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**Research Article**

# Genetic analysis for seed cotton yield and its contributing traits in cotton

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**Abstract**
The nature and magnitude of gene action was estimated for seed cotton yield and its attributing characters in four intra hirsutum crosses of cotton. The magnitude of dominance effect was higher for number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight and seed cotton yield in almost all the characters. Epistasis components additive x additive (i) and dominance x dominance (l) were involved in the expression of number of monopodia per plant and seed cotton yield. Duplicate type of epistasis was observed for most of the character in most of the crosses. The magnitude of heterobeltiosis was high for number of monopodia per plant, number of bolls per plant and seed cotton yield in most of the crosses. Either low or moderate inbreeding depression in both directions was found for most of the traits.

**Key words**
Cotton (*Gossypium hirsutum* L.), Generation mean analysis, Epistasis, Heterosis, Inbreeding depression.

## Introduction

Cotton, which has been reputed as "Queen of the fibre plants" is an important fibre crop in India. Over 90% of cotton grown in the world is *Gossypium hirsutum* L. or upland cotton. The aim of plant breeder is to develop variety with higher yield and hence the knowledge of gene action for seed cotton yield and its component traits is very useful to decide appropriate breeding procedure. Selection for quantitative characters can be effective only when the segregating generations of a cross possess potential genetic variability which is further characterized through an appropriate breeding methodology in order to develop superior genotypes. Hence the present study was undertaken to detect and quantify the genetic behavior of yield and its components. In present study an attempt has been made to estimate gene effects operative for the control of quantitative characters by using generation mean analysis in four crosses of cotton. Additive gene effects provide information related to early generation selection in development of pure line, whereas the knowledge about non-additive effects would be valued in planning an efficient breeding programme.

## Material and Methods

The experimental material comprised of four crosses namely G.Cot 12 × MR 786 (cross 1), G.Cot 16 × GIHV 95 – 145 (cross 2), G.Cot 20 × GJHV 503 (cross 3) and 76 IH 20 × GBHV 148 (cross 4) each having six generations ($P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$). The experiment was laid out in compact family block design with three replications during *kharif*, 2013-14. The crop management practices were followed as per recommendation schedule. The observations were recorded on five competitive plants from $P_1$, $P_2$ and $F_1$, 30 plants from $F_2$ and 15 plants from $BC_1$ and $BC_2$ generations in each replication. The observation were recorded for number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield per plant and ginning %. The scaling test (A, B and C) were calculated for each trait to detect adequacy of additive-dominance model or presence of non-allelic interaction according to Hayman and Mather (1955). The adequacy of additive-dominance model was tested by joint scaling test of Cavalli (1952). The six parameters (m, d, h, i, j and l) were computed according to Hayman (1958). Heterosis and inbreeding depression were also estimated.

## Result and discussion

The analysis of variance for all characters studied in four crosses of cotton is presented in Table 1. The analysis of variance between crosses revealed that the mean square due to crosses were significant for all the crosses. The Bartlett's test for homogeneity of error variance in four crosses indicated that the error variances were homogeneous for all the characters except, ginning %. The analysis of variance among progenies within each family indicated significant differences among six generation means for all the characters studied in all the crosses except number of monopodia per plant in G. Cot 16 x GIHV 95-145 (cross 2) and G. Cot 20 x GJHV 503 (cross 3), number of boll per plant in G. Cot 16 x GIHV 95-145 (cross 2), boll weight in G. Cot 12 x MR 786 (cross 1), ginning % in G. Cot 12 x MR 786 (cross 1) and 76 IH 20 x GBHV 148 (cross 4). The character which failed to show significant variation among the generation in respective crosses were not subjected to further genetic analysis of generation means and analysis of heterosis and inbreeding depression.

Result of scaling test (A, B and C) and joint scaling test ($\chi^2$) revealed the presence of non-allelic interaction for all the traits studied in all crosses except number of monopodia per plant in cross 4. Similar result was reported by Iqbal and Nadeem (2003) for number of sympodial branches per plant. On the other hand, this model was found inadequate for description of variation in generation mean for the remaining crosses based on individual scaling test and joint scaling test indicating presence of epistasis.

