

**HETEROSIS AND COMBINING ABILITY
FOR YIELD AND YIELD CONTRIBUTING
CHARACTERS IN INTER-SPECIFIC
COTTON HYBRIDS
(*G. hirsutum* L. × *G. barbadense* L.)**

By

ANITHA NAKKA

B. Sc. (Ag.)

**THESIS SUBMITTED TO THE
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CHAIR PERSON: Dr. V. CHENGA REDDY



**DEPARTMENT OF GENETICS AND PLANT BREEDING
AGRICULTURAL COLLEGE, BAPATLA
ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY**

2014

CERTIFICATE

This is to certify that the thesis entitled “**HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN INTER-SPECIFIC COTTON HYBRIDS (*G. hirsutum* L. × *G. barbadense* L.)**” submitted in partial fulfillment of the requirements for the degree of Master of science in Agriculture of the Acharya N. G. Ranga Agricultural University, Hyderabad is a record of the bonafide original research work carried out by **Ms. ANITHA NAKKA** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

Thesis approved by the student advisory committee

Chairman : **Dr. V. CHENGA REDDY**

Principal Scientist (Cotton)

RARS, Lam, Guntur.

Member : **Dr. P.V. RAMA KUMAR**

Professor and Head

Department of Genetics and Plant Breeding
Agricultural College, Bapatla.

Member : **Dr. V. SRINIVASA RAO**

Associate Professor and University Head

Department of Statistics and Mathematics
Agricultural College, Bapatla.

Date of final viva-voce:

CERTIFICATE

Ms. ANITHA NAKKA has satisfactorily prosecuted the course of research and that thesis entitled “**HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN INTER-SPECIFIC COTTON HYBRIDS (*G. hirsutum* L. × *G. barbadense* L.)**” submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any university.

Date:

(V. CHENGA REDDY)
Chairperson
Principal Scientist (Cotton)
RARS, Lam, Guntur.

DECLARATION

I, **ANITHA NAKKA**, hereby declare that the thesis entitled “**HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN INTER-SPECIFIC COTTON HYBRIDS (*G. hirsutum* L. × *G. barbadense* L.)**” submitted to the **Acharya N. G. Ranga Agricultural University** for the degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

Place:

(ANITHA NAKKA)

Date :

I. D. No. **BAM-11-13**

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Date :

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LIST OF SYMBOLS AND ABBREVIATIONS

$^{\circ}\text{C}$	:	Degree Centigrade
%	:	Per cent
AICCP	:	All India Coordinated Cotton Improvement Project
A.M	:	Ante Meridiem
ANOVA	:	Analysis of Variance
CD	:	Critical Difference
cm	:	Centimeter
cont.	:	Continued
CV	:	Coefficient of Variation
df	:	Degrees of Freedom
<i>et al.</i> ,	:	And co-workers
F_1	:	First generation hybrid of a cross
g	:	Grams
g/inch	:	Grams per inch
g/tex	:	Grams per tex
GA	:	Genetic advance
GAM	:	Genetic Advance as per cent of mean
<i>gca</i>	:	General combining ability
GCV	:	Genotypic Coefficient of Variation
$\hat{h}^2(\text{ns})$	:	Heritability in narrow sense
<i>i.e.</i> ,	:	That is
K_2O	:	Potassium
kg/ha	:	Kilogram per hectare
km/H	:	Kilometer per hour
L x T	:	Line x Tester
m	:	Meter
max	:	Maximum
min	:	Minimum
mm	:	Millimeter
MSL	:	Mean Sea Level
MSS	:	Mean Sum of Square
N	:	Nitrogen
No.	:	Number
NS	:	Non-Significant
P_2O_5	:	Phosphorus
P.M	:	Post Meridiem
PCV	:	Phenotypic Coefficient of Variation
<i>per se</i>	:	As such with mean
RBD	:	Randomized Block Design
S	:	Significant
<i>sca</i>	:	Specific combining ability
SE	:	Standard Error
SS	:	Sum of square
via	:	Through
<i>viz.</i> ,	:	Namely
vs	:	Against

ABSTRACT

Name of the author	:	ANITHA NAKKA
Title of the thesis	:	HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN INTER-SPECIFIC COTTON HYBRIDS (<i>G. hirsutum</i> L. × <i>G. barbadense</i> L.)
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The study was carried out during *kharif* 2012-13 at Regional Agricultural Research Station, Lam Farm, Guntur with 40 hybrids along with their 13 parents (8 lines and 5 testers) and standard check to elicit information on genetic variability, heritability, genetic advance, combining ability, heterosis, correlation and the magnitude of direct and indirect effects.

The data were recorded on 16 economically important characters viz., plant height (cm), days to 50% flowering, number of monopodia plant⁻¹, number of sympodia plant⁻¹, number of bolls plant⁻¹, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire value (10⁻⁶ g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g).

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the material used in the present investigation possessed sufficient variability. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation indicating the influence of the environment on the expression of the traits. High

variability coupled with high heritability and high genetic advance as per cent of mean was observed for lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) indicating the operation of additive gene action in the inheritance of the trait.

The ratio of *gca* variance to *sca* variance indicated the preponderance of additive gene action for days to 50% flowering, 2.5% span length (mm), micronaire value (10⁻⁶ g/inch), bundle strength (g/tex), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g). The role of both additive and non-additive gene action was observed for number bolls plant⁻¹. Whereas, non-additive gene action is important for plant height (cm), number of monopodia per plant, number of sympodia plant⁻¹, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), uniformity ratio and fibre elongation (%).

Based on *gca* effects among the lines, L 1227 and L 1238 were identified as good general combiners. Among the testers, RHCB 011, Suvin and GSB 41 were identified as good general combiners.

The character association and path analysis studies revealed that number of bolls plant⁻¹, boll weight (g), ginning out-turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ were found to have significant positive association with seed cotton yield plant⁻¹. Major emphasis should be laid on selecting lint yield plant⁻¹ (g) for the improvement of seed cotton yield.

Based on overall performance (*per se* performance, *sca* effects and standard heterosis) the crosses viz., L 1374 x RHCB 011, L 1238 x GSB 41 and L 1227 x GSB 41 were found superior. These hybrids can be exploited through heterosis breeding for commercial cultivation after thorough testing in wider environments for their conformity. These crosses can also be studied for further exploitation in segregating generations to isolate superior segregants from these cross derivatives.

Chapter - I

INTRODUCTION

Cotton ‘King of fibre crops’ is the most important natural textile fiber and the sixth largest vegetable oil source in the world, and it is the cornerstone of textile industries worldwide (Ulloa *et al.*, 2006). In the agro based industry economy of the country cotton, the ‘White Gold’ enjoys a pre-eminent status among all the commercial crops by providing livelihood to nearly sixty million people and is an important agricultural commodity providing remunerative income to millions of farmers both in developed and developing countries.

In India, all the four cultivated cotton species viz., *Gossypium arboreum* L., *G. herbaceum* L., *G. hirsutum* L. and *G. barbadense* L., are grown on a commercial scale. Out of the four cultivated species, *Gossypium hirsutum* L. and *Gossypium barbadense* L. are tetraploids ($2n = 4x = 52$) and are commonly called as new world cottons. Whereas, *Gossypium arboreum* L. and *Gossypium herbaceum* L. are diploids ($2n = 2x = 26$) and were known as old world cottons.

In India, cotton is being grown over an area of 117.73 lakh ha with an annual production of 356.10 lakh bales (1 bale=170 kg) with a productivity of 496.39 kg lint/ha (AICCIP Annual Report, 2012-13). In Andhra Pradesh, cotton is a crop of great economic value, playing significant role in the socio-economic status of the farmers. It occupies an area of about 22.69 lakh ha with an annual production of 72.00 lakh bales and productivity of 506.96 kg lint/ha (AICCIP Annual Report, 2012-13).

Cotton improvement programmes primarily lay emphasis on the development of varieties/hybrids that have contributed for the improvement of productivity of cotton. The hybrid cotton era in India had started in 1970 with the release of world’s first intra-specific cotton hybrid ‘H 4’ (Patel, 1971). Later, the world’s first inter-specific hybrid between *G. hirsutum* L. and *G. barbadense* L. was released under the name “Varalaxmi” (Katarki, 1971). With the success of these two hybrids, heterosis breeding programmes got momentum in the country and several hybrids were released for commercial cultivation. Among the hybrids, maximum area is covered by intra-hirsutum hybrids (*G. hirsutum* L. × *G. hirsutum* L.) followed by inter-specific hybrids between *G. hirsutum* L. and *G. barbadense* L.

The extra long staple cotton is not sufficient to meet the domestic requirement of our country. There is a need to develop suitable high yielding extra long staple hybrids with desirable fibre qualities to cater the needs of Indian textile industry (Dhamayanthi, 2011). The present investigation was undertaken to study the performance of the inter-specific hybrids (*G. hirsutum* L. × *G. barbadense* L.) for their yielding ability and fibre quality characteristics.

Information on the extent of genetic variability, heritability and genetic advance present in the material, coupled with details on character association and path-coefficient analysis of yield and yield components and quality traits would also assist the breeder in selection of the suitable parents and to decide the appropriate breeding methodology for crop improvement.

