Genetic Variability Studies in Segregating Generation of *Gossypium barbadense* Lines in Cotton

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Abstract

The research work comprising of genetic variability, heritability and genetic advance study for seed cotton yield and its components in segregating F5 generation of cotton (*Gossypium Barbadense* L.) was carried out during 2011 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, India. ‘F’ test indicated highly significant variation among the barbadense lines for all the characters except number of bolls per plant. Genetic potential of segregating F5 generation for different parameters revealed plant height (65.33 cm to 100.33 cm), number of bolls per plant (22.5 to 39.33), mean boll weight (1.67 g to 3.23 g) and seed cotton yield (441.81 kg/ha to 2175.70 kg/ha). The broad sense heritability for plant height was moderate (0.125), genetic advance was low (3.01) and genetic advance as per cent of mean was about 3.68%. For number of bolls per plant, the phenotypic variance was 31.38, genotypic variance was 4.53 and moderate broad sense heritability (0.14). The GCV and PCV values for number of bolls per plant were low to moderate. The phenotypic variance and genotypic variance for mean boll weight were 0.19, 0.05, respectively. The broad sense heritability for boll weight was 0.26, while the genetic advance or gain was 0.24 under 5%. The GCV and PCV values of mean boll weight were low to moderate in all population. For seed cotton yield, heritability was high (0.72) and genetic advance under 5% selection intensity was 680.51. The phenotypic coefficient of variation (38.97) and genotypic coefficient of variation (33.05) were high.

Keywords

Segregating generation; Genetic variability; *Gossypium barbadense* lines

Introduction

Cotton is one of the most important commercial crops which has occupied importance from historic days. Cotton is a crop of prosperity having a profound influence on men, and matter. It is an industrial commodity of worldwide importance. It occupies the place of pride in Indian agriculture and economy by earning valuable foreign exchange. It is primarily used in textile industries providing highest employment during production, processing, spinning, weaving and marketing throughout the world.

Creating genetic variability is pre-requisite for plant breeders to exercise selection, as a part of continuous variation is due to heredity. The phenotypic and genotypic coefficients of variation were estimated using genotypic and phenotypic variances respectively. The coefficient of variation indicates only the extent of variability existing for various traits, but does not give any information about the heritable portion of it. Therefore, heritability accompanied by estimates of genetic advance and genetic advance as per cent mean were also estimated.

Heritability in itself provides no indication about the genetic progress that would result from selection. However, at a fixed selection pressure, the amount of advance varies with magnitude of heritability. Genetic advance in a population cannot be predicted from heritability alone, the genetic gain for specific selection pressure has to be worked out. Many investigations had been made on heritability for seed cotton yield and other traits. Basbag and Gencer (2004) indicated that seed cotton weight per boll and 100 seed weight had high heritability; bolls per plant had low heritability, while other characters had moderate heritability. The characters with high heritability suggested some possibilities in obtaining required genotypes by selection in early segregating generations (F2, F3); while selection for improvement was delayed due to low heritability for some characteristics. Basal and Turgut (2005) mentioned that moderate heritability
estimates were observed for earliness ratio (0.53), fiber strength (0.50) seed cotton weight per boll (0.42) and lint % (0.40), however, bolls per plant and seed cotton weight per plant showed low heritability estimates, 0.33 and 0.22, respectively.

Khurram et al (2009) evaluated thirty five G.barbadense genotypes for variability parameters. It was observed that the traits, number of monopodia per plant, seed cotton yield and number of bolls per plant showed high PCV and GCV indicating substantial variability for these characters.

Dhamayanathi et al (2010) studied twenty five G.barbadense L. genotypes to obtain information on genetic variability, heritability and genetic advance for seed cotton yield and its yield attributes. Significant differences were observed for characters among genotypes. High genetic differences were recorded for sympodia, bolls per plant, Seed cotton yield and lint index indicating ample scope for genetic improvement of these characters through selection. Results also revealed high heritability coupled with high genetic advance for yield and most of the yield components.

The primary objective of this study was to determine levels of genetic variability, heritability and genetic advance in G. barbadense lines. Such information can profitably be exploited in formulating efficient selection programme for synthesis and development of new cotton genotypes with improved yield and yield contributing traits.