Estimates of genetic effect using six parameter model are presented in Table 2. The additive (d) effect was found significant and positive only in cross 4 for boll weight. In contrast, the additive (d) effect was found significant and negative for number of sympodia per plant and ginning percentage in cross 2. The additive component of variation can be exploited by simple pedigree selection. Mass selection for several early generation aimed at the improvement of heterozygous population by modifying the frequencies of desirable gene followed by single plant selection in the resulting material would be cheapest and quickest procedure. However, the presence of non-fixable (h, j and l) component together with duplicate type of epistasis may cause delay in the improvement in this trait through selection in early generations.

The hybrid showing digenic interaction had positive and significant dominance (h) effects for number of monopodia per plant in cross 1, for number of sympodia per plant in cross 3, for number of bolls per plant in cross 3 and cross 4, for boll weight in cross 4 and for seed cotton yield per plant in cross 1, cross 3 and cross 4. The magnitude of dominance (h) component was higher than that of additive (d) effect, suggesting greater importance of dominance effect in the expression of these characters. For the exploitation of dominance effect heterosis procedure might be adopted. The results are in agreement with Haleem *et al*. (2010). As in the present study, the importance of additive and dominance effects was also observed by Srivastava and Kalsy (1990) for number of bolls per plant and boll size. Greater importance of dominance effect as observed in various crosses for above traits are in accordance with the result of Mehetre *et al*. (2003) for plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight and seed cotton yield.

The dominance (h) and dominance x dominance (l) components had opposite sign in all the above cases except number of bolls per plant in cross 3 and seed cotton yield per plant in cross 1 and cross 3, presuming largely duplicate type of epistasis in former and complementary epistasis in exceptional cases. Duplicate type of epistasis was also reported by Mehetre *et al*. (2003) for days to boll bursting, number of sympodia per plant, boll weight and ginning percentage and Haleem *et al*. (2010) reported duplicate epistasis for days to 50% flowering, first fruiting, number of open bolls, seed cotton yield, lint yield, number of fruiting branches and boll weight

The sign of dominance x dominance (l) effect was negative for number of boll, boll weight and seed cotton yield in cross 4 and ginning percentage in cross 2 indicating their reducing effect in the expression of these characters. While negative sign of dominance x dominance (l) component for number of monopodia per plant in cross 1 suggesting the beneficial effect. The sign of dominance x dominance (l) component was positive in the other character indicating their enhancing effect in the expression of that character.

Significant and positive additive x additive (i) type of gene effect was detected for number of monopodia per plant in cross 1 and for number of bolls per plant and seed cotton yield in cross 4. Similarly, the significance of additive x additive (i) component for days to first flower, boll number, seed cotton yield and lint yield was reported by Esmail (2007).

It is clear from the result that epistasis cannot be ignored when establishing a new breeding programme to improve cotton population for economic traits. The inheritance of all the traits studied was controlled by additive and non additive genetic effects, with greater value of dominance gene effect than the additive one in most cases. Among the non-additive effect, the other fixable component, *i.e*., additive x additive (i) type of interaction was also significant and constitutes a major portion of gene effects; therefore it may be possible to exploit it.

The conclusion drawn in the present investigation can be compared with those reported in cotton by other workers. Jagtap (1986) stated that when additive effects are larger than non-additive ones, selection in early generation would be effective, while if the non-additive portions are larger than additive one, the improvement of the character need intensive selection through later generation. The evidence of non-allelic interaction was reported by Refaey and Razek (2013) for number of bolls per plant, seed cotton yield, lint yield and boll weight.

Heterosis and inbreeding depression of four cotton crosses for all the traits studied are presented in Table 3. The heterosis measured over the better parent is of much practical importance. The commercial exploitation of heterosis is considered to be an outstanding application of principles of genetics into the field of plant breeding.

Heterobeltiosis for number of bolls per plant (68.09% in G. Cot 12 x MR 786), seed cotton yield per plant (53.86% in 76 IH 20 x GBHV 148), and boll weight (15.5% in G. Cot 20 x GJHV 503) exhibited high magnitude as compared to rest of the characters. Several research worker have also reported heterosis in desired direction for various character in cotton like, number of monopodia per plant and boll weight (Verma *et al*., 2006) and number of sympodia per plant and ginning percentage (Geddam *et al*., 2011).

