

Genetic Variability, Coefficient of Variance, Heritability and Genetic Advance in American Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

The present investigation was carried out to study the genetic variability, coefficient of variance, heritability and genetic advance in American cotton. The material was evaluated in a Randomized Block Design (RBD) with three replications during kharif 2019. In this experiment analysis of variance indicated that significant variation present among the accessions of the upland cotton for all the traits under study. The highest genotypic (GCV) and phenotypic coefficient of variation (PCV) were exhibited by the number of monopodia per plant, number of bolls per plant and boll weight. High heritability with high genetic advance was observed in the boll weight, number of monopodia per plant, number of bolls per plant, seed cotton yield per plant, number of sympodia per plant and lint index. The combination of the high heritability and high genetic advance provide the clear image of the trait in the selection process.

Keywords: Genetic advance, Heritability, GCV, PCV, Coefficient of variability.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) $2n = 4x = 26$), is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. It provides the basic raw material (cotton fibre) to cotton textile industry. Cotton in India provides direct livelihood to 6 million farmers and about 40-50 million people are employed in cotton trade and its processing. It is an important fibre and oilseed crop of nearly

80 countries with India, China, United States, Pakistan and Brazil being five of the largest producers of cotton.

Cotton, semi-xerophytes, is grown in tropical and sub-tropical conditions. A minimum temperature of 15°C is required for better germination at field conditions. The optimum temperature for vegetative growth is 21-27°C and it can tolerate temperature to the extent of 43°C but temperature below 21°C is detrimental to the crop.

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Warm days of cool nights with large diurnal variations during the period of fruiting are conducive to good boll and fibre development. Cotton is grown on a variety of soils ranging from well drained deep alluvial soils in the north to black clayey soils of varying depth in central region and in black and mixed black and red soils in south zone. Cotton is semi-tolerant to salinity and sensitive to water logging and thus prefers well drained soils.

There are four cultivated species of cotton viz., *Gossypium arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense*. The first two species are diploid ($2n=26$) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid ($2n=52$) and are also known as New world cottons. *G. hirsutum* is also known as American cotton or upland cotton and *G. barbadense* as Egyptian cotton or Sea Island cotton or Peruvian cotton or Tanguish cotton or Quality cotton.

MATERIALS AND METHODS

Plant material

The present investigation carried out at Cotton Research Station, Junagadh Agricultural University, Junagadh during *kharif* 2019. The experimental material consisted of fifty diverse genotype of cotton (*Gossypium hirsutum* L.). The pure seeds of these genotypes were obtained from the Cotton Research Station, Junagadh Agricultural University, Junagadh.

Field trial

Fifty genotypes of cotton were sown on 26th June, 2019 in a Randomized Block Design (RBD) with three replications at Cotton Research Station, Junagadh Agricultural University, Junagadh. Each line was sown in a single row plot of 6.3 × 1.2 m length with each row spaced 120 cm apart and plant to plant distance within row was 45 cm. The genotypes were randomly allotted to the plots in each replication. Fertilizers at recommended doses were applied and other cultural practices were carried out at regular intervals during the course of experimentation. Application of N

was split into two equal instalments i.e., basal and top dressing. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. The observations were recorded on five randomly selected plants from each genotype in each replication for days to flowering, days to boll opening, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed cotton yield per plant (g), ginning percentage (%), seed index (g), lint index (g) and oil content (%).

Statistical analysis

The analysis of variance for randomized block design (RBD) was done for each character as per Panse and Sukhatme (1985). The genotypic and phenotypic coefficient variations were calculated as per the formula given by Burton (1952). Heritability and expected genetic advance as per cent of mean (GA as % of mean) was calculated for each character by adopting the procedure as suggested by Allard (1960).

RESULTS AND DISCUSSION

Variability is the prerequisite for organization of breeding programmes and its estimates helps in realization of response to selection as the progress in breeding depends upon its amount, nature and magnitude of variability (Singh & Narayanan, 2013).