Materials and Methods
To create recombinational variability for combining ability, the elite barbadense lines DB 533 and DB 534 were crossed during 2007-2008. During two seasons 2008-2009 and 2009-2010 these barbadense crosses were advanced to F2 and F3 generations, respectively. The F3 lines were evaluated for productivity and fibre quality parameters realizing the emphasis laid on developing ELS (Extra Long Stable) cotton hybrids out of 171 F3 lines, only 53 F3 lines with acceptable fibre strength were utilized in this study. The crossing programme was taken up during 2010. The 28 out of 53 F4 barbadense lines were crossed with four common hirsutum testers to obtain derived F1 crosses seeds. The barbadense population of F4 lines was selfed and material was advanced to F5 generation during the same year.

The entire experimental material was planted on a medium black soil at College of Agriculture, Dharwad under irrigated condition. All the 53 F5 (included Suvin variety as check) lines, four hirsutum testers and derived F1 crosses along with the straight crosses (Bench Mark Crosses (BMC)) and ruling commercial checks (MRC 6918 Bt check and DCH 32 non Bt check) were sown during kharif 2011 in a Randomized Block Design with two replications and a spacing of 90 cm between rows and 60 cm between the plants within a row. Recommended fertilizer doses were applied and other cultural practices were carried out at regular interval. Plant protection measures were taken at appropriate time to control pests and diseases. To estimate fibre quality parameters, one sample was taken from pool of kapas derived from all the replications. Hence, these characters were not subjected to RBD analysis.

Statistical Analysis
The mean and variances were analyzed based on the formula given by Singh and Chaudhary (1977). The genotypic and phenotypic coefficient of variation was computed according to Burton and Devane (1953). The extent of genetic advance to be expected from selecting five per cent of the superior progeny was calculated using the following formula (Robinson et al., 1955).

Heritability measures the relative amount of the heritable portion of variability and provides useful information for effective selection. The ration of the total genetic variation to the total phenotypic or observed variation is termed as co-efficient of heritability in broad sense where as the ratio of the additive genetic variation to the total observed variation is called the co-efficient of heritability in the narrow sense.

Phenotypic and genotypic variances, their coefficients, heritability and genetic advance were calculated as follows:

Genotypic variance \( (\sigma^2_g) = \frac{M_2 - M_1}{r} = \frac{(\sigma^2_e - r \sigma^2_g)}{r} - \sigma^2_g \)

Phenotypic variance \( (\sigma^2_p) = \frac{M_2}{r} = \frac{(\sigma^2_e + r \sigma^2_g)}{r} \)

Heritability (H %) = \( \frac{\sigma^2_g}{\sigma^2_p} \times 100 \) or \( = \frac{M_2 - M_1}{M_1} \times 100 \)
**Results and Discussion**

**Analysis of variance (RBD)**

The preliminary RBD analysis was carried out for fourteen characters under study for 53 barbadense lines (included Suvin as check). Mean sum of squares for fourteen characters are presented in Table 1. ‘F’ test indicated highly significant variation among the barbadense lines for all the characters except number of bolls per plant. These results are in conformity with the studies of Vande and Thombre (1983), Vaman et al (1985), Mirkhmedov et al (1987), Mehla et al (1988), Simongulyan and Kim (1990), Munasov et al. (1990), Tagiev (1991), Virk et al (1991), Dever and Gannaway (1992) and Akumurdov and Chapau (1992). These authors also observed substantial amount of variability for seed cotton yield among F2, F4 and F5 generations of different cotton crosses.

| Source            | d.f. | Mean sum of squares |
|-------------------|------|---------------------|
|                   |      | Seed cotton yield (kg/ha) | Plant height (cm) | No. of bolls | Mean boll weight (g) |
|                   | 1    | 109528.60**         | 241.45**         | 99.37**      | 1.25**              |
| Replications      | 2    |                     |                  |              |                    |
|                   | 52   | 362766.12**         | 154.16**         | 26.85        | 0.24**              |
| Genotypes         | 52   | 59269.06            | 119.91           | 35.90        | 0.14                |
| Error             | 52   | 243.45              | 10.95            | 5.99         | 0.38                |
| S.E d             |      |                     |                  |              |                    |
| CD@ 5%            | 342.16 | 15.39               | 8.42             | 0.53         |                    |
| C.D. 1%           | 455.91 | 20.51               | 11.22            | 0.70         |                    |

Note: * Significant at P=0.05; ** Significant at P=0.01

**Genetic variability studies in segregating F5 generation population of G.barbadense**

The data obtained from individual plant observations for all characters of F5 population was utilized for estimating different variability parameters, broad sense heritability and genetic advance. The results pertaining to these aspects are presented in Table 2.

