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# Genetic analysis of yield and its components in okra (*Abelmoschus esculentus* (L) Moench)

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**Abstract:** Combining ability variance and effect of yield and its components in okra (*Abelmoschus esculentus* (L) Moench) were studied through half diallel analysis of 28 $F_1$ hybrids derived by crossing nearly homozygous germplasm lines namely PK, VRO35, VRO54, 7218, VO-2, KS-404, 7109 during Kharif 2010 (July to October) at vegetable research form C.S.A.U.A & T Kalyanpur, Kanpur India the role of non-additive gene action for all the characters in both the generations except for nodes per plant, width of fruit, number of fruits per plant and yield per plant and role of additive gene action for all the a characters is both generation. The mean performance and significant gca effect revealed that the parents (KS -404, 7218, VRO-54 and BO-2) were good combiner for days to flowering and KS-40 4 & PK are good general combiner for yield/Plant. The crosses significant and positive and desirable SCA ca effect for yield per plant was founded 12 cross combination $F_1$ generation and 11 in $F_2$ generation. There were PK x KS-404, PK x P-7, KS- 404 x BO-2 and 7218 x VRO -54 should utilized in recombination breeding with single plant selection in the passing generations to capitalized additive gene action to develop high yielding lines or verities in Okra.

**Keywords:** Combining ability effects gene effects germplasm line, half diallel analysis

## Introduction

The cultivated Okra is *Abelmoschus esculentus* (L) Moench. It is native of Ethiopia (Vavilov, 1951) it is worn season vegetable in the tropical & subtropical countries of the world.Hybridization is been must successful approach in increasing in productivity in vegetable crop selection of genetically superior and suitable genotypes is the most important stage from the stand point of hybridization of vegetable crops in order to develop new genotypes having desirable characters. One of the main problem of vegetable breeders for developing high yielding variety through either heterosis breeding or pedigree breeding is to select good parents and crosses. In the systematic breeding programme is essential to identify superior parents for hybridization and crosses to expand the genetic variability for selection of superior genotype. (Inamullah *et al*., 2006). The value of any population depends on its potential per say and its combining ability in crosses. Selection of parents on the basic of phenotypic performance of a genotype alone is not a sound procedure, since phonotypically superior line may not lead to exact degree of heterosis in $F_1$ generation or through superior transgressive segregating generations. Thus any methods which would help in choosing desirable parents for hybridization will be important for the vegetable breeders. Combining ability analysis is important to decide parents, crosses and appropriate breeding procedure to be followed to select heterotic $F_1$ hybrids or desirable Segregates (Salgotra *et al*., 2009) Diallel analysis is one of the powerful tools for characterizing the genetic architecture of breeding material and estimate the GCA of parents and selecting of desirable parents and crosses with high specific combining ability (SCA) for the exploitation of heterosis (Sarkar *et al.,* 2002).

## Material and Methods

Eight elite intermediary diverse line of Okra namely. PK, VRO-35, VRO-54, 7218 BO-2, KS-404 and 7109 were crossed in all possible combinations excluding reciprocals (n(n-1)/2) to develop 28 half diallel crosses during summer 2010. 28 $F_1$ along with 8 parents were evaluated in a randomized block design with three replications during mid Kharif (July-Oct,- 2010) at vegetable research farm of C.S.A.U.A. & T. Kanpur. In each replication each entry was gown in a double row plot of 3.0m length and 1.5m width. Maintaining row to row spacing of 60 cm and plot to plot spacing of 30 cm apart. All the recommended Agronomical practices