In heterosis breeding programme, the selection of parents or inbreds based on their good combining ability is very important in producing superior hybrids. Combining ability analysis is an important tool for the selection of desirable parent together with the information regarding nature and magnitude of gene controlling the quantitative traits. The analysis of general combining ability and specific combining ability effects help in identifying potential parents for the production of superior hybrids. The line x tester analysis is one of the simplest and efficient methods of evaluating large number of parents for their combining ability (Kempthorne, 1957). Based on the information from line x tester analysis, it is possible for identification and production of commercially viable hybrids.

Keeping this in view, 40 hybrids were produced by crossing 8 lines and 5 testers in line x tester fashion which were developed from heterotic gene pools. These 40 hybrids along with their parents and standard check were evaluated for their yield and yield contributing traits at RARS Lam Farm, Guntur during *kharif* 2012 with the following objectives.

1. To assess the genetic parameters (heritability ($\hat{h}^2_{(ns)}$), GCV, PCV, GAM) of hybrids for yield, yield contributing characters and fibre quality parameters.
2. To study the type of gene action and combining ability effects in inter-specific hybrids of cotton.
3. To study the heterosis of hybrids and identification of promising high yielding inter-specific hybrids.
4. To study the character association, direct and indirect effects of yield components and fibre quality parameters.

Chapter - II

REVIEW OF LITERATURE

The review of work done on cotton relevant to the present investigation is furnished under the following headings.

2.1. Genetic variability

2.2. Heritability ($\hat{h}^2_{(ns)}$) and genetic advance as per cent of mean

2.3. Combining ability and gene action

2.4. Heterosis

2.5. Character association

2.6. Path coefficient analysis

2.1 GENETIC VARIABILITY

An insight into the magnitude of variability present in a crop species is of the utmost importance as it provides the basis for effective selection. The phenotype is the resultant of interactions between genotype and environment. Partitioning of observed variability into heritable and non-heritable components is essential to get a true indication of the genetic variation of the trait.

The available literature on genetic variability studies in cotton were reviewed and presented in Table 2.1.

2.2 HERITABILITY ($\hat{h}^2_{(ns)}$) AND GENETIC ADVANCE (GA) AS PER CENT OF MEAN

Heritability is the good index which measures the relative amount of the heritable portion of variability. Heritability in narrow sense is the ratio of additive or fixable genetic variance to the total or phenotypic variance. Since it is estimated from additive (heritable) genetic variance, it plays an important role in the selection of elite genotypes from segregating populations. Consistence in the performance of selection in succeeding generations depends on the magnitude of heritable variation present in relation to observed variation. Basic information on heritability is a pre-requisite for planning any breeding programme.

Genetic advance (GA) helps to measure the amount of progress that could be expected with selection in a character. Estimates of heritability ($\hat{h}_{(ns)}^2$) along with the estimates of genetic advance (GA) are more useful in choice of selection methods rather than heritability or genetic advance alone (Johnson *et al.*, 1955). High heritability coupled with high genetic advance indicates the improvement that could be made for a character by simple selection on phenotypic performance.

The available literature on heritability ($\hat{h}_{(ns)}^2$) and genetic advance (GA) were presented in Table 2.2.

2.3 COMBINING ABILITY

Combining ability refers to the ability of parents to transmit desirable alleles to its hybrid progeny. It helps in the evaluation of inbreds in terms of their genetic value and in selection of suitable parents for hybridization.

The information on combining ability will help the breeder in developing the future breeding programme to be adopted for exploiting additive and/or non-additive components present in the material.

The general combining ability is the average performance of an inbred in cross combinations involving a set of other inbreds. It is specific for the set of lines and testing environment, whereas specific combining ability is the relative performance of an inbred in a specific cross combination expressed as negative or positive deviation of a particular cross from the values expected from general combining abilities of the parental inbreds (Sprague and Tatum, 1942).

The *gca* effect reflects the breeding value of the parental genotype concerned while the *sca* represents the non-reliable component of the genotypic value arising due to the contribution from dominance deviation and inter-allelic interactions. Hence, *sca* effect is the main cause for superiority of any cross combination.

The available literature on gene action governing the inheritance of yield and yield components were presented in Table 2.3.

2.4 HETEROSIS

Shull (1914) first coined the term heterosis. Heterosis is the superiority of F_1 over the mean of the parents (relative or mid parent heterosis) or over the better parent (heterobeltiosis) or over the standard check (standard heterosis) (Hays and Foster, 1976) with respect to agriculturally useful traits. The primary objective of heterosis breeding is to achieve a quantum jump in yield and quality aspects of crop plants. Heterotic performance can be used as the measure of nicking ability of any inbred line when crossed with a common tester. Exploitation of heterosis to increase the yield of agricultural crops has become one of the most important techniques in plant breeding.

The available literature on heterosis over mid parent, better parent and standard check in cotton were summarized and presented in Table 2.4.

2.5 CHARACTER ASSOCIATION

Yield is a complex and polygenically inherited trait which is highly influenced by the environment. Therefore, the direct selection for yield is not much effective. But it could be improved by selecting various component characters which are correlated to yield and are simple in inheritance with less environment influence. Hence, correlation studies paved a path in order to find out the association between highly heritable independent character and most economic but dependent character like yield which would help the breeder in improvement of yields.

2.5.1 Association of component characters with seed cotton yield

The available literature on association of component characters with seed cotton yield were presented in Table 2.5.

2.5.2 Association among the yield component characters

The available literature on the association among the yield component characters were presented in Table 2.6.

2.6 PATH COEFFICIENT ANALYSIS

The estimation of path coefficients gives an exact picture of relative importance of the direct and indirect contribution of the component characters to yield. Path analysis proposed by Dewey and Lu (1959) facilitates the partitioning of the correlation

coefficients into direct and indirect effects of various characters on seed cotton yield. Thus path analysis would give a better insight into the cause and effect relationship between the pairs of characters.

The available literature on the direct and indirect effects of fibre quality parameters and other yield components on seed cotton yield are reviewed and were presented in Table 2.7.

Chapter - III

MATERIAL AND METHODS

The present investigation entitled combining ability studies in inter-specific hybrids of cotton for yield was carried out during *kharif* 2012-13. The material used and methods followed are presented in this chapter.

3.1 DESCRIPTION OF THE EXPERIMENTAL MATERIAL

The experimental material for this study consisted of 40 inter-specific crosses of cotton along with their 13 parents and one standard check. The crosses were generated by crossing 8 lines with 5 testers in a Line $\times$ Tester fashion (Kempthorne, 1957) during *kharif* 2011-2012 at Regional Agricultural Research Station, Lam Farm, Guntur. The evaluation of these hybrids has been undertaken during *kharif* 2012-2013. The details of the crosses and their parents used in this study are presented in Table 3.1

3.2 EXPERIMENTAL SITE LOCATION AND WEATHER CONDITION

The experiment was conducted at RARS Lam, Guntur, Andhra Pradesh which was located at an altitude of 31.5m above MSL, 16⁰2'N latitude and 80⁰3'E longitude. The soils were black cotton type with clay texture.

3.3 METHODS

3.3.1 Experimental Technique

The details of the experimental techniques followed in the present investigation had been furnished in Table 3.2

Table 3.1. The parents, crosses and check employed in the present investigation for the analysis of combining ability and heterosis in cotton

S. No.	LINES	S.No.	TESTERS
1	L 788	1	RHCB 011
2	L 804	2	Suvin
3	P 72-9-37	3	GSB 41
4	L 1227	4	DB 10
5	L 1238	5	GSB 39
6	L 1369		
7	L 1374		
8	L 1376		
CROSSES			
1	L 788 X RHCB 011	21	L 1238 X RHCB 011
2	L 788 X Suvin	22	L 1238 X Suvin
3	L 788 X GSB 41	23	L 1238 X GSB 41
4	L 788 X DB 10	24	L 1238 X DB 10
5	L 788 X GSB 39	25	L 1238 X GSB 39
6	L 804 X RHCB 011	26	L 1369 X RHCB 011
7	L 804 X Suvin	27	L 1369 X Suvin
8	L 804 X GSB 41	28	L 1369 X GSB 41
9	L 804 X DB 10	29	L 1369 X DB 10
10	L 804 X GSB 39	30	L 1369 X GSB 39
11	P 72-9-37 X RHCB 011	31	L 1374 X RHCB 011
12	P 72-9-37 X Suvin	32	L 1374 X Suvin
13	P 72-9-37 X GSB 41	33	L 1374 X GSB 41
14	P 72-9-37 X DB 10	34	L 1374 X DB 10
15	P 72-9-37 X GSB 39	35	L 1374 X GSB 39
16	L 1227 X RHCB 011	36	L 1376 X RHCB 011
17	L 1227 X Suvin	37	L 1376 X Suvin
18	L 1227 X GSB 41	38	L 1376 X GSB 41
19	L 1227 X DB 10	39	L 1376 X DB 10
20	L 1227 X GSB 39	40	L 1376 X GSB 39
CHECK			
1	DCH 32		

Table 3.2. Experimental details of heterosis and combining ability analysis for seed cotton yield in inter-specific cotton hybrids.

