GAU Res. J., 34 (1) : 20-28 (2009)

# Stability analysis for fruit yield and Its attributing characters in okra [*Abelmoschus esculentus* (L.) Moench]

**H.M. Babariya, H.L. Dhaduk, D.R. Mehta, N.B. Patel and V.K Poshiya**

Department of Agricultural Botany, College of Agriculture
Junagadh Agricultural University, Junagadh–362 001 (Gujarat)

## Abstract

**The experimental material consisting of fifty-four entries viz., fourteen parents and their forty crosses over three seasons to study stability analysis in okra. The stability analysis exhibited significant differences among the genotypes (G), environments (E) and G x E interactions for all the traits except variance due to G x E for fruit girth indicating variable response of different genotypes for various traits under varied agro-climatic conditions. The results on environmental index revealed that *kharif* season was most congenial for fruit yield per plant and majority of the yield attributing traits. Higher magnitude of mean square due to environment (linear) as compared to G x E (linear) indicated that linear response of environment accounted for the major part of total variation for most of the characters. The parents Parbhani Kranti, US-7109, GO-1 and JOL-01-3 were stable for fruits yield and its components. On the basis of three stability parameters *viz.*, overall mean, regression coefficient ($b_i$) and deviation from regression ($S^2di$), it was observed that the cross GO-2 x JOL-01-3 was found to be the best with highest mean yield, regression coefficient near to unity ($b_i$ = 1) and least deviation from regression ($S^2di$=0) indicating its stable performance under all the seasons. The hybrid, AOL-35-32 x JOL-02-16 (206.43 g) was found to be below average responsive as it depicted regression coefficient greater than one ($b_i$ >1) and non-significant deviation from regression ($S^2di$) indicating its better performance to favourable environmental conditions. On the other hand, hybrid US-7109 x Arka Abhay exhibited above average response ($b_i$ <1) with higher mean illustrating its adaptability to poor environmental conditions.**

**Key words :** Okra, stability analysis, environment and genotype

## Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop grown throughout the country both as summer as well as rainy season crop for its green fruits. Okra fruit is a good source of nutrients and minerals. Besides the genetic factors, an environment plays an important role in the phenotypic expression of fruit yield and its component characters. A genotype is known to show a differential phenotypic response in development when introduced in different environments. This genotypic x environment interaction is particularly important in the expression of quantitative characters which are modified by environmental influences. The information on the estimates of various genetic components gained from single environment testing is biased due to the genotype x environment interaction effects. Thus, in order to have unbiased estimates, it is imperative to conduct an experiment over different environments, which help in separating out the contributions made by the genotypic x environment interaction and in isolating the stable genotypes over a wide range of varied environments. Such studies become more important in vegetable crops which are highly influences by varied agro-climatic conditions. Therefore, an attempt had been made to identify stable okra genotypes for fruits yield and yield attributing traits in okra.

## Materials and methods

The experimental material, consisting fifty-four entries including fourteen parents (GO-2, JOL-1, JO-01-1, JO-02-11, JO-2k-19, AOL-35-32, Parbhani Kranti, Ankur-40, US-7109 and VRO-5 as female parents and

GO-1, JOL-01-3, JOL-02-16 and Arka Abhay as male parents) and their forty crosses, was laid-out in a randomized block design with three replications over three seasons *viz;* summer, *Kharif* and semi-rabi, 2005 at the Instructional Farm, Junagadh Agricultural University, Junagadh. Each entry was sown in a single-row plot of ten plants, spaced at 45 x 30 cm. All recommended agronomic practices and plant protection measures were followed uniformly in all the three environments. Five competitive plants were randomly selected for recording the observations on different characters like days to flowering, number of nodes per plant, internodal length (cm), plant height (cm), branches per plant, fruit length (cm), fruit girth (cm), number of fruits per plant and fruits yield per plant (g). The pooled analysis of variance over the three seasons was also done to test the interaction of genotypes and its sub-divisions with environments given by Comstock and Robinson (1). The statistical analysis for genotype x environment interaction and stability was carried out according to Eberhart and Russel (2) for fruit yield and its component characters in okra.

## Results and discussion

The analysis of variance for stability analysis (Table 1) revealed significant differences among the genotypes and environments for all the characters when tested against pooled error and pooled deviations except mean square due to environments for number of branches per plant. While testing the significance of mean squares due to genotype x environment (G x E) interaction and E + (G x E) against pooled error and pooled deviation, it was observed that the mean squares due to both these sources were found significant for all the characters except fruit girth. The mean squares due to environments (linear) and genotype x environment (linear) component were also significant for all the traits except fruit girth when tested against pooled error and pooled deviations. The non-linear components of G x E interaction (pooled deviation) was significant against pooled error for days to 50 % flowering, number of nodes per plant, plant height, number of branches per plant, fruit length and fruit girth.

The estimates of environment index worked out for different characters are presented in Table 2. Summer season ($E_1$) was observed to be favourable for days to 50 % flowering (-0.75), internodal length, while *kharif* season ($E_2$) was found to be congenial for number of nodes per plant (9.32), plant height (8.86), number of