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Table 1: Analysis of variance for combining ability in respect to 10 characters in okra

| Source of variation | | d.f. | Days to flowering | Plant height | Branches per plant | Number of first fruiting node | Node/plant | Length of internode | Length of fruit | Width of fruit | Number of fruit/plant | Yield/plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gca | $F_1$ | 7 | 15.81** | 214.69** | 0.276** | 2.71** | 12.00** | 0.79** | 2.57** | 0.73** | 10.196** | 1562.93** |
| | $F_2$ | 7 | 15.67** | 195.17** | 0.262** | 3.06** | 10.68** | 3.29** | 2.11** | 0.50** | 7.24** | 1461.88** |
| Sca | $F_1$ | 28 | 3.21** | 32.86** | 0.33** | 0.512** | 1.19** | 1.14** | 0.82** | 0.06** | 0.215** | 46.28** |
| | $F_2$ | 28 | 2.54** | 25.01** | 0.26** | 0.46** | 0.52** | 0.39** | 0.63** | 0.05** | 0.62** | 34.68** |
| Error | $F_1$ | 70 | 0.021 | 7.55 | 0.006 | 0.049 | 0.003 | 0.004 | 0.003 | 0.003 | 0.042 | 1.27 |
| | $F_2$ | 70 | 0.016 | 1.46 | 0.005 | 0.007 | 0.002 | 0.003 | 0.006 | 0.0002 | 0.047 | 1.26 |
| $\sigma^2$gca | $F_1$ | | 1.58 | 20.71 | 0.027 | 0.266 | 1.199 | 0.078 | 0.257 | 0.072 | 1.015 | 156.17 |
| | $F_2$ | | 1.57 | 19.37 | 0.026 | 0.305 | 1.067 | 0.328 | 0.210 | 0.049 | 0.719 | 146.06 |
| $\sigma^2$sca | $F_1$ | | 3.19 | 25.31 | 0.324 | 0.463 | 1.187 | 1.136 | 0.817 | 0.057 | 0.173 | 45.01 |
| | $F_2$ | | 2.52 | 23.55 | 0.255 | 0.453 | 0.518 | 0.387 | 0.624 | 0.049 | 0.573 | 33.42 |
| $\sigma^2$g/ $\sigma^2$s | $F_1$ | | 0.49 | 0.82 | 0.08 | 0.574 | 1.01 | 0.07 | 0.31 | 1.26 | 5.87 | 3.47 |
| | $F_2$ | | 0.62 | 0.82 | 0.101 | 0.673 | 2.06 | 0.85 | 0.34 | 1.00 | 1.25 | 4.37 |
| $\sigma^2$s/ $\sigma^2$g | $F_1$ | | 1.41 | 1.10 | 3.06 | 1.31 | 0.76 | 3.81 | 1.78 | 0.88 | 0.41 | 0.52 |
| | $F_2$ | | 1.26 | 1.11 | 3.13 | 1.30 | 0.69 | 1.08 | 1.72 | 1.00 | 0.88 | 0.46 |
| GPR | $F_1$ | | 0.50 | 0.62 | 0.14 | 0.53 | 0.66 | 0.12 | 0.38 | 0.71 | 0.92 | 0.87 |
| | $F_2$ | | 0.55 | 0.62 | 0.16 | 0.57 | 0.80 | 0.62 | 0.40 | 0.66 | 0.71 | 0.89 |

*Significant at 5% level
**Significant at 1% level

**Table 2:** General combining ability effects and corresponding mean performance of 8 parents in okra

| Parents | Days to flowering | | Plant height | | Branches per plant | | Number of first fruiting node | | Node per plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | GCA | | GCA | | GCA | | GCA | | GCA | | Mean |
| | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ | |
| PK | 0.77** | 0.62** | 7.14** | 6.04** | 0.01** | -0.03** | 0.60** | 0.54** | 1.64** | 1.90** | 23.00 |
| KS-404 | -1.65** | -1.46** | 3.91** | 4.26** | -0.31** | -0.28** | -0.19** | -0.24** | 1.42** | 0.91** | 22.30 |
| 7218 | -2.05** | -1.95** | -4.16** | -3.98** | 0.02** | 0.09** | 0.25** | 0.12** | 0.25** | 0.18** | 20.20 |
| VRO-54 | -0.02** | -0.07** | -7.01** | -6.60** | 0.14** | 0.15** | -0.25** | -0.20** | -0.06** | -0.23** | 19.56 |
| VRO-35 | 0.77** | 0.63** | -1.52** | -2.60** | 0.09** | 0.04** | 0.06** | 0.26** | -0.24** | -0.09** | 20.14 |
| P-7 | 1.16** | 1.56** | 0.64 | 1.04** | -0.07** | -0.06** | 0.72** | 0.82** | -1.45** | -1.40** | 17.45 |
| BO-2 | -0.24** | -0.57** | -2.19** | -1.63** | -0.11** | -0.15** | -0.85** | -0.91** | -0.42** | -0.33** | 19.56 |
| 7109 | 1.26** | 1.23** | 3.18** | 3.47** | 0.23** | 0.22** | -0.34** | -0.40** | -1.14** | -0.94** | 18.67 |
| SE (gi) ± | 0.002 | 0.001 | 0.66 | 0.13 | 0.0005 | 0.0004 | 0.004 | 0.0006 | 0.0003 | 0.0002 | - |
| SE (gi-gj) ± | 0.004 | 0.003 | 1.51 | 0.29 | 0.001 | 0.0009 | 0.009 | 0.0014 | 0.006 | 0.0004 | - |