Location	RARS Lam, Guntur
Season	<i>Kharif</i> 2012-2013
Design	Randomized Block Design
Entries	54 (8lines + 5testers + 40 crosses) and one standard check
Replications	3
No. of Rows	1
No. of Plants /row	10
Row Length	6m
Plot Size	1 row of 6m length
Spacing (cm)	105cm between rows x 60cm within row
Fertilizers	120 N: 60 P ₂ O ₅ : 60 K ₂ O kg/ha

3.3.2 Observations

Observations were recorded on randomly selected five plants of each genotype in each replication and were used for statistical analysis. However days to 50% flowering, ginning out turn (%), 2.5% span length (mm), micronaire value (10⁻⁶g/inch), uniformity ratio and elongation (%) were recorded on plot basis.

To estimate the fibre quality parameters a composite sample of 300g of kapas was obtained from each genotype in each replication and ginned for seed and lint and the lint sample was used for estimating the fibre properties. The data on the following seed cotton yield and yield components and quality parameters were recorded.

3.3.2.1 Plant height (cm)

Plant height was measured from the base of the plant to apex of the plant at maturity.

3.3.2.2 Days to 50% flowering

The number of days taken by each genotype from sowing to the date on which 50 per cent of the plants were seen flowering in the population.

3.3.2.3 Number of monopodia plant⁻¹

The total number of vegetative branches on the main stem were counted and recorded at the time of harvest.

3.3.2.4 Number of sympodia plant⁻¹

The total number of sympodial branches *i.e.*, number of fruiting branches present in the plant at maturity was counted.

3.3.2.5 Number of bolls plant⁻¹

The total number of fully opened bolls harvested from each plant were counted and averaged.

3.3.2.6 Boll weight (g)

Seed cotton obtained from a random sample of 25 bolls per plant was used to determine boll weight.

3.3.2.7 Ginning-out turn (%)

A random sample of 300g seed cotton from each entry was ginned and the lint obtained was weighed. The ginning out-turn was calculated by the following formula.

$$\text{Ginning out turn (\%)} = \frac{\text{weight of the lint (g)}}{\text{weight of the seed cotton (g)}} \times 100$$

3.3.2.8 Seed index (g)

It is the absolute weight of 100 seeds recorded.

3.3.2.9 Lint index (g)

It is the absolute weight of lint obtained from 100 seeds.

FIBRE PROPERTIES:

Based on the availability of sufficient lint for testing, few plants were subjected for detailed investigation for fibre properties. Following characters were analyzed under HVI (High Volume Instrumentation) at Central Institute for Research on Cotton Technology (CIRCOT), Regional Quality Evaluation Unit situated at Lam Farm, Guntur, Andhra Pradesh.

3.3.2.10 2.5% Span length (mm)

The distance from the clamp on a fibre beard to a point up to which only 2.5% of the fibres extend. It is expressed as span length in (mm) and was estimated by premier HFT 9000 V 2.1.3 SP high volume instrument.

3.3.2.11 Micronaire value (10^{-6} g/inch)

A physical property indicating the cross-sectional thickness of fibre, which determines the spinning value of a variety. The fibre fineness was estimated by premier HFT 9000 V 2.1.3 SP high volume instrument.

3.3.2.12 Bundle strength (g/tex)

A measure of the tensile strength of the fibre using the principle of constant rate of loading. This was measured by using premier HFT 9000 V 2.1.3 SP high volume instrument at 1/8th gauge length.

3.3.2.13 Uniformity ratio

The ratio between two span lengths (2.5% and 50%) expressed as a percentage of the longer length and was determined by using premier HFT 9000V 2.1.3 SP high volume instrument.

3.3.2.14 Fibre elongation (%)

It is fibre extensibility measured with the help of premier HFT 9000V 2.1.3 SP high volume instrument.

3.3.2.15 Lint yield plant⁻¹ (g)

Total weight of lint obtained from five plants was recorded and averaged.

3.3.2.16 Seed cotton yield plant⁻¹ (g)

Total weight of seed cotton obtained from five plants were recorded and averaged.

3.3.3 Statistical Analysis

The data recorded on various characters were subjected to the following statistical analysis.

3.3.3.1 Analysis of variance

The Analysis of variance for each character was done as per standard statistical procedure for randomized complete block design as given by Panse and Sukhatme (1978).

$$Y_{ij} = \mu + t_i + r_j + e_{ij}$$

Where,

Y_{ij} = Performance of i^{th} genotype in j^{th} block

μ = General mean

t_i = i^{th} genotype effect

r_j = j^{th} block effect

e_{ij} = Random error

The structural analysis of variance was as follows.

Table 3.3. ANOVA table for Randomized Block Design

Source of variation	Degrees of freedom	Mean sum of squares	Expected mean sum of squares	“F” calculated value
Replications	(r-1)	M_r	$\sigma_e^2 + g \sigma_r^2$	M_r / M_e
Genotypes	(g-1)	M_g	$\sigma_e^2 + r \sigma_g^2$	M_g / M_e
Error	(r-1) (g-1)	M_e	σ_e^2	
Total	(rg-1)			

Where,

r = number of replications

g = number of genotypes

M_r = replication mean squares

M_g = genotype mean squares

M_e = error mean squares

σ_r^2 = variance due to replications

σ_g^2 = variance due to genotypes

σ_e^2 = error variance

3.4.1. Estimation of Genetic Parameters

The following genetic parameters were studied for all the characters in order to assess and quantify the genetic variability among the parents and F₁ hybrids.

3.4.1.1. Estimation of Variance Components

The genotypic and phenotypic variances were estimated using the following formula

$$\text{Genotypic variance } (\sigma^2g) = \frac{Mg - Me}{r}$$

$$\text{Phenotypic variance } (\sigma^2p) = \sigma^2g + Me$$

The test of significance was carried out using 'F' table value of Fisher and Yates (1963).

3.4.1.2. Coefficient of Variation

The genotypic and phenotypic coefficients of variation were calculated using the formula by Burton (1952).

a) Genotypic coefficient of variation (GCV)

$$\text{GCV} = \frac{\text{Genotypic standard deviation } (\sigma g)}{\text{General mean } (\bar{X})} \times 100$$

b) Phenotypic coefficient of variation (PCV)

$$\text{PCV} = \frac{\text{Phenotypic standard deviation } (\sigma p)}{\text{General mean } (\bar{X})} \times 100$$

The GCV and PCV values were classified as described by Sivasubramanian and Menon (1973).

Classification	GCV/PCV
Low	Less than 10%
Moderate	10-20%
High	More than 20%

3.4.2.1. Heritability in narrow sense

Heritability in narrow sense is defined as the ratio of additive and/or additive x additive genetic variance to the total phenotypic variance. It has been estimated as per the formula given by Mather (1943).

$$\text{Heritability in narrow sense } (\hat{h}_{ns}^2) = \frac{\text{Additive variance } (\sigma^2 A)}{\text{Phenotypic variance } (\sigma^2 p)} \times 100$$

The range of heritability in narrow sense was classified as suggested by Johnson *et al.* (1955).

Classification	Heritability
Low	Less than 30%
Moderate	30-60%
High	More than 60%

3.5. GENETIC ADVANCE (G A)

This was estimated as per the formula proposed by Lush (1940) and Johnson *et al.* (1955).

$$G. A = k \times \sigma_p \times \hat{h}_{ns}^2$$

Where, k = Selection differential at 5% selection intensity which accounts to a constant value of 2.06.

$(\hat{h}_{(ns)}^2)$ = Heritability in narrow sense.

σ_p = Phenotypic standard deviation.

Genetic advance was estimated as per cent of mean (GAM) of the population.

$$GAM = \frac{GA}{\bar{X}} \times 100$$

Where, GA = Genetic advance

$\bar{X}$ = Grand mean

The range of genetic advance as per cent of mean was classified as suggested by Johnson *et al.* (1955)

Classification	GAM
Low	Less than 10%
Moderate	10-20%
High	More than 20%

3.6 COMBINING ABILITY ANALYSIS

The combining ability analysis of parents and crosses was taken up for different characters using the Line x Tester model as given by Kempthorne (1957).

Mathematical model for combining ability analysis is

$$Y_{ijk} = \mu + g_i + g_j + s_{ij} + r_k + e_{ijk}$$

Where, Y_{ijk} = Any measurable character of the cross $i \times j$ in the k^{th} replication

μ = population mean effect

g_i = general combining ability effect of the female parent

g_j = general combining ability effect of the male parent

s_{ij} = specific combining ability effect of $(i \times j)^{\text{th}}$ cross

r_k = effect due to K^{th} replication

e_{ijk} = environmental effect on $(ijk)^{\text{th}}$ individual

Table 3.4. ANOVA of Line $\times$ Tester mating design for combining ability in inter-specific hybrids of cotton (*G. hirsutum* L. $\times$ *G. barbadense* L.)