**Seed cotton yield (kg/ha)**

A F5 segregating population exhibited wide range (441.81 kg/ha to 2175.7 kg/ha) for seed cotton yield. The mean for this trait was 1178.82. The phenotypic variance and genotypic variances were 211017.6 and 151748.5, respectively. There were no much differences between phenotypic co-efficient of variation and genotypic co-efficient of variation observed. Consequently, estimate of h²bs for seed cotton yield per plant was high (0.72) and genetic advance under 5% selection intensity was 680.51. Although range can provide a preliminary idea about the variability but coefficient of variation is reliable as it is independent of unit of measurement. The extent of variability as measured by PCV and GCV also gives information regarding the relative amount of variation in different populations. The phenotypic
Table 2 Variability parameters in segregating F5 population of 53 *G. barbadense* cotton

| Genetic parameters | Seed cotton yield (kg/ha) | Plant height (cm) | No of bolls | Mean boll weight (g) |
|--------------------|----------------------------|-------------------|-------------|----------------------|
| Grand mean         | 1178.82                    | 81.92             | 29.93       | 2.43                 |
| Range              | 441.81–2175.7              | 65.33–100.33      | 22.5–39.33  | 1.67–3.23            |
| $\sigma^2_g$       | 151748.5                   | 17.125            | 4.526       | 0.051                |
| GCV                | 33.046                     | 5.051             | 7.108       | 9.257                |
| $\sigma^2_p$       | 211017.6                   | 137.034           | 31.376      | 0.192                |
| PCV                | 38.968                     | 14.289            | 18.715      | 18.016               |
| $h^2$ (Broad sense) | 0.719                      | 0.125             | 0.144       | 0.264                |
| GA                 | 680.507                    | 3.014             | 1.664       | 0.238                |
| GAM                | 57.728                     | 3.678             | 5.561       | 9.799                |

Note: $\sigma^2_g$: Genotypic variance; $\sigma^2_p$: Phenotypic variance; $h^2$ bs: Heritability in broad sense; PCV: Phenotypic co-efficient of variation; GCV: Genotypic co-efficient of variation; GA: Genetic advance; GAM: Genetic advance as percent of mean

Coefficient of variation (38.97) and genotypic coefficient of variation (33.05) were high. Similar results were reported by Krishnarao and Mary (1990), Neelam and Patdukhe (2002), Kaushik and Kapoor (2006), Kalet al (2007), Saktli et al (2007).

**Plant height (cm)**

Plant height exhibited the mean of 81.92 and range from 65.33 cm to 100.33 cm. The phenotypic variance (137.034) and genotypic variance (17.125) as well as phenotypic co-efficient of variation (14.289) and genotypic co-efficient of variation (5.051) was observed. Plant height had low to moderate GCV and PCV values for all the populations. These results are in accordance with results of Krishnarao and Mary (1990), Deshpande and Baig (2003), Leela Pratap (2006), Kaushik and Kapoor (2006), Kale et al (2007), and Eswar (2008). On the other hand Neelam and Patdukhe (2002) noticed high estimates of GCV and PCV for plant height. Low to moderate GCV and PCV values for plant height indicate the influence of the environment on this trait and also limited scope of selection for improvement of this character. The $h^2$bs was moderate (0.125), GA was low (3.01) and GAM was about 3.68%. Plant height is a very important trait and has close association with bolls per plant (if no lodging occurred) and has ultimate positive effect on seed cotton yield.

**Number of bolls per plant**

Number of bolls exhibited the mean of 29.93 and ranges of 22.5 to 39.33. The phenotypic variance (31.38), genotypic variance (4.53) and moderate $h^2$bs (0.14). The GCV and PCV values for number of bolls per plant were low to moderate all the four population (7.11) and (18.72) respectively. Concurrent results to this effect was also reported by Krishnarao and Mary (1990), Laxman and Ganesh (2003), Gururajan and Sundar (2004), Neelima et al (2005), Tuteja et al (2006 b), Kale et al (2007), Saktli et al (2007), Neelima et al (2008). The genetic advance was 1.66 and genetic advance as per cent of mean (5.56) was low.

**Mean boll weight (g)**

The range observed for mean boll weight was 1.67 g to 3.23 g with the population mean boll weight 2.43. The phenotypic variance and genotypic variance for boll weight were 0.19, 0.05 respectively. The $h^2$bs for boll weight was 0.26, while the genetic advance or gain was 0.24 under 5%. Boll weight is second major yield component after number of bolls per plant and have a greater contribution in enhancement of seed cotton yield. The GCV and PCV values of mean boll weight were low to moderate in all population. Concurrent results to this effect was also reported by Krishnarao and Mary (1990), Laxman and Ganesh (2003), Gururajan and Sundar (2004), Neelima et al (2005), Tuteja et al (2006 b), Kale et al (2007), Saktli et al (2007), Neelima et al (2008). The genetic advance was 0.24 and genetic advance as per cent of mean (9.80) was low.