Analysis of variance

The analysis of variance revealed that mean square due to genotypes was highly significant for all the characters indicating the presence of sufficient amount of variability in the experimental used (Table-1). Similar results were obtained by Dhivya et al. 2014; Dahiphale et al. 2015; Chaudhari, 2017 and Lokeshkumar and Patil, 2018.

Genotypic and phenotypic coefficients of variation

Close relationship between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was observed for all the characters (Figure-I & Table-2). The magnitude of PCV was slightly greater than

GCV revealed a very little influence of environmental variation for their expression. This indicated that phenotypic variability may be considered as reliable measure of genotypic variability. Similar results have also been reported by Ashokkumar and Ravikesavan, 2010; Katageri et al. 2015; Padmavathi et al. 2015 and Shabana et al. 2017.

The high GCV and PCV were observed for number of monopodia per plant followed by number of bolls per plant and boll weight. The high genotypic coefficient of variation indicated the presence of wide variation for the characters under study to allow selection for individual traits. High value of GCV and PCV for number of monopodia per plant was also reported by Dahiphale et al. 2015; Lokeshkumar and Patil, 2018; and Nawaz et al. 2019. High estimates of GCV and PCV for number of bolls per plant were reported by Dinakaran et al. 2012 and Nawaz et al. 2019. High GCV and PCV was reported in cotton for boll weight by Khokhar et al. 2017 and Shruti et al. 2019.

In the present study moderate value for phenotypic and genotypic coefficient of variation was observed for seed cotton yield per plant and in addition to this, three characters *viz.*, number of sympodia per plant, plant height and lint index also exhibited moderate value for phenotypic coefficient of variation only. This finding is in accordance with Reddy and Pradeep, 2001; Dhivya et al. 2014; Vinodhana et al. 2013; Latif et al. 2015; Lokeshkumar and Patil, 2018 and Nawaz et al. 2019.

Days to flowering, days to boll opening, ginning percentage, seed index and oil content exhibited low magnitude of both genotypic and phenotypic coefficient of variation. This finding is in accordance with Chaudhari, 2017 for days to flowering; Reddy and Pradeep, 2001 for lint index; Vinodhana et al. 2013 and Sunayana et al. 2017 for ginning percentage; Muhammad et al. 2015 for seed index and Khan et al. 2010 for oil content.

Heritability

In present study, very high heritability in broad sense estimates were observed for boll weight

(97.27 %), number of monopodia per plant (97.22 %), days to flowering (94.80 %), oil content (92.79 %), number of bolls per plant (92.52%), days to boll opening (91.90 %), ginning percentage (90.90 %), seed cotton yield per plant (85.42 %) and number of sympodia per plant (85.04 %). High estimate of heritability were observed for lint index (79.29 %), plant height (76.80 %) and seed index (72.97 %). Very high heritability estimates for boll weight by Khokhar et al. 2017 and Shruti et al. 2019; for number of monopodia per plant by Dahiphale et al. 2015; Lokeshkumar and Patil, 2018; and Nawaz et al. 2019; for days to flowering by Chaudhari, 2017; for oil content by Khan et al. 2010 and Chaudhari, 2017; for number of bolls per plant by Dinakaran et al. 2013 and Nawaz et al. 2019; for ginning percentage by Vinodhana et al. 2013 and Sunayana et al. 2017; for seed cotton yield per plant by Vinodhana et al. 2013 and Nawaz et al. 2019; for number of sympodia per plant by Dhivya et al. 2014 and Latif et al. 2015; for lint index by Reddy and Pradeep, 2001 and Vinodhana et al. 2013; for plant height by Dhivya et al. 2014 and Lokeshkumar and Patil, 2018; and for seed index by Muhammad et al. 2015 and Sunayana et al. 2017.