In the present study, either low or moderate amount of inbreeding depression (ID) was found in most of the traits. The higher magnitude of inbreeding depression was noted in seed cotton yield per plant in cross 3. It is desirable to have highly significant and positive heterosis with low inbreeding depression for character like seed cotton yield and its component. The highest significant and positive inbreeding depression for seed cotton yield per plant was observed in cross G. Cot 20 x GJHV 503 followed by 76 IH 20 x GBHV 148 and G. Cot 12 X MR 786. Yield attributing characters of cross G. Cot 20 x GJHV 503 also expresses significant and positive inbreeding depression for number of sympodia per plant, number of bolls per plant and boll weight. The significant and positive inbreeding depression was reported by Mehetre *et al*. (2004) for seed cotton yield and contributing characters, Khan *et al*. (2010) for seed cotton yield and Panni *et al*. (2012) for bolls per plant, boll weight, plant height and seed cotton yield.

The coincidence of sign and magnitude of heterosis and inbreeding depression was detected for most of the traits. This is logistic and expected since the expression of heterosis in $F_1$ will be followed by a considerable reduction in $F_2$ due to heterozygosity. The contradiction between heterosis and inbreeding depression for number of sympodia per plant and seed cotton yield in cross 1 could be due to presence of linkage between genes in these plant materials.

**References**

Cavalli, L.L. 1952. An analysis of linkage in quantitative inheritance. In "Quantitative Inheritance". Ed. E.C.R. Reeve and C.H. Waddington, HMSO, London. pp.135-144.

Esmail, R.M. 2007. Genetic analysis of yield and its contributing traits in two intra specific cotton crosses. *J. Appl. Sci. Res*., **3**(12): 2075-2080.

Geddam, S., Khadi, B.M., Mogali, S., Patil, R.S., Katageri, I.S., Nadaf, H.L. and Patil, B.C. 2011. Study of heterosis in genetic male sterility based diploid cotton hybrids for yield, yield component and fibre quality characters. *Karnataka J. Agric. Sci*., **24**(2): 118-124.

Haleem, S.H.M.A., Metwali, E.M.R. and Felail, A.M.M. 2010. Genetic analysis of yield and its component in some Egyptian cotton (*Gossypium barbadense* L.) varieties. *World J. Agric. Sci*., **6**(5): 615-621.

Hayman, B.I. 1958. The separation of epistatic from additive and dominance variation in generation means. *Heredity*, **12**: 371-390.

Hayman, B.I. and Mather, K. 1955. The description of genetic interactions in continuous variation. *Biometrics*, **11**: 69-82.

Iqbal, M.Z. and Nadeem, M.A. 2003. Generation mean analysis for seed cotton yield and number of sympodial branches per plant in cotton (*Gossypium hirsutum* L.). *Asian J. Pl. Sci*., **2**(4): 395-399.

Jagtap, D.R. 1986.Combining ability in upland cotton. *Indian J. Agric. Sci*., **56**(12): 833-840.

Khan, N.U., Basal and Hassan, G. 2010. Cotton seed oil and yield assessment via economic heterosis and heritability in intra specific cotton population. *African J. Biotech*., **9**(44): 7418-7428.

Mehetre, S.S., Rajput, H.J., Mokate, A.S. and Shinde, G.C. 2004. Inbreeding depression for seed cotton yield of intraspecific hybrids. *Adv. Plant Sci.,***17**(1): 317-321.

Mehetre, S.S., Shinde, S.K. and Shinde, G.C. 2003.Genetic analysis for seed cotton yield and its components in cotton. *J. Maharashtra Agric. Uni*., **28**(1): 46-50.

Panni, M.K., Khan, N.U., Sundas, F.B. and Maryam, B. 2012. Heterotic studies and inbreeding depression in $F_2$ populations of upland cotton. *Pak. J. Bot*., **44**(3): 1013-1020

Refaey, R. and Razek, U. 2013. Generation mean analysis for yield, its components and quality characteristics in four crosses of Egyptian cotton (Gossypium barbadense L.). *Asian J. Crop Sci*., **5**(2): 153-166.