Source	d.f	MSS	Expected MSS
Replications	$r-1$	M_r	
Genotypes	$(g-1)$	M_g	
Parents	$(p-1)$	M_p	
Crosses	$(c-1)$	M_{pc}	
Parents vs Crosses	1	M_c	
Lines	$(l-1)$	M_l	$\sigma_p^2 + r\sigma_s^2 + r\sigma_f^2$
Testers	$(t-1)$	M_t	$\sigma_p^2 + r\sigma_s^2 + r\sigma_m^2$
Line x Tester	$(l-1)(t-1)$	M_{lt}	$\sigma_p^2 + r\sigma_s^2$
Error	$(r-1)(g-1)$	M_e	σ_e^2

Where, r = number of replications

g = number of genotypes

p = number of parents

c = number of crosses

l = number of lines or female parents

t = number of testers or male parents

c = number of crosses

σ^2_e = random error

σ^2_s = variance of interaction between lines and testers

σ^2_f = variance due to lines

σ^2_m = variance due to testers

3.6.1 Estimation of combining ability effects

(i) *gca* effect of line and tester

$$\text{Line } g_i = \frac{X_{j.}}{tr} - \frac{X_{...}}{ltr}$$

$$\text{Tester } g_j = \frac{X_{i.}}{tr} - \frac{X_{...}}{ltr}$$

(ii) *sca* effect of cross

$$S_{ij} = \frac{X_{ij}}{r} - \frac{X_{i.}}{lr} - \frac{X_{.j}}{tr} + \frac{X_{...}}{ltr}$$

Where, x_i = Total of i^{th} line over all testers and replications

x_j = Total of j^{th} tester over all lines and replications

x_{ij} = X_{ij}^{th} combination total over all replications

$x_{...}$ = Total of all hybrid combination over all replications

Standard Errors for combining ability effects

Standard errors pertaining to *gca* and *sca* effects of different combinations were calculated as follows:

$$S.E\ g_i(\text{lines}) = \sqrt{Me/t_r}$$

$$S.E\ g_j(\text{testers}) = \sqrt{Me/l_r}$$

$$S.E\ s_{ij}(\text{crosses}) = \sqrt{Me/r}$$

$$S.E\ d\ g_i(g_i - g_k)(\text{between } gca \text{ effects of two lines}) = \sqrt{2Me/t_r}$$

$$S.E\ g_i(g_j - g_l)(\text{between } gca \text{ effects of two testers}) = \sqrt{2Me/l_r}$$

$$S.E\ g_i(s_{ij} - g_{kl})(\text{SEd for any two } sca \text{ effects of hybrids}) = \sqrt{2Me/r}$$

Tests of significance for *gca* and *sca* effects:

The *gca* and *sca* effects were tested against zero for significance by calculation of 't' value by using the following formulae.

$$t\ cal = \frac{g_i - 0}{SE(g_i)}$$

$$t\ cal = \frac{g_j - 0}{SE(g_j)}$$

$$t\ cal = \frac{s_{ij} - 0}{SE(s_{ij})}$$

The values are compared with 't' table value at error degrees of freedom.

3.6.2 Estimation of genetic components of variation

The estimates of variance components were obtained from the algebraic manipulation of mean sum of squares in the ANOVA of L x T mating design for combining ability.

Estimation of Covariances

Covariance of full-sibs and half-sibs were estimated using the formula as given below.

$$\text{Cov(HS)} = \frac{M_t + M_l - 2M_{lt}}{r(t + l)}$$

$$\text{Cov(FS)} = 1/3r(\{M_t - M_l + M_{lt} - 3M_e + 6r \text{Cov(HS)} - r(t + l)\text{Cov(HS)}\})$$

The genetic components of variation were estimated by relating the variance components to covariance of half sibs (Cov.HS) and full sibs (Cov.FS) as

$$\sigma_f^2 = \sigma_m^2 = \text{Cov. HS}$$

$$\sigma_s^2 = \text{Cov. FS} - 2\text{Cov. HS}$$

$$\sigma_{gca}^2 = \text{Cov. HS} = \left[\frac{1 + F}{4} \right] \sigma_A^2$$

$$\sigma_{sca}^2 = \text{Cov. FS} - \text{Cov. HS} = \left[\frac{1 + F}{4} \right] \sigma_D^2$$

Where,

$$\sigma_{gca}^2 = \text{general combining ability variance}$$

$$\sigma_{sca}^2 = \text{specific combining ability variance}$$

$$F = \text{inbreeding coefficient}$$

Proportional contribution of lines, testers and their interactions

$$\text{Percent contribution of lines} = \frac{SS_l}{SS_c} \times 100$$

$$\text{Percent contribution of testers} = \frac{SS_t}{SS_c} \times 100$$

$$\text{Percent contribution of l x t} = \frac{SS_{lt}}{SS_c} \times 100$$

Where,

SS_l = sum of squares of lines

SS_t = sum of squares of testers

SS_{lt} = sum of squares of lines x testers

SS_c = sum of squares of crosses

3.7 Estimation of heterosis

The heterotic effects were measured as deviation of F_1 mean from mid parent (relative heterosis), better parent (heterobeltiosis) and the standard check (standard heterosis) mean as per the following formula given by Liang *et al.* (1971).

The percent of heterosis was calculated as follows;

$$\text{Relative heterosis (\%)} = \frac{F_1 - \text{Mean of mid parent}}{\text{Mean of mid parent}} \times 100$$

$$\text{Heterobeltiosis (\%)} = \frac{F_1 - \text{Mean of better parent}}{\text{Mean of better parent}} \times 100$$

$$\text{Standard heterosis (\%)} = \frac{F_1 - \text{Mean of superior check}}{\text{Mean of superior check}} \times 100$$

3.7.1 Test of significance of heterosis

To test the significance of heterosis over mid parent and better parent were used as suggested by Snedecor and Cochran (1967) and Arunachalam (1976).

$$\text{Heterosis 't'} = \frac{\text{Mean of F1} - \text{Mean of mid parent(or) better parent}}{\sqrt{2\text{EMS}/r}}$$

$$\text{Standard heterosis 't'} = \frac{\text{Mean of F1} - \text{Mean of superior check}}{\sqrt{2\text{EMS}/r}}$$

The estimated 't' value was compared with 't' table values at respective degrees of freedom.

3.8. Correlation

Phenotypic and genotypic correlations were worked out to determine the degree of association of a character with yield and also among the yield components using covariance technique as suggested by Falconer (1964).

Phenotypic coefficients of correlation (r_p) =

$$r(x_i x_j)_p = \frac{\text{COV}(x_i x_j)_p}{\sqrt{v(x_i)_p \cdot v(x_j)_p}}$$

Where,

$r(x_i x_j)_p$ = Correlation between i^{th} and j^{th} characters

$\text{Cov}(x_i x_j)_p$ = Covariance between i^{th} and j^{th} characters

$v(x_i)_p$ = Phenotypic variance of i^{th} character

$v(x_j)_p$ = Phenotypic variance of j^{th} character

Genotypic coefficient of correlation (r_g) =

$$r(x_i x_j)_g = \frac{\text{COV}(x_i x_j)_g}{\sqrt{v(x_i)_g \cdot v(x_j)_g}}$$

Where,

$r(x_i x_j)_g$ = Genotypic correlation between i^{th} and j^{th} character

$Cov(x_i x_j)_g$ = Genotypic covariance between i^{th} and j^{th} character

$v(x_i)_g$ = Genotypic variance of i^{th} character

$v(x_j)_g$ = Genotypic variance of j^{th} character

3.8.1 Test of significance

Significance of correlation coefficients was tested by comparing phenotypic correlation coefficients with the table values (Fisher and Yates, 1963) at $(n-2)$ degrees of freedom at 5% and 1% level where 'n' denotes the number of paired observations used in the calculation.

3.9 Path Coefficient Analysis

Path coefficient analysis was carried out by using the correlation coefficients to know the direct and indirect effects of the component characters on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

Path coefficients were obtained by solving the simultaneous equations which express the basic relationship between correlations and path coefficients.

The equations are as follows:

$$r_{1y} = P_{1y} + r_{12}P_{2y} + r_{13}P_{3y} + \dots + r_{1k}P_{ky}$$

$$r_{2y} = r_{21}P_{1y} + P_{2y} + r_{23}P_{3y} + \dots + r_{2k}P_{ky}$$

$$\vdots \quad \quad \quad \vdots \quad \quad \quad \vdots \quad \quad \quad \vdots \quad \quad \quad \vdots \quad \quad \quad \vdots$$

$$r_{ky} = r_{k1}P_{1y} + r_{k2}P_{2y} + r_{k3}P_{3y} + \dots + r_{kk}P_{ky}$$

Where, r_{1y} to r_{ky} = Coefficient of correlation between causal factors 1 to k and dependent character y.

r_{12} to r_{k-1} , k = Coefficient of correlation among causal factors

P_{1y} to P_{ky} = Direct effects of characters 1 to k on character y

The residual effect was computed by using the formula

$$R = \sqrt{[1 - (P_{1y}r_{1y} + P_{2y}r_{2y} + P_{3y}r_{3y} + \dots\dots\dots)]}$$

Where,

R = Residual effect

P_{1y} = Direct effect of independent character '1' on dependent character 'y'

r_{1y} = Correlation coefficient of independent character '1' on dependent character 'y'

Chapter - IV

RESULTS AND DISCUSSION

Variability in a crop species is of utmost importance as it provides the basis for effective selection. The amount of variability present in a population is generally measured in terms of phenotypic and genotypic coefficients of variation. The information on the nature and magnitude of genetic variability present in a population is a prerequisite to start any crop improvement programme.