**Table 1.** Pooled analysis of variance for stability parameters for fruit yield and its attributes in okra.

| Source of variation | d.f. | Days to flowering | Number of nodes per plant | Internodal length | Plant height | Branches per plant | Fruit length | Fruit girth | Fruits per plant | Yield per plant |
|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes (G) | 53 | 11.60*+ | 7.95*+ | 0.31*+ | 303.71*+ | 0.58*+ | 1.42*+ | 0.14*+ | 4.46*+ | 1684.58*+ |
| Environments (E) | 2 | 1025.18*+ | 3538.64*+ | 88.44*+ | 3197.87*+ | 0.37 | 35.41*+ | 0.35*+ | 577.58*+ | 318440.30*+ |
| G x E | 106 | 4.46*+ | 5.37*+ | 0.14*+ | 119.59*+ | 0.19*+ | 0.77*+ | 0.07 | 2.67*+ | 896.66*+ |
| E.+ (G x E) | 108 | 23.37*+ | 70.80*+ | 1.78*+ | 176.59*+ | 0.19*+ | 1.41*+ | 0.08 | 13.31*+ | 6777.10*+ |
| Environments (Lin.) | 1 | 2050.37*+ | 7077.28*+ | 176.87*+ | 6395.73*+ | 0.73*+ | 70.82*+ | 0.70*+ | 1155.16*+ | 636880.70*+ |
| G x E (Linear) | 53 | 6.92*+ | 9.59*+ | 0.23*+ | 158.53*+ | 0.26*+ | 1.13*+ | 0.07 | 4.62*+ | 1620.25*+ |
| Pooled Deviation | 54 | 1.98* | 1.13* | 0.06 | 79.16* | 0.13* | 0.40* | 0.07* | 0.70 | 169.86 |
| Pooled Error | 318 | 0.74 | 0.71 | 0.07 | 24.46 | 0.08 | 0.17 | 0.02 | 0.76 | 231.17 |
| Total | 161 | 19.50 | 50.11 | 1.29 | 218.44 | 0.33 | 1.42*+ | 0.14*+ | 4.46*+ | 1684.58*+ |

*, + Significant against pooled error and pooled deviation, respectively at 5 % level of significance

**Table 2.** Estimates of environmental index for various traits under different environments in okra

| Sr. No. | Characters | Environmental Index | | |
|---|---|---|---|---|
| | | $E_1$ | $E_2$ | $E_3$ |
| 1 | Days to 50 % flowering | -0.75 | 4.68 | -3.93 |
| 2 | Number of nodes per plant | -4.01 | 9.32 | -5.31 |
| 3 | Internodal length | -0.60 | 1.47 | -0.87 |
| 4 | Plant height | -3.87 | 8.86 | -4.99 |
| 5 | Number of branches per plant | 0.00 | 0.08 | -0.08 |
| 6 | Fruit length | 0.08 | 0.77 | -0.85 |
| 7 | Fruit girth | 0.05 | 0.05 | -0.09 |
| 8 | Number of fruits per plant | -1.31 | 3.72 | -2.42 |
| 9 | Fruit yield per plant | -34.13 | 87.94 | -53.81 |

$E_1$ = Summer-2005, $E_2$ = *kharif*-2005, $E_3$ = Semi rabi-2005

branches per plant (0.08), fruit length (0.77), number of fruits per plant (3.72) and fruit yield per plant (87.94) and semi rabi season ($E_3$) was favourable only for days to 50 % flowering (-3.93), internodal length (-0.87) and fruit girth (-0.09).

The stability parameters for individual genotype for various traits (Table 3) indicated that all the parents (lines and testers) studied were found stable for days to 50% flowering except the line JO-02-11 as it had exhibited significant deviation from regression. The parent Parbhani Kranti (45.89 days) was earliest among the parents, regression co-efficient near to unity ($b_i$=0.85) and non-significant deviation from regression indicating its stable performance over varying environments. Thirty-three hybrids were found stable for this trait. Of these, only five hybrids *viz*., JO-2K-19 x JOL-02-16 (44.67), JO-2K-19 x Arka Abhay (45.89), US-7109 x Arka Abhay (46.22), JO-02-11 x JOL-01-3 (46.22) and JO-2K-19 x GO-1 (46.44) exhibited earlier days to flowering, regression coefficient near to unity ($b_i$1) and non-significant deviation from regression ($S^2$di) indicating their stable performance for earliness over varied seasons.

The tester, GO-1 expressed average responsiveness and stability across environments with highest mean (21.19) for number of nodes per plant as it depicted regression coefficient around unity and non-significant deviation from regression. The other desirable parents *viz*., JOL-01-3 (20.74), Parbhani Kranti (19.62) and VRO-5 (18.94) had higher mean number of nodes per plant along with unit regression coefficient and non-significant deviation from regression. The genotype US-7109 had above average responsive as it depicted regression coefficient less than unity ($b_i$<1) and was suitable for poor season. Out of forty hybrids, thirty-six hybrids recorded non-significant deviation from regression ($S^2$di) indicating their stability over environments for number of nodes per plant. Three hybrids *viz*., GO-2 x JOL-02-16 (24.14), VRO-5 x JOL-02-16 (21.60) and JO-2K-19 x JOL-02-16 (21.37) expressed higher mean, regression coefficient near unity ($b_i$1) and non-significant deviation from regression indicated their stable performance associated with these hybrids.

Estimates of stability parameters for internodal length revealed that all the parents and hybrids (except VRO-5 x GO-1) were stable as all had non-significant deviation from regression. Two lines, VRO-5 (5.00) and JOL-1 (5.08) and one tester, Arka Abhay (5.12) had short internodal length, average responsiveness and stable performance in all the three seasons as they exhibited regression coefficient around unity ($b_i$1) and non-significant deviations from regression ($S^2$di). Similarly, three hybrids i.e. JOL-1 x JOL-02-16 (4.69), JO-01-1 x JOL-02-16 (4.96) and JOL-1 x JOL-01-3 (4.99) recorded comparatively shorter internodal length with stable performance over environments as they depicted regression coefficient near unity ($b_i$1) and least deviation from regression ($S^2$di).