Srivastava, M. and Kalsy, H.S. 1990. Generation mean analysis in an intervarietal cross of upland cotton (*Gossypium hirsutum* L.). *J. Cotton Res. Dev.,* **4**:33-36.

Verma, S.K., Tuteja, O.P., Kumar, S., Ramprakash, R.N. and Monga, D. 2006. Heterosis for seed cotton yield and its qualitative characters in cotton (*G. hirsutum* L.). *J. Cotton. Res. Dev*., **20**(1): 14-17.

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**Table 1. Analysis of variance for crosses and generations for different characters in cotton**

| Source of variation | d.f. | Number of monopodia per plant | Number of sympodia per plant | Number of boll per plant | Boll weight (g) | Seed cotton yield per plant (g) | Ginning % |
|---|---|---|---|---|---|---|---|
| Analysis of variance between crosses | | | | | | | |
| Replication | 2 | 0.0 | 0.09 | 3.89 | 0.01 | 1.67 | 0.28 |
| Crosses | 3 | 3.20** | 2.22** | 174.39** | 0.92** | 902.23** | 5.15** |
| Error | 6 | 0.02 | 0.27 | 3.58 | 0.02 | 53.45 | 0.38 |
| $\chi^2$ test | 3 | NS | NS | NS | NS | NS | S |
| Analysis of variance between generations within cross | | | | | | | |
| G. Cot 12 x MR 786 | | | | | | | |
| Replication | 2 | 0.09 | 1.82 | 18.16 | 0.03 | 250.09 | 2.17 |
| Generations | 5 | 9.44** | 5.48** | 182.26** | 0.06 | 2195.16** | 16.72 |
| Error | 10 | 0.10 | 0.58 | 8.83 | 0.02 | 94.45 | 5.89 |
| G. Cot 16 x GIHV 95-145 | | | | | | | |
| Replication | 2 | 0.05 | 0.32 | 9.64 | 0.03 | 149.31 | 0.90 |
| Generations | 5 | 0.71 | 13.71** | 19.89 | 0.16** | 363.86* | 14.51* |
| Error | 10 | 0.29 | 0.55 | 12.42 | 0.02 | 96.48 | 0.36 |
| G. Cot 20 x GJHV 503 | | | | | | | |
| Replication | 2 | 0.22 | 1.59 | 21.29 | 0.22** | 234.42 | 0.15 |
| Generations | 5 | 0.18 | 8.61** | 150.18* | 0.20** | 3211.39** | 3.16** |
| Error | 10 | 0.19 | 0.72 | 31.38 | 0.02 | 154.58 | 0.25 |
| 76 IH 20 x GBHV 148 | | | | | | | |
| Replication | 2 | 0.11 | 1.63* | 38.72 | 0.04 | 338.31 | 5.22 |
| Generations | 5 | 0.99* | 2.73** | 69.67* | 0.09* | 903.55* | 12.87 |
| Error | 10 | 0.22 | 0.28 | 17.10 | 0.02 | 168.98 | 7.16 |

**Table 2 .Estimation of Scaling test, joint scaling test and genetic parameters for different characters of four crosses in cotton**