Yield is being a complex character; depends on many component traits. It is necessary to have knowledge on the extent of association between yield and yield contributing characters. Expression of various traits often varies with breeding material and environment. Therefore, the information on character association between the traits themselves and with the seed cotton yield for the specific breeding material being used at a particular location is important for breeding high yielding cotton genotypes. Apart from the information on degree and direction of relationship between two or more traits it is very important to know the cause of association by knowing the direct and indirect effects of independent characters on the dependent character.

Hybridization is the most potent technique for breaking the yield barriers. Selection of parents on the basis of phenotypic performance alone may be misleading many a times, since phenotypically superior lines may yield poor hybrid combinations. It is, therefore essential that parents should be chosen on the basis of their combining ability.

The knowledge on general and specific combining ability (Sprague and Tatum, 1942) helps the breeder in assessing lines to be used as parents in the hybridization programmes. It also helps in exploiting the gene action involved in the inheritance of a particular trait. The magnitude of heterosis is strongly influenced by genetic variability and combining ability of the parents. Many mating designs are being adopted to elicit information on combining ability and nature of gene action. However, the Line $\times$ Tester analysis (Kempthorne, 1957) has been one of the simplest and efficient methods of evaluating large number of inbreds for combining ability. Line $\times$ Tester mating design involves hybridization between lines (females) and testers (males) in one-to-one fashion, generating female (f) $\times$ male (m) = fm hybrids. Generally, the lines (test genotypes) are used as females and testers as pollen or male parents.

The availability of extra long staple cotton is inadequate to meet the domestic requirement of our country. There is every need to develop suitable high yielding extra long staple cotton hybrids/varieties with desirable fibre qualities to cater the need of Indian textile industry (Damayanthi, 2011). So the present investigation was carried out with 40 hybrids derived from crossing 8 lines with 5 testers in Line x Tester fashion with 13 parents and a standard check, at Regional Agriculture Research Station, Lam Farm, Guntur during *kharif* 2012 for various qualitative and quantitative characters.

The data were recorded on plant height (cm), days to 50% flowering, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire value (10^{-6} g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), lint yield per plant (g) and seed cotton yield per plant (g) from five randomly selected plants which were subjected to the statistical analysis. The results are presented and discussed under the following headings.

4.1 Analysis of variance

4.2 Genetic variability, heritability and genetic advance as per cent of mean

4.3 Combining ability

4.4 Heterosis

4.5 Character association

4.6 Path coefficient analysis

4.1 ANALYSIS OF VARIANCE

The raw data collected from the experimental material was subjected to the analysis of variance and data was presented in the Table 4.1. The mean performances of the genotypes for different characters are presented in Appendix-II. It is perceptible from the table that the treatment differences for all the sixteen characters including seed cotton yield were significant for all the genotypes. Thus, the experimental material chosen for the present study was highly variable in nature.

4.2 VARIABILITY, HERITABILITY ($\hat{h}^2_{(NS)}$) AND GENETIC ADVANCE

The success of any breeding programme depends on the quantum of genetic variability present in the population. Wider range of genetic variability helps in selection of the desired genotypes. In addition to the genetic variability, knowledge on heritability and genetic advance helps the breeder to employ the suitable breeding

strategy. Therefore, it is necessary to have knowledge of genetic variability, heritability ($\hat{h}^2_{(ns)}$) and genetic advance present in the available genetic material. Seed cotton yield being a complex character, is the product of interplay among its attributes coupled with varying environmental conditions (Khan, 2003 and Khan *et al.*, 2009). Upland cotton genotypes have high genetic variability for seed cotton yield and cotton seed traits (Khan, 2003).

In order to ascertain these facts, the statistical analysis pertaining to variability, heritability ($\hat{h}^2_{(ns)}$) and genetic advance as per cent of mean (GAM) were worked out and presented in Table 4.2.

The results are discussed here under character-wise

4.2.1 Plant height (cm)

Plant height ranged from 108.63 (GSB 41) to 173.2 (L 788 x GSB 39) with an average of 137.80 cm. The PCV (12.20) and GCV (11.14) were moderate indicating the availability of narrow variability for this trait. These findings were in accordance with those of Neelima *et al.* (2008), Rajanna (2010), Kulkarni *et al.* (2011), Tulasi (2011), Haritha *et al.* (2012).

Low heritability (27.41) and moderate genetic advance as per cent of mean (12.54) were recorded for plant height indicating the role of non-additive gene action and influence of the environment in the expression of this trait than genetic factors. Further improvement of this character would be possible either through heterosis breeding or population improvement through various forms of recurrent selection. Contrary to this high heritability and high genetic advance in this trait was reported by Muhammad *et al.* (2009), Sabir *et al.* (2010), Kulkarni *et al.* (2011), Dhanalakshmi *et al.* (2012) and Ranganatha *et al.* (2013).

4.2.2 Days to 50% flowering

Days to 50% flowering ranged from 55.00 (L 804) to 73.66 (Suvin) with an average of 64.00 days. Low estimates of PCV (7.58) and GCV (7.29) were recorded for this trait indicating presence of low variability. These findings were in accordance with those of Kulkarni *et al.* (2011), Tulasi (2011), Vineela (2011), Haritha *et al.* (2012) and Venkatesh (2012).

High heritability (78.79) along with low genetic advance as per cent of mean (5.47) revealed the predominance of both additive and non-additive gene action in the inheritance of this trait and offers the best possibility of improvement through progeny selection or any modified selection procedures aiming to exploit the additive gene effects. These findings were in supportive of Kale *et al.* (2007) and Ravikesavan *et al.* (2008), Mahantesh (2009), Rajanna (2010) and Venkatesh (2012)

4.2.3 Number of Monopodia per plant

The number of monopodia per plant ranged from 0.60 (L 1376) to 2.73 (L 804 x Suvin) with a mean value of 1.60. High PCV (34.90) and GCV (31.91) were recorded for this trait indicating greater variability and scope for improvement of the character and the results are in agreement with the findings of Mohan (2011), Kulkarni *et al.* (2011) and Kishore *et al.* (2011), Dhanalakshmi *et al.* (2012) and Venkatesh (2012).

Moderate heritability (31.32) with high genetic advance as per cent of mean (23.05) was observed indicating the role of both additive and non-additive gene action in the inheritance of this trait. Improvement of this trait can be aimed through cyclic hybridization, diallel selective mating and biparental mating. These research findings were in agreement with that of Vijayalaxmi (2007), Abbas *et al.* (2008), Muhammad *et al.* (2009), Dhanalakshmi *et al.* (2012) and Venkatesh (2012).

4.2.4 Number of Sympodia per plant

The variation of number of sympodia per plant ranged from 13.26 (Suvin) to 23.66 (L 1376 x GSB 41) with an average of 17.73. Moderate PCV (14.39) and GCV (11.93) were observed for this trait indicating presence of variation. These findings were in agreement with those of Rao *et al.* (2009b), Bazi (2011), Tulasi (2011) and Haritha *et al.* (2012).

Low heritability (19.61) coupled with low genetic advance as per cent of mean (5.36) was observed for this trait, which indicates the preponderance of non-additive gene action in controlling the trait and further improvement of this character would be possible either through heterosis breeding or population improvement through various forms recurrent selection. These research findings were in accordance with the reports of Kumari and Chamundeswari (2005), Ahmed *et al.* (2006), Murthy *et al.* (2006), Rao and Rajamani (2009) and Bazi (2011).

4.2.5 Number of Bolls per plant

The number of bolls per plant ranged from 30.86 (L 788 x Suvin) to 82.10 (L 1376 x RHCB 011) with a mean value of 55.33. PCV (20.07) and GCV (17.82) were observed to be moderate indicating the presence of variation. These results are in accordance with Rajmani *et al.* (2009), Srinivasulu *et al.* (2010a), Venkateswarulu *et al.* (2010a) and Haritha (2011).

Moderate heritability (54.17) with high genetic advance as per cent of mean (22.63) indicated the role of both additive and non-additive gene action in the inheritance of this trait. Improvement of this trait can be aimed through cyclic hybridization, diallel selective mating and biparental mating. These results are in agreement with the findings of Iqbal *et al.* (2011) and Dhanalakshmi *et al.* (2012), Venkatesh (2012), Ranganatha *et al.* (2013) and Rao and Gopinath (2013).

4.2.6 Boll weight (g)

The boll weight ranged from 2.46 (Suvin) to 4.70 (L 1227) with general mean of 3.55. Moderate estimates of PCV (16.63) and GCV (15.87) were recorded for this trait indicating presence of variation and the findings were in accordance with those of Vijayalaxmi (2007), Neelima *et al.* (2008), Vijayalaxmi *et al.* (2008), Rajanna (2010) and Bazi (2011).

Moderate heritability (45.69) coupled with moderate genetic advance as per cent of mean (13.24) was observed indicating both additive and non-additive gene action for boll weight and offers the possibility of further improvement through mass, pure line selection, family selection or any other suitable modified selection procedures aiming to exploit additive component. In contrary to this, high heritability and high genetic advance for this trait was reported by Haritha *et al.* (2012), Santoshkumar *et al.* (2012), Venkatesh (2012), Dhanalakshmi *et al.* (2012), Ranganatha *et al.* (2013) and Rao and Gopinath (2013). This may be due to the differences in breeding material studied in different environments.