On the basis of regression coefficient ($b_i$) and deviation from regression ($S^2$di) of parents and crosses, complete absence of g x e interaction was recorded

in nine lines, all the four testers and twenty six crosses for plant height. Two testers, JOL-01-3 (81.22) and GO-1 (78.03) were found stable for tallness with regression coefficient near to unity ($b_i$1) and non-significant deviation from regression. Four crosses *viz.*, VRO-5 x JOL-02-16 (94.51), Ankur-40 x JOL-02-16 (94.41), VRO-5 x JOL-01-3 (88.50) and US-7109 x Arka Abhay (87.72) recorded high *per se* performance, average responsiveness ($b_i$1) and non-significant deviation from regression ($S^2$di) indicating their stable performance over seasons for plant height.

Estimates of stability parameters for number of branches per plant indicated that all the parents were found stable for this trait. Among the parents, Parbhani Kranti (2.61), JO-2K-19 (2.46) and JOL-1 (2.46) and GO-1 (2.57) had higher mean, unit regression coefficient ($b_i$1) and non-significant deviation from regression indicating their average stability across the three environments. Among 33 stable hybrids, three hybrids *viz.*, GO-2 x JOL-02-16 (3.63), GO-2 x GO-1 (3.14) and JO-01-1 x Arka Abhay (3.06) recorded higher mean values with unit regression coefficient ($b_i$1) and least deviation from regression, which indicated average stability across the environments. Two hybrids namely VRO-5 x Arka Abhay (3.02) and AOL-35-32 x Arka Abhay (2.71) were above average responsive with regression coefficient less than one ($b_i$<1) and non-significant $S^2$di suggesting their stable performance under unfavourable/poor environments for number of branches per plant.

For fruit length, prediction of performance would be possible for eight lines, three testers and 35 hybrids as they depicted non-significant deviation from regression. The line, JO-02-11 (12.86) and the tester, JOL-01-3 (12.89), were found average responsive with higher mean values and $S^2$di. Out of 35 stable hybrids, four hybrids *viz.*, JO-01-1 x JOL-02-16 (14.02), JO-2K-19 x JOL-01-3 (14.11), AOL-35-32 x GO-1 (14.17) and VRO-5 x JOL-01-3 (13.98) had recorded higher fruit length with regression coefficient around unity ($b_i$1) and least deviation from regression indicating their high *per se* performance under varying environmental conditions.

Prediction of performance for fruit girth was possible for six parents and thirty-six hybrids as they expressed non-significant deviations from regression. Two parents *viz.*, US-7109 (5.64) and JO-01-1 (5.48) had high fruit girth, regression coefficient around unity ($b_i$1) and non-significant deviation from regression, which indicated average stability across environments. The tester Arka Abhay (5.86) and the line GO-2 (5.78) were found to be above average stable parents as both depicted regression coefficient less than unity ($b_i$<1) and least deviation from regression ($S^2$di) and were found to be best for poor environments. Out of 36 stable hybrids, only two hybrids namely Parbhani Kranti x JOL-02-16 (5.80) and JO-2K-19 x GO-1 (6.09) were found average responsive with high mean, regression coefficient around unity ($b_i$1) and non-significant deviation from regression for fruit girth.

Estimate of stability parameters for parents and hybrids indicating that all the parents and hybrids were found stable for number of fruits per plant. The testers, GO-1 (13.04) and JOL-01-3 (12.52) and the line JO-02-11 (12.53) were observed to be average responsive with regression coefficient around unity and non-significant deviation from regression but had recorded lower mean values as compared average number of fruits per plant. However, Parbhani Kranti (14.01) and US-7109 (13.90) had higher numbers of fruits per plant with above average responsiveness ($b_i$<1) and stable performance indicated that both parents were found to be most suitable for poor environments. Out of forty stable hybrids, fourteen hybrids were found average responsive, while hybrid JO-2K-19 x JOL-02-16 has recorded highest mean number of fruits per plant (15.69) with regression coefficient equal to one ($b_i$=1) and proved to be best adaptive hybrid in all environmental conditions.

Looking to mean fruit yield per plant, regression co-efficient and deviation from regression, it was observed that among parents, the line Parbhani Kranti exhibited highest mean performance (210.30g) followed by the line US-7109 (191.01 g) with average responsiveness ($b_i$1), non-significant deviation from regression ($S^2$di) indicating their superiority to all the environmental conditions. Out of forty hybrids, thirty-nine hybrids were observed to be stable for fruit yield per plant due to their non-significant deviation from regression. Among the 39 stable hybrids, 18 hybrids had average responsiveness with regression coefficient around unity ($b_i$1). The cross GO-2 x JOL-01-3 was found to be the best with highest mean yield (226.13 g), regression coefficient near to unity ($b_i$1) and least deviation from regression ($S^2$di=0) indicating its stable performance under all the season. The hybrid, AOL-35-32 x JOL-02-16 (206.43 g) was found to be below average responsive as it depicted regression coefficient greater than one ($b_i$>1) and non-significant deviation from regression ($S^2$di) indicating its better performance to favourable