* Significant at 5% level
** Significant at 1% level

| Parents | Length of internode | | Length of fruit | | Width of fruit | | Number of fruit/plant | | Yield per plant | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ | $F_1$ | $F_2$ |
| PK | 0.49** | 0.74** | 0.55** | 0.54** | 0.39** | 0.31** | 1.23** | 0.96** | 11.68** | 10.41** |
| KS-404 | -0.26** | -0.21** | -0.35** | -0.29** | -0.26** | -0.24** | 1.68** | 1.36** | 20.11** | 19.84** |
| 7218 | 0.30** | 0.11** | -0.06** | -0.10** | 0.05** | 0.06** | -0.37** | -0.17** | -9.57** | -9.31** |
| VRO-54 | -0.27** | -0.85** | -0.18** | -0.18** | -0.32** | -0.27** | -0.97** | -0.89** | 11.01** | -11.02** |
| VRO-35 | -0.18** | -0.44** | 0.03** | 0.04** | 0.15** | 0.12** | -0.02** | 0.02** | 9.35** | 9.46** |
| P-7 | -0.19** | -0.13** | 0.91** | 0.80** | 0.00 | 0.01** | 0.27** | 0.35** | 0.58** | 0.63** |
| BO-2 | 0.12** | 0.87** | -0.68** | -0.62** | -0.29** | -0.23** | -0.96** | -0.90** | -14.41** | -13.43** |
| 7109 | -0.02** | -0.09** | -0.21** | -0.19** | 0.29** | 0.23** | -0.86** | -0.72** | -6.72** | -6.57** |
| SE (gi) ± | 0.0004 | 0.0003 | 0.0003 | 0.0005 | 0.0003 | 0.00002 | 0.004 | 0.004 | 0.11 | 0.11 |
| SE (gi-gj) ± | 0.0008 | 0.0006 | 0.0006 | 0.0012 | 0.0006 | 0.00004 | 0.008 | 0.009 | 0.25 | 0.25 |

* Significant at 5% level
** Significant at 1% level

were followed to raise a good crop. Regular plot protection measures were carried out to safe guard the crop from pest and diseases. Observation were recorded on five randomly selected competitive plants in each genotypes in each replication for days to 50% flowering, plant height (cm), number of braches per plant, number of first fruiting node, number of nodes per plant, length of Internodes, Length of fruit, width of fruit, number of fruits per plot and yield per plants. The variances of general combining ability and their effects and specific combining ability effects were calculated as per Griffings (1956) method-2 model I . The variance for general combining ability and specific combining abilities were tested against their respective error variance derived from analysis of variance redressed mean level. Significant test for GCA and SCA effect were performed