4.2.7 Seed index (g)

The variation for seed index ranged from 6.80 (L 1376 x RHCB 011) to 12.56 (L 1369 x GSB 41) with a general mean of 9.38. Moderate estimates of PCV (14.33) and GCV (12.56) were recorded for seed index indicating the presence of variation. These results are in agreement with Rajanna (2010), Dhanalakshmi (2011), Bazi (2011), Haritha *et al.* (2012) and Venkatesh (2012).

Moderate heritability (30.83) coupled with low genetic advance as per cent of mean (9.71) was noticed for seed index which may be due to the preponderance of non-additive gene action as well as influence of environment. Hence further improvement of this character would be possible either through heterosis breeding or population improvement through various forms of recurrent selection. The research findings of Sivaprasad *et al.* (2004b) and Sakthi *et al.* (2007) were in supportive of the present findings.

4.2.8 Lint index (g)

The variation for lint index was ranged from 3.06 (L 804 x DB 10) to 6.03 (L 1369 x GSB 41) with a general mean value of 4.55. The estimates of PCV (15.61) and GCV (12.59) were moderate indicating the presence of variation. These results are in accordance with findings of Vijayalaxmi (2007), Neelima *et al.* (2008) and Rao *et al.* (2009b).

Moderate heritability (31.21) and moderate genetic advance as per cent of mean (10.49) indicating both additive and non-additive gene action for lint index and offers the possibility of improvement through mass, pure line selection, family selection or any other suitable modified selection procedures aiming to exploit the additive component. Contrary to this high heritability and high genetic advance in this trait was reported by Naqib *et al.* (2010), Lu and Myers (2011), Dhanalakshmi *et al.* (2012), Haritha *et al.* (2012) and Santoshkumar *et al.* (2012).

4.2.9 Ginning out-turn (%)

The ginning out-turn ranged from 29.79 (L 1374 x DB 10) to 36.10 (L 1374) with an average of 32.65. PCV (4.97) and GCV (4.03) were recorded low for this trait indicating presence of low variability. Similar results were earlier reported by Mahantesh (2009), Sarada *et al.* (2010), Haritha *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

Low heritability (24.08) coupled with low genetic advance as per cent of mean (1.45) revealed the role of non-additive gene action in the expression of this trait. Further improvement of this character would be possible either through heterosis breeding or population improvement through various forms of recurrent selection. This is in conformity with the observations of Murthy *et al.* (2006), Srinivasulu (2009) and Venkatesh (2012).

4.2.10 2.5% Span length (mm)

The range for 2.5% span length varied from 27.20 (L 1238 x RHCB 011) to 37.20 (P 72-9-37 x Suvin) with a general mean value of 32.10. The estimates of PCV (9.84) and GCV (9.64) values were low indicating presence of low variability and the findings are in agreement with Kishore *et al.* (2011), Vineela (2011), Haritha *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

High heritability (86.38) coupled with moderate genetic advance as per cent of mean (19.94) indicating the role of additive and non-additive gene action in the inheritance of this trait. This can be improved through cyclic hybridization, diallel selective mating and biparental mating. In Contrary to this, high heritability and high genetic advance in this trait was reported by Bazi (2011) and Venkatesh (2012).

4.2.11 Micronaire value (10^{-6} g/inch)

The micronaire value ranged from 2.60 (L 804 x Suvin) to 4.21 (L 1227 x GSB 41) with a mean value of 3.54. The PCV (11.33) and GCV (10.61) were moderate indicating the presence of variation. The results are in broad agreement with Sarada *et al.* (2010), Vineela (2011), Haritha *et al.* (2012), Natera *et al.* (2012) and Venkatesh (2012).

High heritability (84.56) combined with high genetic advance as per cent of mean (21.56) indicating the preponderance of additive gene action in the inheritance of this trait and offers the scope for improvement through simple selection procedures. Similar results were earlier reported by Muhammad *et al.* (2008), Ravikesavan *et al.* (2008), Muhammad *et al.* (2010) and Bazi (2011) and Venkatesh (2012).

4.2.12 Bundle strength (g/tex)

The variation for bundle strength ranged from 21.79 (L 1376) to 30.56 (GSB 39) with a general mean value of 25.26. The PCV (7.80) and GCV (7.19) were low indicating the presence of low variation and the results are in conformity with the research findings of Rajanna (2010) and Bazi (2011), Haritha *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

The high heritability (65.52) and low genetic advance as per cent of mean (8.96) which were recorded indicating the role of additive and non-additive gene action in the inheritance of this trait. This can be improved through cyclic hybridization, diallel selective mating and biparental mating. These findings are in agreement with Sakthi *et al.* (2007), Rajanna (2010), Kulkarni *et al.* (2011) and Choudki *et al.* (2012).

4.2.13 Uniformity ratio

The uniformity ratio ranged from 45.00 (L 1376 x GSB 39) to 50.33 (L 1369 x GSB 41) with an average value of 47.58. PCV (3.30) and GCV (2.92) were recorded low indicating the presence of low variation. These results are in accordance with the reports of Mohan (2011), Kishore *et al.* (2011), Natera *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

Moderate heritability (35.55) and low genetic advance as per cent of mean (2.52) indicating the role of non-additive gene action in the inheritance of uniformity ratio would give scope for improvement of this character either through heterosis breeding or population improvement through various forms of recurrent selection. This is in conformity with the observations of Vijayalaxmi (2007), Rajanna (2010), Tulasi (2011), Choudki *et al.* (2012) and Rao and Gopinath (2013).

4.2.14 Fibre elongation (%)

The variation for fibre elongation ranged from 5.26 (DB 10) to 6.26 (L 1227 x DB 10) with a mean value of 5.83. The PCV (4.79) and GCV (4.67) were low indicating the presence of low variation and the research findings were in accordance with the reports of Mohan (2011), Kulkarni *et al.* (2011), Haritha *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

Low heritability (16.51) and low genetic advance as per cent of mean (1.75) fibre elongation indicating the role of non-additive gene action and would give scope for improvement through heterosis breeding or population improvement through various forms of recurrent selection. These results are in agreement with that of Rao (2008), Rajanna (2010), Bazi (2011) and Choudki *et al.* (2012).

4.2.15 Lint yield per plant (g)

The lint yield per plant ranged from 20.74 (Suvin) to 91.64 (L 1374 x RHCB 011) with a general mean value of 53.52. PCV (32.09) and GCV (29.85) were high indicating presence of greater variability and scope for improvement. These results are in agreement with that of Patil (2010), Vineela (2011), Natera *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

High heritability (60.15) along with high genetic advance as per cent of mean (38.02) indicating the preponderance of additive gene action in the inheritance of lint yield per plant and offers the scope for further improvement through simple selection procedures. Similar results were earlier reported by Rajanna (2010), Lu and Myers (2011), Iqbal *et al.* (2011), Venkatesh (2012) and Rao and Gopinath (2013).

4.2.16 Seed cotton yield per plant (g)

The seed cotton yield per plant ranged from 64.40 (Suvin) to 275.40 (L 1374 x RHCB 011) with a general mean value of 163.40 PCV (30.60) and GCV (28.38) were high indicating presence of greater variability and scope for improvement. These results are in agreement with that of Choudki *et al.* (2012), Natera *et al.* (2012), Santoshkumar *et al.* (2012), Venkatesh (2012), Ranganatha *et al.* (2013) and Rao and Gopinath (2013).

High heritability (63.17) and high genetic advance as per cent of mean (39.89) indicating the preponderance of additive gene action in the inheritance of seed cotton yield per plant and offers the scope for improvement through simple selection procedures. These research findings were parallel to the findings of Bazi (2011) and Iqbal *et al.* (2011), Choudki *et al.* (2012), Haritha *et al.* (2012), Venkatesh (2012), Ranganatha *et al.* (2013) and Rao and Gopinath (2013).

In the present study, wide genetic variability was observed for number of monopodia per plant, lint yield per plant and seed cotton yield per plant, where as it was moderate for plant height, number of sympodia per plant, number of bolls per plant, boll weight, lint index and micronaire and low for other parameters. The characters viz., days to 50% flowering, 2.5% span length, micronaire value, bundle strength, lint yield per plant and seed cotton yield per plant recorded high heritability. Number of monopodia per plant, number of bolls per plant, boll weight, seed index, lint index and uniformity ratio recorded moderate heritability while, plant height, number of sympodia per plant, fibre elongation and ginning out-turn recorded low heritability values.

High heritability in conjunction with high genetic advance as per cent of mean were recorded in case of micronaire value, lint yield per plant and seed cotton yield per plant indicating the preponderance of additive gene action in the inheritance of these traits and offers the scope for further improvement through simple selection procedures.

Moderate heritability coupled with high genetic advance as per cent of mean was observed for number of monopodia per plant, and number of bolls per plant indicating the operation of both additive and non-additive gene action in the inheritance of these traits. High heritability coupled with low to moderate genetic advance as per cent of mean was observed for days to 50% flowering, 2.5% span length and bundle strength indicating the role of both additive and non-additive gene action and further improvement of these traits would be possible through cyclic hybridization, diallel selective mating and biparental mating.

Low heritability and low genetic advance as percent of mean were recorded in case of number of sympodia per plant, ginning out-turn and fibre elongation indicating preponderance of non-additive gene action. Low heritability and moderate genetic advance as percent of mean was recorded in case of plant height. However, the characters which are governed by non-additive gene action need to be exploited by heterosis breeding or population improvement through various forms of recurrent selection.