**Table 3.** Stability parameters for fruit yield and its component traits in okra

| Genotypes | Days to 50 % flowering | | | Number of nodes per plant | | | Internodal length | | | Plant height | | | Number of branches per plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ |
| GO-2 | 51.11 | 0.76 | 0.40 | 16.88 | 0.91 | 1.17 | 5.52 | 0.40 | -0.08 | 74.32 | -0.95 | -7.43 | 2.25 | 5.61 | -0.07 |
| JOL-1 | 48.00 | 1.51 | 1.20 | 15.80 | 1.06 | -0.94 | 5.08 | 1.41 | -0.08 | 59.66 | 2.04 | -26.02 | 2.46 | 3.01 | -0.05 |
| JO-01-1 | 47.11 | 1.50 | -0.59 | 16.51 | 0.75 | -0.10 | 5.34 | 1.20 | -0.04 | 65.70 | -0.27 | 10.55 | 2.14 | -4.78 | -0.07 |
| JO-02-11 | 44.78 | 1.59 | 8.16** | 19.27 | 1.04 | -0.02 | 5.34 | 1.13 | -0.05 | 71.78 | 2.88 | 44.62 | 2.34 | 2.95 | -0.05 |
| JO-2k-19 | 47.00 | 1.20 | -0.76 | 17.54 | 0.77 | -0.90 | 5.52 | 0.63 | -0.03 | 70.56 | 0.77 | 8.52 | 2.46 | 0.19 | -0.07 |
| AOL-35-32 | 49.33 | 0.72 | 0.19 | 17.43 | 0.77 | -0.54 | 5.61 | 0.90 | -0.09 | 70.14 | 0.83 | -25.20 | 2.09 | 1.68 | -0.08 |
| Parbhani Kranti | 45.89 | 0.85 | 1.63 | 19.62 | 0.84 | -0.90 | 5.81 | 1.02 | -0.08 | 85.81 | -1.71 | 244.15** | 2.61 | -6.54 | -0.02 |
| Ankur - 40 | 48.89 | 1.15 | 0.84 | 18.31 | 0.85 | -0.78 | 5.62 | 1.28* | -0.09 | 76.90 | 1.12 | -27.04 | 1.73 | -0.02 | -0.05 |
| US-7109 | 47.67 | 1.10 | -0.37 | 18.33 | 0.65* | -0.91 | 5.58 | 1.51 | 0.00 | 73.46 | 0.88 | -3.00 | 2.32 | 2.16 | -0.08 |
| VRO-5 | 48.33 | 0.95 | -0.17 | 18.94 | 0.99 | -0.43 | 5.00 | 1.23 | -0.07 | 77.74 | 1.04 | -25.53 | 1.82 | 3.78 | -0.05 |
| GO-1 | 50.22 | 1.22 | -0.04 | 21.19 | 0.86 | -0.82 | 5.74 | 0.84 | -0.09 | 78.03 | 0.80 | -24.37 | 2.57 | -2.65 | 0.08 |
| JOL-01-3 | 48.67 | 0.95 | -0.17 | 20.74 | 0.92 | 0.75 | 5.66 | 0.78 | -0.07 | 81.22 | 0.57 | -21.29 | 2.03 | 3.08 | -0.05 |
| JOL-02-16 | 51.11 | 0.79 | -0.36 | 18.06 | 1.01 | -0.92 | 5.55 | 0.84 | -0.09 | 74.07 | 1.51 | -25.28 | 1.70 | 4.19 | -0.06 |
| Araka Abhay | 49.33 | 0.95 | -0.17 | 18.07 | 0.98 | -0.93 | 5.12 | 1.18 | 0.22 | 67.15 | 1.67 | -22.97 | 1.98 | 1.01 | -0.08 |
| GO-2 x GO-1 | 50.33 | 0.75 | -0.48 | 18.02 | 1.01 | -0.60 | 5.59 | 1.04 | -0.08 | 70.29 | 1.52 | -24.13 | 3.14 | -2.86 | 0.12 |
| GO-2 x JOL-01-3 | 48.00 | 1.06 | 0.19 | 21.23 | 0.93 | -0.76 | 5.89 | 0.79* | -0.09 | 81.62 | -1.24 | -12.67 | 2.58 | 3.69 | -0.07 |
| GO-2 x JOL-02-16 | 50.11 | 0.69* | -0.76 | 24.14 | 1.37 | 2.20 | 5.98 | 0.59 | -0.05 | 87.10 | -0.28 | -14.95 | 3.63 | -1.65 | 0.00 |
| GO-2 x Arka Abhay | 49.44 | 0.96 | 0.95 | 20.66 | 1.04 | -0.86 | 5.78 | 0.61 | -0.08 | 84.55 | 0.35 | -17.97 | 2.43 | 0.54 | 0.03 |
| JOL-1 x GO-1 | 50.33 | 0.95 | -0.17 | 17.17 | 0.81 | -0.87 | 5.90 | 0.72 | 0.22 | 66.51 | 1.35 | -21.67 | 2.73 | -3.04 | 0.03 |
| JOL-1 x JOL-01-3 | 51.00 | 0.79 | 4.93** | 19.51 | 1.06 | -0.75 | 4.99 | 1.32 | -0.02 | 76.28 | 0.61 | -13.17 | 2.98 | 0.54 | -0.06 |
| JOL-1 x JOL-02-16 | 50.78 | 0.34* | -0.74 | 17.71 | 1.02 | 0.03 | 4.69 | 1.07 | -0.09 | 61.63 | 3.80 | 60.32 | 2.05 | 2.99 | -0.04 |
| JOL-1 x Arka Abhay | 48.44 | 0.91 | 4.79** | 17.52 | 1.05 | -0.94 | 5.21 | 0.95 | 0.00 | 64.54 | 1.71 | 50.01 | 2.34 | 6.41 | -0.04 |
| JO-01-1 x GO-1 | 48.00 | 1.12 | 2.68* | 17.48 | 1.27 | 1.25 | 5.10 | 1.09 | -0.08 | 59.76 | 2.81 | -12.01 | 1.91 | 1.14 | -0.01 |
| JO-01-1 x JOL-01-3 | 49.22 | 0.97 | 1.33 | 19.23 | 1.19 | -0.69 | 5.26 | 0.97 | 0.03 | 64.91 | 1.60 | 5.57 | 1.71 | 6.24 | 0.33* |
| JO-01-1 x JOL-02-16 | 49.44 | 0.65 | -0.56 | 20.42 | 1.33 | 4.41* | 4.96 | 0.75 | -0.07 | 60.68 | 2.22 | 70.99 | 2.47 | 9.94 | 0.27* |
| JO-01-1 x Arka Abhay | 50.78 | 0.31 | 1.49 | 19.90 | 1.08 | 0.33 | 6.00 | 0.82 | -0.09 | 93.24 | -0.37 | 203.63** | 3.06 | -0.45 | -0.05 |
| JO-02-11 x GO-1 | 46.56 | 1.71* | -0.66 | 18.41 | 1.25 | -0.49 | 5.92 | 0.95 | -0.07 | 69.58 | 2.41 | 7.48 | 2.62 | -2.24 | -0.03 |
| JO-02-11 x JOL-01-3 | 46.22 | 1.77 | -0.48 | 16.47 | 1.01 | 0.17 | 5.03 | 1.15 | -0.09 | 72.61 | 1.45 | 84.66* | 1.74 | 1.54 | -0.05 |

