodes per plant | Internodal length (cm) | Plant height (cm) | No. of branches per plant | Fruit length (cm) | Fruit girth (cm) | No. of fruits per plant |
|---|---|---|---|---|---|---|---|---|---|---|
| Pant Bhindi x JOL-1 | 60.18 ** | -2.96 | -2.72 | 47.11 ** | 0.10 | 24.44 ** | 8.70 | 4.18 | -4.24 | 55.76 ** |
| Pant Bhindi x P.K. | 59.14 ** | -0.74 | -0.68 | 43.50 ** | -1.29 | 23.15 ** | 26.09 | 4.98 | -5.08 | 55.53 ** |
| Pant Bhindi x GO-2 | 58.75 ** | -1.48 | -1.36 | 46.21 ** | 7.66 ** | 22.83 ** | 65.22 ** | 4.18 | -1.33 | 53.38 ** |
| Pant Bhindi x HRB-55 | 57.44 ** | -2.22 | -2.04 | 39.71 ** | 10.65 ** | 16.40 | 26.09 | 2.83 | 1.21 | 45.16 ** |
| D-1-87-5 x GO-2 | 57.05 ** | -4.44 ** | -4.08 * | 32.67 ** | 16.52 ** | 19.49 | -26.09 | 3.01 | -1.57 | 42.86 ** |

* and ** indicates significance values at P=0.05 and 0.01, resepctively

economic heterosis (65.22 %) for number of branches per plant. Singh and Syamal (2006) and Yadav *et al*. (2007) reported positive heterosis for this trait.

An examination of performance of hybrids for fruit length revealed that the only two hybrids displayed significant and positive heterobeltiosis and economic heterosis. The hybrids D-1-87-5 x Parbhani Kranti (17.61 %) and HRB-108-2 x Parbhani Kranti (10.33 %) had significant and positive effects over better parent. Whereas, the hybrid D-1-87-5 x Parbhani Kranti (22.21 %) and BO-13 x JOL-1 (16.03 %) exhibited significant and positive heterosis over standard check for this character. These findings are in conformity with those of Borgaonkar *et al*. (2005), Shoba and Mariappan (2007) and Yadav *et al*. (2007).

Two crosses over better parent and three crosses over standard check exhibited significant and positive heterosis for fruit girth. The cross EC-329372 x HRB-55 had recorded highest significant and positive heterosis over better parent (12.22 %) and standard check (11.14 %). The consumers do not prefer thicker pods. However, pod girth and pod length directly contribute towards the total yield and hence the positive value increases the total yield. Heterosis for fruit girth also was reported by Singh and Syamal (2006) and Shoba and Mariappan (2007).

Regarding number of fruits per plant, 2 and 24 crosses showed significant and positive heterosis over better parent and standard check, respectively. The cross combination Chhodawadi x GO-2 (14.81 %) followed by HRB-108-2 and GO-2 (13.81 %) expressed maximum degree of heterobeltiosis, whereas the cross combination Pant Bhindi x JOL-1 (55.76 %) showed highest magnitude of economic heterosis for number of fruits per plant. Numerous workers including Singh and Syamal (2006), Dahake *et al*. (2007), Desai *et al*. (2007) and Yadav *et al*. (2007) observed heterosis for number of fruits per plant in okra.

Yield is the attribute of economic importance, for which considerable magnitude of heterosis was registered in number of crosses in the present investigation. Two crosses showed significant and positive heterobeltiosis, while 28 crosses expressed significant and positive

economic heterosis for fruit yield per plant. The cross combination BO-13 x GO-2 (15.72 %) registered maximum heterosis over better parent followed by BO-13 x HRB-55 (15.39 %), whereas, the cross combinations Pant Bhindi x JOL-1 (60.18 %) and Pant Bhindi x Parbhani Kranti (59.14 %) exhibited highest economic heterosis for fruit yield per plant. It was found that heterosis for fruit yield per plant was mainly due to increased fruit number per plant. Heterosis for fruit yield per plant was observed by Borgaonkar *et al*. (2005), Desai *et al.* (2007) and Shoba and Mariappan (2007). Heterobeltiosis in okra was recorded by Singh and Syamal (2006), Desai *et al.* (2007) and Pandey *et al*. (2008). Standard heterosis in okra was reported by Dahake *et al*. (2007) and Eswaran *et al*. (2007). Comparison of five most economic heterotic crosses for fruit yield with other yield attributing traits (Table 3) revealed that among the top yielding hybrids, the hybrid Pant Bhindi x JOL-1 followed by Pant Bhindi x Parbhani Kranti and Pant Bhindi x GO-2 showed highest heterosis over the standard check, it was attributed to more number of fruits per plant, more number of nodes per plant and tall plant. Other crosses *viz*., Pant Bhindi x HRB-55 and D-1-87-5 x GO-2 also depicted significant and high economic heterosis for fruit yield per plant and they were found mainly due to more number of fruits per plant and nodes per plant.

Findings of the present investigation revealed that Pant Bhindi x JOL-1 and Pant Bhindi x Parbhani Kranti were found to be the best cross combinations for fruit yield and yield attributing traits on the basis of *per se* performance and heterosis over standard check. Therefore, these hybrids may be advanced and exploited in future breeding programmes for improving yield and its components in okra.

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