4.3 Combining Ability and Gene Action

The knowledge of genetic structure and mode of inheritance of quantitative and qualitative traits help the breeders to employ suitable breeding method for improvement of these traits. Combining ability analysis is an important tool for selection of the desirable parents together with the information regarding nature and magnitude of gene controlling quantitative and qualitative traits. The information on gene action and combining ability helps in identifying the best combiners which may be hybridized either to exploit heterosis or to produce the transgressive or recombinant segregants in F_2 and subsequent generations. Exploitation of heterosis is primarily dependant on the screening and selection of the lines in the available germplasm that could produce better combinations of important characters.

The entire genetic variability observed in the analysis for each trait was partitioned into its components *i.e.* general and specific combining ability (Sprague and Tatum, 1942). General combining ability (GCA) is used to designate the average performance of a line in hybrid combinations while specific combining ability (SCA) define those cases in which certain combinations do relatively better or worse than expected on the basis of the average performance of the lines involved. The general combining ability (*gca*) effects were due to the additive type of gene action whereas, specific combining ability (*sca*) effects are due to the genes which are non-additive *i.e.* either dominant or epistatic in nature (Sprague and Tatum, 1942).

The relative importance of general and specific combining ability can be assessed by estimating the components of variance and expressed in the ratio $2\sigma^2 gca / 2\sigma^2 gca + \sigma^2 sca$ (Baker, 1978). The closer the ratio to unity, greater is the magnitude of additive gene action and vice versa. Further the gene action can be confirmed by the estimates of narrow sense heritability. Higher values of narrow sense heritability indicate the presence of additive gene action.

The purpose of this study was to determine the GCA and SCA effects for seed cotton yield, yield contributing characters and fibre quality parameters so as to choose appropriate parents and hybrids for the genetic enhancement.

In present field experiment, forty inter-specific cross combinations were made in a line x tester design utilizing 8 lines (*G. hirsutum* L.) *viz.*, L 788, L 804, P72-9-37, L 1227, L 1238, L 1369, L 1374 and L 1376 and 5 testers (*G. barbadense* L.) *viz.*, RHCB 011, Suvin, GSB 41, DB 10 and GSB 39, during *kharif* 2011-12. The forty F_1 's along with 13 parents were evaluated during *kharif* 2012-13 to study the combining ability and gene action governing 16 traits *viz.*, plant height (cm), days to 50% flowering, number of monopodia plant⁻¹, number of sympodia plant⁻¹, number of bolls plant⁻¹, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire value (10⁻⁶g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g).

The analysis of variance for combining ability revealed significant differences among crosses and line x tester effects for all the characters in line x tester effect (Table 4.3). The analysis of variance also revealed significant differences among the lines for number of monopodia per plant, number of bolls per plant, boll weight, 2.5% span

length, uniformity ratio, lint yield per plant and seed cotton yield per plant and in testers for days to 50% flowering, number of bolls per plant, 2.5% span length, micronaire value, bundle strength, lint yield per plant and seed cotton yield per plant.

The character-wise estimates of *gca* effects of parents and *sca* effects of crosses are presented in Table 4.4 and Table 4.5 and the estimates of genetic components of variance and proportional contribution of lines, testers and line x tester interaction to the total variance are presented in Table 4.6. The ratio of GCA/SCA gene action studies of seed cotton yield and its component characters are presented in Table 4.7. Individual character-wise results are discussed and presented here under.

4.3.1 Plant height (cm)

Among the lines, L 788 (10.82**) and L 1376 (7.15**) recorded significant positive *gca* effects and found to be good general combiners for plant height. While, Suvin (-6.16**) in testers exhibited significant negative *gca* effects.

The proportional contribution to the genetic variance of lines, testers and line x tester were 30.96%, 6.25% and 62.77%. The lines had contributed more to the genetic variance as compared to testers involved while the line x tester component had the maximum share towards genetic variance. The estimated components of variance due to *gca* (7.57) was lower than *sca* (130.88**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.06, which revealed the operation of non-additive gene action. As non-additive gene action was predominant, breeding methods involving selection, intermating among selected ones and reselection may help to improve this trait besides exploiting the methods of heterosis breeding. Similar results were earlier reported by Patil *et al.* (2011b), Tulasi (2011), Patel *et al.* (2012), Venkatesh (2012), Vineela *et al.* (2012b) and Simon *et al.* (2013).

Out of 40 crosses only 9 crosses viz., L 1369 x GSB41 (25.34**), L 1374 x GSB 39 (19.65**), L 1376 x RHCB 011 (19.65**), L 1374 x DB 10 (19.50**), L 788 x GSB 39 (18.29**), L 804 x DB 10 (11.20**), L 1374 x Suvin (10.70**), P 72-9-37 x RHCB 011 (10.05*), L 1227 x GSB 39 (8.32*) and P 72-9-37 x GSB 39 (8.17*) recorded positive significant *sca* effects. Out of these, L 788 x GSB 39 (high x low), L 1369 x GSB 41 (low x low), L 1374 x GSB 39 (low x low) were found to be superior based on their *per se* performance and *sca* effects. Superiority of the hybrids from low x low

general combiners may due to the high nicking ability of the parents while the hybrid from high x low general combiners indicated the role of additive x non-additive genetic component of variance which may be due to the complementary gene action and are likely to throw desirable transgressive segregants.

4.3.2 Days to 50% flowering

The lines L 788 (-1.13**), L 804 (-1.52**) and L 1376 (-2.19**) and the tester DB 10 (-2.91**) and GSB 39 (-4.45**) exhibited significant negative *gca* effects suggesting that they were good general combiners with favourable genes for earliness.

The testers (62.05%) had contributed more to the genetic variance as compared to the lines (17.31%) and line x tester (20.63%). The estimated components of variance due to *gca* (7.87) was greater in magnitude than *sca* (3.99**). The ratio of general combining ability component of variance to specific combining ability of variance was 1.97 which revealed the operation of additive gene action. This showed the possibility of improvement of this trait through selection, inter-mating among the selected ones and reselection besides heterosis breeding. This trait can be improved by hybridization followed by simple selection through pedigree method of breeding. These results were in agreement with the studies of Reshmi *et al.* (2007), Kalpande *et al.* (2008), Wankhade *et al.* (2008) and Shinde *et al.* (2012).

Out of 40 cross combinations evaluated, 11 crosses showed significant negative *sca* effects. The crosses viz., L 804 x RHCB 011 (-3.10**), P 72-9-37 x RHCB 011 (-2.90**), L 1369 x GSB 39 (-2.35**), L 1238 x Suvin (-2.30**), L 1238 x GSB 39 (-2.22**), L 1227 x DB 10 (-2.16**), L 804 x Suvin (-2.10*), L 788 x GSB 39 (-2.08*), L 788 x DB10 (-2.04*), L 1369 x DB 10 (-1.89*) and L 1376 x GSB 41 (-1.56*) were found to be superior. The cross L 788 x GSB 39 (high x high) was identified as superior based on its *per se* and *sca* performance. The cross combination involving high x high general combiners indicated the role of additive and additive x additive genetic component of variance where the trait can be improved through simple selection procedures in recombinant breeding.

4.3.3 Number of Monopodia per plant

The lines L 1238 (0.42**), L 788 (0.29**), L 804 (0.26**) and L 1376 (0.19**), and GSB 39 (0.12**) in testers exhibited significant positive *gca* effects suggesting that they were good general combiners for improving this character.

The proportional contribution of line x tester (56.93%) component had contributed more to the genetic variance as compared to lines (41.33%) and testers (1.73%). The estimated components of variance due to *gca* (0.01) was lower than *sca* (0.20*). The ratio of general combining ability component of variance to specific combining ability of variance was 0.09 which revealed the operation of non-additive gene action. This showed the possibility of improvement of this trait through heterosis breeding. Rajanna (2010), Patil *et al.* (2011b), Tulasi (2011), Shinde *et al.* (2012) and Vineela *et al.* (2012b) also observed similar findings through their studies.

Out of 40 crosses only 12 crosses viz., L 804 x Suvin (0.80**), P 72-9-37 x RHCB 011 (0.75**), L 1227 x GSB 39 (0.72**), L 788 x Suvin (0.64**), L 1374 x GSB 39 (0.63**), L 1376 x RHCB 011 (0.63**), L 1238 x GSB 41 (0.39**), L 788 x DB 10 (0.34*), L 1374 x RHCB 011 (0.32*), L 1376 x DB 10 (0.29*), L 1374 x GSB 39 (0.27*) and L 1376 x Suvin (0.27*) showed significant *sca* effect. The cross combinations viz., L 804 x Suvin (high x low) and L 788 x Suvin (high x low) were found to be promising based on *per se* and *sca* performance and indicated the role of additive x non-additive genetic component of variance and superiority may be due to the complementary gene action.

4.3.4 Number of Sympodia per plant

The lines L 1376 (1.78**) and L 1374 (0.81**) and GSB 39 (0.98**) in testers exhibited significant positive *gca* effects suggesting that they were good general combiners for improving this character.