Genetic advance expressed as per cent of mean

The genetic advance expressed as per cent of mean was highest for number of monopodia per plant (78.61 %), number of bolls per plant (48.22 %), boll weight (42.99 %), seed cotton yield per plant (30.29 %), number of sympodia per plant (26.83 %) and lint index (20.88 %). The highest values of genetic advance expressed as per cent of mean have been reported in cotton for number of monopodia per plant by Dahiphale et al. 2015; Lokeshkumar and Patil, 2018; and Nawaz et al. 2019; for boll weight by Khokhar et al. 2017 and Shruti et al. 2019; for seed cotton yield per plant by Vinodhana et al. 2013 and Nawaz et al. 2019; for number of sympodia per plant by Dhivya et al. 2014 and Latif et al. 2015 and for lint index by Reddy and Pradeep, 2001 and Vinodhana et al. 2013.

The moderate estimate of genetic advance as per cent of mean was observed for the plant height (19.56 %), fibre strength (15.40 %), days to flowering (15.00 %), seed index (34.28 %), days to boll opening (11.47 %) and ginning percentage (10.45 %). The similar result were observed for days to flowering, by Chaudhari, 2017; for plant height by Dhivya et al. 2014; seed index by Muhammad et al. 2015 and for ginning percentage by Vinodhana et al. 2013 and Sunayana et al. 2017. The lower genetic advance as per cent of mean was observed for the oil content (2.42 %). The similar finding was also obtained by Khan et al. 2010 and Chaudhari, 2017.

High heritability coupled with high genetic advance expressed as per cent of mean was more valuable in predicting the effect of selection (Figure II). In the present investigation, the estimates of high heritability coupled with high genetic advance expressed as per cent of mean was observed for boll weight, number of monopodia per plant, number of bolls per plant, seed cotton yield per plant, number of sympodia per plant and

lint index. These characters may have contributed to preponderance of additive gene action and selection pressure could profitably be applied on these characters for their rationale improvement (Panse, 1957).

The high heritability associated with moderate genetic advance expressed as per cent of mean was observed for days to flowering, days to boll opening, ginning percentage, plant height and seed index. The high heritability associated with low genetic advance as per cent of mean was found for oil content. It may be inferred that these traits were regulated by non-additive gene action and presence of high genotype \times environment interaction. The heritability is being exhibited due to favourable influence of environmental factors rather than the genotypes alone and simple selection will not be rewarding. As such, progeny testing is to be practiced for amelioration of these traits. However, they can be improved either by development of hybrid varieties if commercially feasible or by utilization of transgressive segregants in segregating generations.

Table 1: Analysis of variance for all the characters in 50 genotypes of cotton

| Source of variation | d.f. | Days to flowering | Days to boll opening | Plant height (cm) | Number of monopodia per plant | Number of sympodia per plant | Number of bolls per plant |
|---------------------|------|-------------------|----------------------|-------------------|-------------------------------|------------------------------|---------------------------|
| Replications | 2 | 1.01 | 4.93 | 150.50 | 0.13 | 7.52 | 26.92 |
| Genotypes | 49 | 93.99** | 141.94** | 789.47** | 2.26** | 16.57** | 220.11** |
| Error | 98 | 4.88 | 11.49 | 183.15 | 0.06 | 2.48 | 16.46 |

| Source of variation | d.f. | Boll weight (g) | Seed cotton yield per plant (g) | Ginning percentage (%) | Seed index (g) | Lint index (g) | Oil content (%) |
|---------------------|------|-----------------|---------------------------------|------------------------|----------------|----------------|-----------------|
| Replications | 2 | 0.07 | 50.43 | 0.36 | 1.47 | 0.40 | 0.0004 |
| Genotypes | 49 | 1.31** | 827.25** | 10.56** | 1.90** | 0.81** | 0.17** |
| Error | 98 | 0.04 | 120.62 | 0.96 | 0.51 | 0.17 | 0.01 |