**Table 3.** Conti.....

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JO-02-11 x JOL-02-16 | 46.22 | 1.05 | 2.39* | 20.55 | 0.88 | 0.13 | 5.23 | 1.14 | -0.09 | 79.54 | 0.86 | -13.44 | 2.35 | 0.22 | -0.04 |
| JO-02-11 x Arka Abhay | 48.89 | 0.69 | 7.86** | 17.44 | 0.91 | -0.06 | 5.57 | 1.29 | -0.08 | 75.04 | 1.19 | -27.65 | 2.73 | -7.33 | 0.62** |
| JO-2k-19 x GO-1 | 46.44 | 1.15 | -0.51 | 19.27 | 1.33* | -0.94 | 5.51 | 1.09 | 0.06 | 80.95 | 1.65 | 67.38 | 2.38 | 1.26 | -0.08 |
| JO-2k-19 x JOL-01-3 | 47.67 | 0.71 | 0.37 | 20.14 | 1.45 | 1.53 | 5.58 | 1.06 | 0.02 | 82.73 | 1.34 | 158.76* | 2.57 | 4.12 | -0.03 |
| JO-2k-19 x JOL-02-16 | 44.67 | 1.30 | -0.03 | 21.37 | 1.00 | 1.57 | 5.37 | 1.11 | -0.02 | 76.91 | 1.34 | 175.78** | 3.12 | -0.41 | 0.04 |
| JO-2k-19 x Arka Abhay | 45.89 | 1.22 | -0.04 | 19.69 | 0.83 | -0.35 | 5.48 | 1.38 | -0.09 | 74.19 | 1.08 | 164.73** | 2.74 | -7.69 | 0.03 |
| AOL-35-32 x GO-1 | 46.44 | 1.89* | -0.77 | 17.37 | 1.00 | -0.89 | 5.19 | 1.72* | -0.09 | 63.97 | 2.43 | 8.52 | 2.32 | 6.14 | 0.00 |
| AOL-35-32 x JOL-01-3 | 44.78 | 2.02* | -0.66 | 19.46 | 1.17 | 1.25 | 5.14 | 1.14* | -0.09 | 65.63 | 2.34 | 15.75 | 1.63 | 7.77 | 0.97** |
| AOL-35-32 x JOL-02-16 | 45.11 | 1.45 | 5.50** | 17.64 | 0.6 | 0.08 | 5.99 | 0.87 | 0.05 | 79.22 | 0.29 | 90.41* | 2.22 | 0.88 | -0.01 |
| AOL-35-32 x Arka Abhay | 46.33 | 1.59 | 2.56* | 18.87 | 1.05 | -0.67 | 5.79 | 1.17 | -0.03 | 69.44 | 2.32 | 94.99* | 2.71 | -1.34* | -0.08 |
| Parbhani kranti x GO-1 | 51.11 | 0.67 | -0.65 | 19.26 | 1.28 | 0.19 | 5.93 | 0.88 | -0.02 | 79.09 | 1.54 | -23.69 | 2.59 | 1.79 | -0.06 |
| Parbhani kranti xJOL-01-3 | 49.44 | 0.53 | 3.25* | 17.48 | 0.79 | -0.45 | 5.70 | 0.70 | -0.04 | 77.04 | 2.26* | -27.61 | 2.08 | 0.36 | -0.06 |
| Parbhani kranti x JOL-02-16 | 49.44 | 0.85 | 1.42 | 20.00 | 1.15 | -0.87 | 5.53 | 1.27* | -0.09 | 83.21 | 1.55 | -18.69 | 1.81 | 5.42 | -0.06 |
| Parbhani kranti x Arka Abhay | 49.44 | 0.91 | 0.12 | 18.68 | 1.28 | -0.74 | 5.39 | 0.78 | 0.00 | 86.13 | 1.44 | 171.15** | 1.87 | 4.50 | -0.07 |
| Ankur-40 x GO-1 | 46.89 | 1.46 | 0.21 | 21.12 | 1.78* | -0.91 | 5.73 | 0.85* | -0.09 | 96.23 | 0.25 | 404.71** | 2.73 | 2.73 | 0.09 |
| Ankur -40 x JOL-01-3 | 48.56 | 0.62 | 1.60 | 19.04 | 0.79 | -0.77 | 5.48 | 1.13 | -0.02 | 78.45 | 0.55 | -25.69 | 1.90 | 3.65 | -0.06 |
| Ankur -40 x JOL-02-16 | 49.00 | 0.68 | -0.37 | 20.77 | 0.92* | -0.94 | 6.16 | 0.65* | -0.09 | 94.41 | -0.34 | -19.41 | 2.67 | 1.02 | 0.00 |
| Ankur -40 x Arka Abhay | 51.22 | 0.33 | 5.49** | 19.66 | 0.70 | 2.97* | 5.60 | 0.98 | -0.09 | 101.36 | -1.43 | 121.93* | 2.47 | -4.37 | -0.05 |
| US-7109 x GO-1 | 50.11 | 0.73 | 2.39* | 20.66 | 1.87 | 0.69 | 5.56 | 0.98 | -0.09 | 88.63 | 0.55 | 500.04** | 1.89 | 11.69 | 0.67** |
| US-7109 x JOL-01-3 | 48.78 | 0.62* | -0.77 | 21.10 | 1.04 | 4.50* | 5.53 | 0.96 | -0.09 | 72.82 | 2.21 | 281.52** | 1.90 | 9.42 | 0.48** |
| US-7109 x JOL-02-16 | 49.33 | 0.69 | 2.75* | 21.59 | 0.54 | 9.74** | 5.35 | 1.55* | -0.09 | 72.93 | 1.97 | 199.91** | 2.25 | -4.29 | -0.04 |
| US-7109 x Arka Abhay | 46.22 | 0.97 | 1.33 | 20.19 | 0.48* | -0.94 | 5.19 | 1.04 | 0.11 | 87.72 | -0.50 | -18.43 | 2.44 | 0.47 | -0.07 |
| VRO-5 x GO-1 | 52.00 | 0.09 | 3.16* | 18.68 | 0.73 | -0.42 | 5.86 | 0.60 | 0.35* | 92.84 | 0.04 | 115.76* | 2.67 | -5.44 | 0.21 |
| VRO-5 x JOL-01-3 | 46.33 | 1.84 | 5.09** | 19.37 | 0.57 | 0.98 | 5.70 | 0.75 | -0.08 | 88.50 | -0.74 | -25.34 | 2.63 | -3.40 | 0.03 |
| VRO-5 x JOL-02-16 | 51.67 | 0.54 | 1.67 | 21.60 | 1.01 | -0.73 | 5.83 | 0.84 | -0.09 | 94.51 | 0.11 | -18.90 | 3.04 | -5.77 | 0.58** |
| VRO-5 x Arka Abhay | 47.00 | 1.20 | -0.76 | 18.90 | 1.06 | 0.12 | 5.45 | 0.91 | -0.09 | 82.30 | 0.62 | -16.28 | 3.02 | -3.89* | -0.08 |
| Mean | 48.43 | 1 | | 19.16 | 1 | | 5.51 | 1 | | 77.1 | 1 | | 2.38 | 1 | |
| S. Em. ± | 0.99 | 0.23 | | 0.75 | 0.09 | | 0.17 | 0.13 | | 6.29 | 0.82 | | 0.25 | 3.06 | |