| Character | Cross | Scaling test | | | | Gene effects | | | | | | Type of epistasis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | $\chi^2$ | m | d | h | i | j | l | |
| Number of monopodia | 1 | -2.18** | 3.02** | -2.62** | ** | 2.24** | 0.13 | 2.87** | 3.47** | -2.60** | -4.31** | D |
| | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 4 | -0.04 | 0.87 | -0.02 | NS | 1.37** | -0.56* | 2.21* | -- | -- | -- | -- |
| Number of sympodia | 1 | -4.22** | -2.42* | -3.18 | ** | 13.92** | 0.73 | -3.70 | -3.47 | -0.90 | 10.11** | D |
| | 2 | -3.49** | -5.04** | -8.98** | ** | 14.12** | -1.89* | 1.71 | 0.44 | 0.78 | 8.09* | C |
| | 3 | 1.20 | -4.29** | -6.96** | ** | 12.18** | 0.51 | 5.90** | 3.87 | 2.74** | -0.78 | D |
| | 4 | -4.16** | -0.82 | -7.33** | ** | 13.67** | -1.00 | 2.96 | 2.36 | -1.67* | 2.62 | C |
| Number of bolls | 1 | -1.47 | 8.91* | 25.00* | ** | 34.20** | -2.29 | 0.28 | -17.56 | -5.19 | 10.11 | C |
| | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 3 | -20.56** | -19.69** | -49.13** | ** | 37.73** | -1.07 | 23.39* | 8.89 | -0.43 | 31.36 | C |
| | 4 | 2.20 | 5.46 | -9.89* | * | 24.47** | -3.42 | 28.90** | 17. 73** | -1.72 | -25.58* | D |
| Boll weight (g) | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 2 | -0.91** | -0.41* | -1.36** | ** | 2.72** | -0.05 | 0.36 | 0.04 | -0.25* | 1.28* | C |
| | 3 | -0.34 | -0.45* | -0.20 | NS | 2.95** | -0.12 | 0.01 | -0.60 | 0.05 | 1.39* | C |
| | 4 | 0.61* | 0.05 | -0.04 | * | 3.06** | 0.32* | 0.89* | 0.69 | 0.28* | -1.35* | D |
| Seed cotton yield (g) | 1 | -31.83* | 16.82 | -19.72 | NS | 111.23* | -6.39 | 70.93* | 4.72 | -24.33* | 10.29 | C |
| | 2 | -26.94* | -18.10 | -21.27 | NS | 94.30** | 8.40 | -8.80 | -23.77 | -4.42 | 68.82 | D |
| | 3 | -78.83** | -105.60** | 196.98** | ** | 101.86** | 8.43 | 89. 15** | 17.54 | 15.89 | 161.60** | C |
| | 4 | 18.59 | 21.67 | -43.86** | ** | 73.11** | -4.70 | 123.62** | 84.11** | -1.54 | -124.37** | D |
| Ginning % | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 2 | -0.09 | 6.72** | 7.62** | ** | 34.92** | -2.18** | 2.93 | -0.99 | -3.40** | -5.64* | D |
| | 3 | -2.20** | -1.14 | -1.50 | ** | 33.90** | 0.84 | -2.28 | -1.84 | -0.53 | 5.18* | D |
| | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**Table 3. Heterosis and inbreeding depression in four crosses of cotton for different characters**

| Crosses | Heterosis (%) over BP | ID (%) | Heterosis (%) over BP | ID (%) |
|---|---|---|---|---|
| | Number of monopodia per plant | | Number of sympodia per plant | |
| G.Cot 12 x MR 786 (Cross 1) | 457.14** | 13.68 | -11.34** | 4.64 |
| G.Cot 16 x GIHV 95-145 (Cross 2) | --- | --- | -7.61** | 16.93** |
| G.Cot 20 x GJHV 503 (Cross 3) | --- | --- | -1.32 | 18.45** |
| 76 IH 20 x GBHV 148 (Cross 4) | 244.44** | 33.33** | -0.42 | 13.50 |
| | Number of boll per plant | | Boll weight (g) | |
| G.Cot 12 x MR 786 (Cross 1) | 68.09** | 7.23 | --- | --- |
| G.Cot 16 x GIHV 95-145 (Cross 2) | --- | --- | 4.09 | 15.56** |
| G.Cot 20 x GJHV 503 (Cross 3) | 31.95** | 34.11** | 15.5** | 10.75** |
| 76 IH 20 x GBHV 148 (Cross 4) | 40.57** | 24.56** | 5.31 | 3.43 |
| | Seed cotton yield per plant (g) | | Ginning % | |
| G.Cot 12 x MR 786 (Cross 1) | 47.67** | 25.343** | --- | --- |
| G.Cot 16 x GIHV 95-145 (Cross 2) | 2.06 | 11.96** | 8.35** | 0.15 |
| G.Cot 20 x GJHV 503 (Cross 3) | 52.27** | 45.50** | -5.06** | 0.46 |
| 76 IH 20 x GBHV 148 (Cross 4) | 53.86** | 29.59** | --- | --- |