*, ** Significant at 5 and 1% levels, respectively

Table 2: Mean, phenotypic range, σ_g^2 , σ_p^2 , σ_e^2 , GCV %, PCV %, heritability, genetic advance, genetic advance per cent of mean for all the characters of cotton

| Character | Mean±SE | Range | | σ_g^2 | σ_p^2 | σ_e^2 | PCV (%) | GCV (%) | Heritability % in Broad Sense | Genetic advance | Genetic advance (% mean) |
|--------------------------------|-------------|-------|--------|--------------|--------------|--------------|---------|---------|-------------------------------|-----------------|--------------------------|
| | | Min. | Max. | | | | | | | | |
| Days to flowering | 72.89±1.28 | 62.00 | 83.00 | 29.70 | 31.33 | 1.63 | 7.68 | 7.48 | 94.80 | 10.93 | 15.00 |
| Days to boll opening | 113.57±1.96 | 99.67 | 128.33 | 43.48 | 47.31 | 3.38 | 6.06 | 5.81 | 91.90 | 13.02 | 11.47 |
| Plant height (cm) | 131.20±7.81 | 93.33 | 170.00 | 202.10 | 263.16 | 61.05 | 12.36 | 10.84 | 76.80 | 25.66 | 19.56 |
| No. of monopodia per plant | 2.21±0.14 | 0.33 | 3.73 | 0.73 | 0.75 | 0.02 | 39.25 | 38.70 | 97.22 | 1.74 | 78.61 |
| No. of sympodia per plant | 15.34±0.91 | 11.60 | 21.40 | 4.69 | 5.52 | 0.83 | 15.32 | 14.13 | 85.04 | 4.12 | 26.83 |
| No. of bolls per plant | 33.85±2.34 | 19.20 | 56.07 | 67.88 | 73.37 | 5.49 | 25.30 | 24.34 | 92.52 | 16.32 | 48.22 |
| Boll weight (g) | 3.08±0.11 | 1.77 | 5.00 | 0.42 | 0.44 | 0.01 | 21.46 | 21.16 | 97.27 | 1.32 | 42.99 |
| Seed cotton yield per plant(g) | 96.45±6.34 | 63.00 | 146.70 | 235.54 | 275.75 | 40.21 | 17.22 | 15.91 | 85.42 | 29.21 | 30.29 |
| Ginning percentage (%) | 33.64±0.57 | 30.30 | 37.97 | 3.20 | 3.52 | .032 | 5.58 | 5.32 | 90.90 | 3.51 | 10.45 |
| Seed index (g) | 8.00±0.41 | 6.97 | 10.70 | 0.46 | 0.63 | 0.17 | 9.96 | 8.51 | 72.97 | 1.19 | 14.97 |
| Lint index (g) | 4.06±0.24 | 3.21 | 5.64 | 0.21 | 0.27 | 0.06 | 12.78 | 11.38 | 79.29 | 0.85 | 20.88 |
| Oil content (%) | 18.79±0.06 | 18.25 | 19.15 | 0.05 | 0.06 | 0.004 | 1.27 | 1.22 | 92.79 | 0.45 | 2.42 |

Where, σ_g^2 , σ_p^2 and σ_e^2 are the genotypic, phenotypic and environmental variance, respectively. GCV % and PCV % are genotypic and phenotypic coefficient of variation, respectively.