**Table 3.** Conti.....

| Genotypes | Fruit length | | | Fruit girth | | | Number of fruits per plant | | | Fruit yield per plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ | Mean | $b_i$ | $S^2di$ |
| GO-2 | 12.01 | 1.35 | 2.48* | 5.78 | -0.77 | 0.04 | 10.54 | 1.10 | -0.24 | 138.72 | 1.11 | -242.3 |
| JOL-1 | 12.53 | -0.45* | -0.22 | 5.87 | 5.15 | 0.18** | 12.97 | 0.88 | 2.14 | 179.08 | 1.19 | 436.6 |
| JO-01-1 | 11.27 | 1.58 | -0.09 | 5.48 | 1.18 | -0.03 | 10.56 | 0.68 | 1.33 | 136.9 | 0.72 | -184 |
| JO-02-11 | 12.86 | 2.13 | -0.13 | 5.80 | -0.98 | 0.10* | 12.53 | 1.00 | -0.84 | 171.22 | 0.87 | -232.5 |
| JO-2k-19 | 11.58 | 1.40 | 0.05 | 5.69 | 2.12 | -0.01 | 11.21 | 0.76 | 0.47 | 168.33 | 0.65 | -51.9 |
| AOL-35-32 | 12.26 | 1.73 | 0.14 | 5.75 | -3.85 | 0.14* | 11.84 | 0.90 | -0.65 | 156.92 | 1.09 | -226.9 |
| Parbhani Kranti | 11.55 | 2.07 | 0.25 | 5.62 | -2.18 | 0.09 | 14.01 | 0.50 | 0.09 | 210.3 | 0.86 | -249.7 |
| Ankur - 40 | 12.42 | 0.44 | 0.67* | 5.92 | 4.66 | 0.35** | 11.74 | 0.87 | -0.69 | 129.5 | 0.65 | -236.2 |
| US-7109 | 11.46 | 1.15 | -0.12 | 5.64 | 1.15 | -0.02 | 13.90 | 0.22 | -0.38 | 191.01 | 0.97 | -233.5 |
| VRO-5 | 13.37 | -0.60 | 0.15 | 5.66 | -1.60 | 0.29** | 11.92 | 1.32 | -0.83 | 159.02 | 1.03 | -210.4 |
| GO-1 | 12.39 | 0.60 | 0.05 | 6.42 | -0.81 | 0.10* | 13.04 | 1.09 | -0.76 | 186.29 | 0.98 | 378.6 |
| JOL-01-3 | 12.89 | 0.78 | -0.06 | 5.72 | 2.99 | 0.02 | 12.52 | 0.96 | 0.33 | 181.87 | 0.32 | -117.4 |
| JOL-02-16 | 12.60 | 0.03 | 0.81* | 5.76 | -1.36 | -0.01 | 11.17 | 1.34 | -0.44 | 160.14 | 1.25* | -253.1 |
| Araka Abhay | 11.36 | 1.70 | 0.47 | 5.86 | -4.40 | 0.07 | 11.62 | 1.03 | -0.83 | 117.18 | 0.91 | 222.6 |
| GO-2 x GO-1 | 12.83 | 1.02 | 0.22 | 5.87 | 3.24 | 0:09* | 13.77 | 1.32 | 1.41 | 189.1 | 1.28 | -0.9 |
| GO-2 x JOL-01-3 | 13.53 | 1.25 | 0.82* | 6.11 | -0.36 | 0.19** | 14.33 | 0.45 | 0.13 | 226.13 | 0.76 | -243.4 |
| GO-2 x JOL-02-16 | 13.37 | 0.97 | -0.16 | 5.87 | 4.57 | -0.03 | 13.16 | 1.94 | 0.3 | 190.78 | 1.87 | -3.9 |
| GO-2 x Arka Abhay | 12.66 | 1.44 | -0.20 | 5.94 | -1.15 | -0.01 | 14.02 | 1.17 | 0.55 | 185.73 | 1.19 | -196.4 |
| JOL-1 x GO-1 | 12.64 | 2.31 | 0.24 | 6.26 | -4.41 | 0.04 | 11.12 | 1.08 | -0.05 | 139.03 | 1.17 | 258.6 |
| JOL-1 x JOL-01-3 | 12.37 | 0.73 | 0.56 | 5.64 | 2.01 | -0.02 | 14.77 | 1.22 | -0.83 | 197.57 | 1.15 | -241.6 |
| JOL-1 x JOL-02-16 | 13.76 | -0.10 | 0.10 | 5.62 | 0.44 | -0.03 | 13.14 | 1.06 | -0.72 | 181.02 | 0.85 | -221.4 |
| JOL-1 x Arka Abhay | 12.80 | -0.09* | -0.23 | 5.46 | 5.99 | 0.01 | 12.86 | 1.35 | 0.83 | 179.94 | 1.38 | 577.8 |
| JO-01-1 x GO-1 | 11.79 | 2.40 | 0.03 | 5.98 | 0.49 | -0.03 | 12.37 | 1.98 | -0.06 | 162.67 | 1.3 | -25.4 |
| JO-01-1 x JOL-01-3 | 12.60 | 1.13 | -0.20 | 5.81 | 2.18 | -0.03 | 12.14 | 1.39 | 0.33 | 164.12 | 1.35 | -45 |
| JO-01-1 x JOL-02-16 | 14.02 | 0.55 | -0.20 | 6.01 | 0.47 | -0.01 | 13.12 | 1.34 | 0.45 | 161.49 | 1.02 | -248.5 |
| JO-01-1 x Arka Abhay | 12.25 | 2.12 | 0.41 | 5.76 | 4.98 | 0.08 | 13.94 | 1.07 | -0.63 | 188.77 | 1.07 | -178.5 |
| JO-02-11 x GO-1 | 12.65 | -0.02 | -0.21 | 5.94 | 0.16 | -0.02 | 12.88 | 1.24* | -0.84 | 187.3 | 1.01 | -247.9 |
| JO-02-11 x JOL-01-3 | 12.52 | 1.59* | -0.23 | 5.70 | 2.44* | -0.03 | 11.87 | 1.60 | 0.78 | 160.38 | 1.28 | 910.10* |