**Table 3:** Ranking of parents for various characters

| Characters | Best combiner on the basis of gca effects | | Best parents based on *per se* performance | Common |
|---|---|---|---|---|
| Days to flowering | $F_1$ | KS-404, 7218, VRO-54, BO-2 | 7218, KS-404, VRO-54, BO-2 | KS-404, 7218, VRO-54, BO-2 |
| | $F_2$ | KS-404, 7218, VRO-54, BO-2 | | |
| Plant height | $F_1$ | PK, VRO-54, 7218, KS-404, 7109 | PK, 7109, KS-404, P-7, VRO-35 | PK, KS-404, 7109 |
| | $F_2$ | PK, VRO-54, KS-404, 7218, 7109 | | |
| Branches per plant | $F_1$ | 7109, KS-404, VRO-54, BO-2 | VRO-54, 7109, 7218, BO-2 | 7109, VRO-54, BO-2 |
| | $F_2$ | KS-404, 7109, BO-2, VRO-54 | | |
| Number of first fruiting node | $F_1$ | BO-2, P-7, PK, 7109 | P-7, PK, VRO-54, VRO-35 | PK, P-7 |
| | $F_2$ | BO-2, P-7, PK, 7109 | | |
| Node per plant | $F_1$ | PK, P-7, KS-404, 7109 | PK, KS-404, 7218, VRO-35 | PK, KS-404 |
| | $F_2$ | PK, P-7, 7109, KS-404 | | |
| Length of internode | $F_1$ | PK, 7218, VRO-54, KS-404 | PK, BO-2, P-7, 7218 | PK |
| | $F_2$ | BO-2, VRO-54, PK, VRO-35 | | |
| Length of fruit | $F_1$ | P-7, BO-2, PK, KS-404 | PK, P-7, 7109, 7218 | PK, P-7 |
| | $F_2$ | P-7, BO-2, PK, KS-404 | | |
| Width of fruit | $F_1$ | PK, VRO-54, BO-2, 7109 | PK, VRO-35, P-7, 7109 | PK, 7109 |
| | $F_2$ | PK, VRO-54, BO-2, 7109 | | |
| Number of fruit per plant | $F_1$ | KS-404, PK, VRO-54, BO-2 | KS-404, PK, P-7, VRO-35 | KS-404, PK |
| | $F_2$ | KS-404, PK, BO-2, VRO-54 | | |
| Yield per plant | $F_1$ | KS-404, BO-2, PK, VRO-54 | KS-404, VRO-35, PK, P-7 | KS-404, PK |

using t test as suggested by Cochran and Cox (1950) and Wynne *et al.,* (1970).

## Result and Discussion

Analysis of variance for combining ability conducted for all the ten characters in both the generations. The mean sum of square due to GCA & SCA was recorded as highly significant for all the characters in both the generations. The estimates of GCA were more than SCA variance in respect for all the attributes. The presence of high estimates of Variance$^2$ SCA in comparison to corresponding Variance$^2$ SCA was observed for all the characters except yield per plant which showed higher estimates of Variance SCA than SCA based on both the generations.

The mean performance and significant GCA effect revealed that the parents KS-404, 7218, VRO-54 and BO-2 were good general combiner for days to 50% flowering; PK, KS-404 and 7109 for plant height; 7109, VRO-54 and BO-2 for branches per plant, PK for length of fruit; PK, 7109 for width of fruit; KS-404 and PK for number of fruits per plant and KS- 404 and PK for yield per plant in both the generations. Among the different parents PK among all was found to be best general combiner for most of the traits studied.

Significant positive and desirable SCA effect for yield per plant was found in 12 cross combinations in $F_1$ generation and 11 in $F_2$ generations. These were PK x KS-404, PK x P-7, KS-404x BO-2 and 7218 x VRO respectively.

The per say performance SCA and corresponding GCA effects revealed that fallowing crosses passes all sort of possible combination between higher and lower order of GCA effect in $F_2$ generation cross combination PK x KS-404, PK x P-7 and PK x VRO-35 showed high x high GCA status. Cross combination KS-404 x BO-2 showed high x low GCA status while 7218 x VRO-54 showed Low x Low parents of GCA combination. This cross also passes significant desirable SCA effect for more than effect for more than 50% characters under study.

Based $F_2$ generation cross combination PK x KS-404 and PK x showed high x high GCA status cross combination KS-404 x BO-2 and PK x BO-2 showed high x Low pattern while 7218 x VRO-54 show also passes significant under study.

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