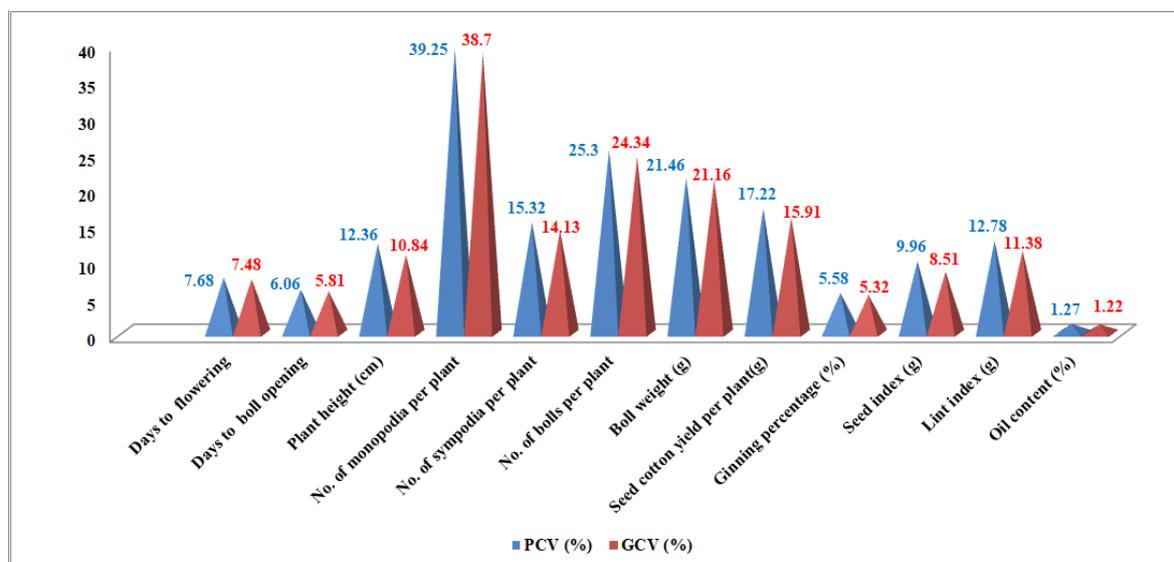


Fig. I: Graphical representation of phenotypic and genotypic coefficients of variation for various characters of cotton

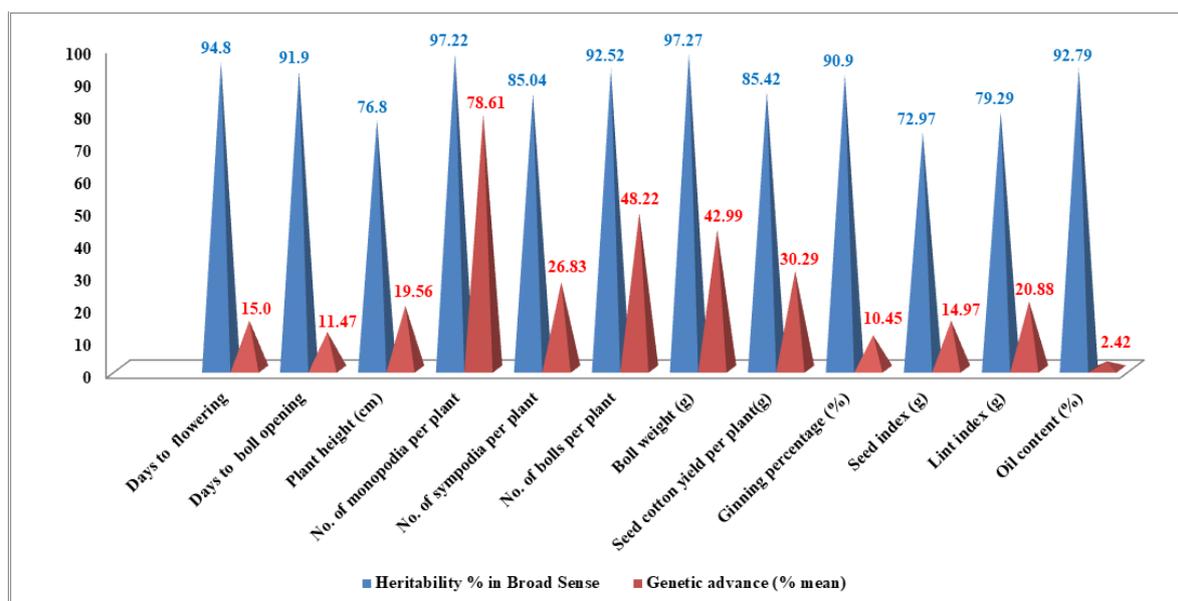


Fig. II: Graphical representation of heritability and genetic advance expressed as per cent of mean for various characters of cotton

CONCLUSION

It could be concluded from the present findings that additive gene action was operating for boll weight, number of monopodia per plant, number of bolls per plant, seed cotton yield per plant, number of sympodia per plant and lint index as it showed high heritability coupled with high genetic advance.

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