**Table 3. Conti.....**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JO-02-11 x JOL-02-16 | 13.39 | -0.23 | 0.00 | 5.72 | 3.63 | -0.03 | 14.40 | 0.76 | 0.9 | 199.07 | 0.83 | -194.5 |
| JO-02-11 x Arka Abhay | 12.47 | -0.05 | -0.12 | 5.92 | 0.33 | -0.01 | 14.41 | 0.43 | -0.63 | 184.49 | 0.98 | -207.5 |
| JO-2k-19 x GO-1 | 12.67 | 0.26 | -0.14 | 6.09 | 0.91 | -0.02 | 14.11 | 1.22 | -0.38 | 187.48 | 1.18 | -230.9 |
| JO-2k-19 x JOL-01-3 | 14.11 | 0.92 | 0.24 | 6.05 | 0.35 | -0.02 | 13.73 | 1.40 | -0.41 | 190.77 | 1.35* | -255.2 |
| JO-2k-19 x JOL-02-16 | 12.41 | 2.82 | -0.02 | 5.84 | 3.74 | 0.01 | 15.69 | 1.00 | -0.84 | 247.53 | 1.31 | -166.1 |
| JO-2k-19 x Arka Abhay | 13.30 | 1.28 | 0.07 | 6.15 | 0.51 | -0.03 | 12.67 | 0.98 | -0.2 | 195.75 | 1.25 | 512.9 |
| AOL-35-32 x GO-1 | 14.17 | -0.28 | 0.75* | 6.24 | -0.69 | -0.02 | 12.09 | 1.31 | 0.8 | 161.94 | 1.67* | -235.2 |
| AOL-35-32 x JOL-01-3 | 13.19 | 1.45 | 0.32 | 5.88 | -0.81 | -0.01 | 11.79 | 1.10 | -0.73 | 174.09 | 1.71 | -174.4 |
| AOL-35-32 x JOL-02-16 | 12.70 | 1.35 | 0.26 | 5.83 | 3.24 | 0.11* | 13.56 | 0.32 | -0.47 | 206.43 | 1.04* | -256.3 |
| AOL-35-32 x Arka Abhay | 13.30 | 0.52 | -0.18 | 5.98 | -0.25 | -0.01 | 13.07 | 1.03 | -0.82 | 179.43 | 1.45 | -237.8 |
| Parbhani kranti x GO-1 | 12.30 | 0.37 | 1.23* | 6.57 | 3.60 | 0.43** | 13.82 | 0.70 | -0.83 | 196.83 | 0.82 | -253.8 |
| Parbhani kranti x JOL-01-3 | 12.67 | 0.13 | 0.01 | 5.95 | -0.36 | 0.05 | 13.56 | 1.01 | -0.8 | 184.13 | 0.75 | -211.4 |
| Parbhani kranti x JOL-02-16 | 12.45 | -0.12 | -0.21 | 5.80 | 1.29 | -0.03 | 13.86 | 0.88 | 0.28 | 187.08 | 0.9 | -231.1 |
| Parbhani kranti x Arka Abhay | 11.62 | 3.60 | 0.65* | 5.81 | 1.55 | 0.04 | 13.20 | 1.47* | -0.84 | 169.6 | 0.97 | -229.8 |
| Ankur-40 x GO-1 | 12.57 | 1.02 | 0.07 | 6.00 | 0.35* | -0.03 | 15.08 | 2.05 | -0.42 | 207.44 | 1.45 | -61.8 |
| Ankur -40 x JOL-01-3 | 12.41 | 1.74 | -0.07 | 5.81 | -2.08 | 0.01 | 12.12 | 0.64 | -0.76 | 158.74 | 0.68 | -248.8 |
| Ankur -40 x JOL-02-16 | 12.71 | 0.86 | 0.01 | 5.61 | 2.35 | 0.03 | 15.22 | 0.30 | -0.61 | 197.57 | 0.35 | 15.4 |
| Ankur -40 x Arka Abhay | 12.34 | 1.74* | -0.22 | 5.65 | 1.96 | -0.03 | 12.82 | 0.81 | 0.33 | 158.27 | 0.62 | -151.1 |
| US-7109 x GO-1 | 13.09 | 1.42 | 0.40 | 6.14 | -0.62 | -0.03 | 14.09 | 1.57 | -0.65 | 172.27 | 1.25 | -214.3 |
| US-7109 x JOL-01-3 | 12.98 | 2.15* | -0.23 | 6.00 | 1.96 | -0.02 | 13.30 | 0.98 | 0.49 | 196.48 | 1.08 | 374.1 |
| US-7109 x JOL-02-16 | 12.81 | 2.08 | -0.15 | 5.78 | 2.38 | 0.00 | 13.02 | 0.77 | 0.19 | 179.68 | 0.41* | -256.3 |