It is not the magnitude of variation but the extent of heritable variation, which matters most for achieving gains in selection programme. The coefficient of variation indicates only the extent of variation for a character and does not discriminate the variability into heritable and non-heritable portion. The heritability worked out in broad sense would suggest how far the variation is heritable and selection is effective.
Though the heritability estimates are the true indicators of genetic potentiality of the genotypes which can be used as a tool for selection, changes in the values of the heritability due to fluctuations of the environmental factors detract for total dependence on such estimates. However, heritability estimates when considered in conjunction with the predicted genetic gain form a reliable tool for selection. They indicate the expected genetic advance of a character in response to the certain selection pressure imposed on them.

References

Akumuradov S., and Chapau A., 1992, Response of varieties to ir radiation, Gossypium hirsutum L., Madras Agric. J., 94(7-12) : 156-161

Karthik S., and Kapoor C.J., 2006, Genetic variability and association study for yield and its component traits in upland cotton (Gossypium hirsutum L.), J. Cotton Res. Dev., 20(2): 185-190

Kushwaha Tausif and Patil, S.S., 2009, Genetic studies on improving productivity and quality traits involving interspecific (H x B) crosses and barbadense genotypes. Karnataka J. Agric. Sci., 22(5)

Krishnarao K.V., and Mary T.N., 1990, Variability correlation and path analysis of yield and fibre traits in upland cotton, Madras Agric. J., 77(3&4): 146-151

Laxman S., and Ganesh M., 2003, Combining ability for yield components and fibre characters in cotton (Gossypium hirsutum L.), J. Res., Acharya N. G. Ranga Agric. Univ., Rajendranagar, Hyderabad

Mehta, A. S., Mor, B. R. and Nadu, M. R., 1988, Genetic analysis of earliness characters in upland cotton (G hirsutum L.). Crop Improv., 15: 156-159

Mirakhamedov S., Stakov V., and Rakhimov M., 1987, Transgressive selection for fibre length, Khlopkovodstvo, 7: 30-33

Munasov K., Alikho Dzhaeva S.S. and Lemeshev N. R., 1990, Variability and heritability of fibre length F1-F2 hybrids and their parents. Refretivinya Zhurnal., 9: 3378

Neelima S., Chengareddy, and Narisireddy A., 2005, Association and path analysis in American cotton (Gossypium hirsutum L.). J. Indian Soc. Cotton Improv., 27(3): 148-152

Neelima S., Chenga R.V., and Narisreddy A., 2008, Genetic parameters of yield and fibre quality traits in American cotton (Gossypium hirsutum L.). Indian J. Agric. Res., 42(1): 67-70

Neelima S., Chengareddy, and Narisi Reddy A., 2005, Association and path analysis in American cotton (Gossypium hirsutum L.). J. Indian Soc. Cotton Improv., 30: 53-58

Robinson, H. F., Comstock, R. E. and Harvey, P., 1966, Quantitative genetics in relation to breeding on the centennial of Mendelism. Indian J. Genet., 26: 171-177

Sakti A.R., Kumar M. and Ravikessavan R., 2007, Variability and association analysis using morphological and quality traits in cotton (Gossypium hirsutum). J. Cotton Res. Dev., 21(2): 148-152

Simongulyan N.G. and Kim V.L., 1990, Variation in quantitative characters I an irradiated cotton population, Genetika., 26: 1815-1821

Sivasubramanian S., and Menon M., 1973, Heterosis and inbreeding depression in rice. Madras Agric. J., 60:1339

Tagiev A.A., 1991, Variation in cotton induced by chemical mutagens. In: Khimicheskii Mutagene Seleceletsii., pp. 214-217

Tuteja O.P., Mahender S., Verma S.K. and Khadi B.M., 2006b, Introgressed lines as source for improvement of upland cotton (Gossypium hirsutum L.) genotypes for yield and fibre quality traits, Indian J. Genet. Plant Breed., 66(3): 251-252

Vaman B.M., Nadarajan N., and Pater S.D., 1985, A note on the evaluation of genetic stock of Gossypium barbadense L., Madras Agric. J., 72: 116-117

Vande N.N. and Thombre M.V., 1983, Variability studies in Egyptian cotton. Cotton Improv., 13: 1-3

Virk P.S., Kalsy H.S., Virk D.S. and Poomi H.S., 1991, An assessment of the breeding potential of a Gossypium hirsutum L., Crop Improv., 18: 7-13