| US-7109 x Arka Abhay | 11.76 | 0.91 | -0.03 | 5.81 | 2.34 | 0.02 | 14.84 | -0.09* | -0.74 | 215.34 | 0.07* | -241.2 |
| VRO-5 x GO-1 | 12.55 | 0.64 | -0.22 | 5.80 | 2.07 | 0.01 | 14.77 | -0.02 | 0.57 | 194.27 | 0.11 | 260.6 |
| VRO-5 x JOL-01-3 | 13.98 | -1.05 | 0.57 | 5.91 | 0.56 | 0.06 | 15.01 | 0.03 | -0.46 | 205.07 | 0.52* | -251.2 |
| VRO-5 x JOL-02-16 | 12.64 | 0.47 | 1.31* | 5.59 | 2.91 | -0.03 | 13.66 | 1.40 | -0.66 | 180.19 | 0.8 | -250.6 |
| VRO-5 x Arka Abhay | 13.32 | 0.83* | -0.23 | 5.80 | 0.49 | 0.02 | 13.20 | 1.13 | -0.44 | 178.71 | 1.21 | -167 |
| Mean | 12.67 | 1 | | 5.86 | 1 | | 13.15 | 1.00 | | 179.8 | 1 | |
| S. Em. ± | 0.45 | 0.55 | | 0.18 | 2.29 | | 0.59 | 0.18 | | 9.2 | 0.1 | |

environmental conditions. On the other hand, hybrids US-7109 x Arka Abhay exhibited above average response ($b_i$<1) with higher mean (215.34g) illustrating its adaptability to poor environmental conditions. Similar results were also reported by Korla and Rastogi (3), Babu *et al.* (4), Ariyo (5), Gondane and Lai (6) and Poshiya and Vashi (7) in okra.

Thus, the present investigation gave the useful information regarding the stability of genotypes for fruit yield per plant and its related traits. Desirable genotypes could be used in further breeding programme to develop high yielding cultivars with stable performance for fruit yield and its components in okra.

## References


1. **Comstock, R.E. and Robinson, H.F.** 1952. Estimation of average dominance of genes in "Heterosis" Edn. G. W. Gowen. Iowa State College Press, Ames, Iowa, pp. 494-516.
2. **Eberhart, S.A. and Russell, W.A.** 1966. Stability parameters for comparing varieties. *Crop. Sci.*, **6**: 26-40.
3. **Korla, B.N. and Rastogi, K.B.** 1979. A notes on phenotypic stability for fruit yield in bhindi. *Punjab Hort. J.*, **19** : 182-183.
4. **Babu, K.V.S., Gopalkrishnan, P.K. and Peter, K.V.** 1983a. Study of phenotypic stability of bhindi. *South Indian Hort.*, **31** :246-247.
5. **Ariyo, O.J.** 1987. Stability of performance of okra as influenced by planting date. *Theoretical and Applied Genetics*, **74** : 83-86.
6. **Gondane, S.U. and Lai, G.** 1993. Study of genotype X environment interaction in okra (*Abelmoschus esculentus* (L.) Moench). *Ann. Plant Physiol.*, **7**: 242-246.
7. **Poshiya, V.K. and Vashi, P.S.** 1997. Phenotypic stability of hybrids and their parents for fruit yield in okra (*Abelmoschus esculentus* (L.) Moench). *Indian J. Genetics*, **57** : 266-268.