The proportional contribution to the genetic variance of lines, testers and line x tester were 18.07%, 9.27% and 72.65%. The lines had contributed more to the genetic variance as compared to testers involved while the line x tester component had the maximum share towards genetic variance. The estimated components of variance due to *gca* (-0.03) was lower than *sca* (3.77**). The ratio of general combining ability component of variance to specific combining ability of variance was -0.01, which revealed the operation of non-additive gene action. As non-additive gene action was predominant, breeding methods involving selection, intermating among the selected ones and reselection may help to improve this trait besides exploiting the methods of heterosis breeding. These results are in agreement with the findings of Senthilkumar *et al.* (2010), Rajanna (2010), Patil *et al.* (2011b), Tulasi (2011) and Vineela *et al.* (2012b).

Out of 40 cross combinations evaluated, 7 crosses viz., L 1376 x GSB 41 (4.05**), L 1374 x DB 10 (3.49**), L 1369 x DB 10 (3.31**), L 1374 x RHCB 011 (2.68**), L 1376 x DB 10 (2.65**), L 788 x GSB 39 (2.48**) and P 72-9-37 x RHCB 011 (1.69**) showed significant positive *sca* effects. The crosses *i.e.*, L 1376 x GSB 41 (high x low) and L 1376 x DB 10 (high x low) were identified as superior based on their *per se* and *sca* performance. The superiority in the crosses may be due to complementary gene action and also revealed the importance of both additive and non-additive gene action.

4.3.5 Number of Bolls per plant

The lines L 1376 (11.94**) and L 1374 (7.84**) and DB 10 (8.48**) in testers exhibited significant positive *gca* effects suggesting that they were good general combiners for improving this character.

Lines (39.69%) component had major proportional contribution to the genetic variance as compared to testers (21.56%) and line x tester (38.74%). The estimated components of variance due to *gca* (26.58) was lower than *sca* (53.17**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.54, which revealed the operation of additive and non-additive gene action. This trait can be improved by selecting breeding methods such as diallel selective mating or bi-parental mating and advancing through pedigree method to exploit both additive and non-additive gene actions. Similar results were earlier reported by Kiani *et al.* (2007), Panhwar *et al.* (2008), Patel *et al.* (2009), Bbebe *et al.* (2010) and Wandhare *et al.* (2010a).

Out of 40 cross combinations evaluated, 6 crosses L 1376 x RHCB 011 (13.61**), L 1374 x Suvin (11.89**), P 72-9-37 x GSB 41 (10.63**), L 1238 x DB 10 (9.50**), L 788 x DB 10 (8.54**) and P 72-9-37 x GSB 39 (7.94**) showed significant positive *sca* effects. Based on *per se* and *sca* performance L 1376 x RHCB 011 (high x low) and L 1238 x DB10 (low x high) were found to be superior. The low x high and high x low general combiners indicated the role of additive x non-additive genetic component of variance and superiority resulted may be due to complementary gene action and are likely to throw desirable transgressive segregants.

4.3.6 Boll weight (g)

The lines L 1238 (0.67**), L 788 (0.31**) and L 1374 (0.25**) exhibited significant positive *gca* effects and identified as good general combiners for improving boll weight. Among the testers Suvin (-0.09*) exhibited significant negative *gca* effects.

The proportion of lines (56.93%) had contributed more to the genetic variance as compared to the testers (1.14%) and line x tester (41.92%). The estimated components of variance due to *gca* (0.03) was lower than *sca* (0.12*). The ratio of general combining ability component of variance to specific combining ability of variance was 0.30, which revealed the operation of non-additive gene action. Breeding methods involving selection, intermating among selected ones and reselection may help to improve this trait besides exploiting the methods of heterosis breeding. Similar results were earlier reported by Rajanna (2010), Patil *et al.* (2011b), Mohan (2011), Shinde *et al.* (2012) and Vineela *et al.* (2012b).

Out of 40 crosses evaluated, 12 crosses showed significant positive *sca* effects viz., L 1376 x GSB 41 (0.63**), L 1369 x DB 10 (0.55**), L 1374 x DB 10 (0.45**), L 1376 x DB 10 (0.39**), L 804 x RHCB 011 (0.38**), L 1227 x GSB 39 (0.33**) and L 1369 x RHCB 011 (0.33**), L 1374 x GSB 41 (0.33**), L 1238 x RHCB 011 (0.24*), L 1238 x Suvin (0.23*), P 72-9-37 x RHCB 011 (0.21*) and L 788 x GSB 39 (0.21*). Based on *per se* and *sca* performance, the cross L 1238 x Suvin (high x low) was found to be superior which may be due to complementary gene action.

4.3.7 Seed index (g)

L 1369 (1.20**) and L 1227 (0.43**) in lines and Suvin (0.57**) and GSB 41 (0.45**) in testers exhibited significant positive *gca* effects implying that they are good general combiners and can be used in hybridization programme for improving seed index in cotton.

Line x tester (61.57%) component had major proportional contribution of to the genetic variance as compared to lines (26.14%) and testers (12.28%). The estimated components of variance due to *gca* (0.12) was lower than *sca* (1.28**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.09, which revealed the operation of non-additive gene action and possibility of improvement of this trait through selection, inter-mating among the selected ones and reselection besides heterosis breeding. Similar results were earlier reported Soomro *et al.* (2010), Mohan (2011), Patil *et al.* (2011b), Venkatesh (2012) and Vineela *et al.* (2012b).

Out of 40 cross combinations evaluated, 9 crosses L 1369 x GSB 41 (1.54**), L 1376 x GSB 41 (1.48**), L 1374 x RHCB 011 (1.42**), L 788 x GSB 39 (1.26**), L 804 x RHCB 011 (1.18**), L 1369 x DB 10 (1.09**), L 1227 x Suvin (1.06**), L 1376 x DB 10 (0.93*) and L 788 x RHCB 011 (0.84*) showed significant positive *sca* effects. Out of these crosses, based on the *per se* and *sca* performance L 1369 x GSB 41 (high x high), L 1369 x DB 10 (low x high) and L 1376 x GSB 41 (low x high) were found to be superior. The cross L 1369 x GSB 41 (high x high) indicated the predominance of additive genetic component of variance which can be exploited through simple selection procedures. Whereas, the crosses L 1369 x DB 10 (low x high) and 1376 x GSB 41 (low x high) indicated the role of additive and non-additive gene action. The superiority of the cross combinations may be due to complementary gene action.

4.3.8 Lint index (g)

The estimates of *gca* effects were significant and positive for the lines L 1369 (0.51**) and L 1227 (0.27*) and P 72-9-37 (0.25*) and for the tester Suvin (0.36**) and GSB 41 (0.23**) which were found to be good general combiners and can be used in hybridization programme for improving this character.

The proportional contribution of line x tester (61.03%) to the genetic variance was more as compared to lines (24.60%) and testers (14.36%). The estimated components of variance due to *gca* (0.03) was lower than *sca* (0.32*). The ratio of general combining ability component of variance to the specific combining ability of variance was 0.11, which revealed the operation of non-additive gene action. As non-additive gene action was predominant, breeding methods involving selection, intermating among selected ones and reselection may help to improve this trait besides exploiting different methods of heterosis breeding. Similar results were earlier reported by Haritha *et al.* (2012), Patil *et al.* (2011b), Mohan (2011), Venkatesh (2012) and Vineela *et al.* (2012b).

Out of 40 cross combinations evaluated, 7 crosses showed significant positive *sca* effects viz., L 1374 x RHCB 011 (1.03**), L 1369 x GSB 41 (0.84**), L 1376 x GSB 41 (0.84**), L 1227 x Suvin (0.58*), L 788 x GSB 39 (0.55*), L 804 x RHCB 011 (0.52*) and L 1376 x DB 10 (0.50*). Based on *per se* and *sca* performance the crosses *i.e.*, L 1374 x RHCB 011 (high x high) and L 1369 x GSB 41 (high x high) and L 1227 x Suvin (high x high) were identified as promising which indicated the role of additive genetic component of variance and can be exploited through simple selection procedures in recombinant breeding.

4.3.9 Ginning out-turn (%)

The estimates of *gca* effects were significant and positive for the lines P 72-9-37 (0.53*) and L 1238 (0.50*) and for the tester Suvin (0.43*) which were found to be good general combiners.

The proportional contribution of line x tester (62.59%) to the genetic variance was more as compared to lines (25.82%) and testers (11.57%). The estimated components of variance due to *gca* (0.05) was lower than *sca* (0.38*). The ratio of general combining ability component of variance to specific combining ability of variance was 0.13, which revealed the operation of non-additive gene action and breeding methods involving selection, intermating among the selected ones, reselection and heterosis breeding may help to improve this trait. Similar results were earlier reported Panhwar *et al.* (2008), Patel *et al.* (2009), Bbebe *et al.* (2010), Dhanalakshmi (2011) and Tulasi (2011).

Out of 40 crosses evaluated, 2 crosses showed significant positive *sca* effects viz., L 1374 x RHCB 011 (1.72**) and P 72-9-37 x DB 10 (1.22**). Based on *per se* and *sca* performance the cross P 72-9-37 x DB 10 (high x low) was found superior and indicated the role of both non-additive and additive genetic component of variance which may be due to the complementary gene action.

4.3.10 2.5% Span length (mm)

Lines P 72-9-37 (2.00*), L 1376 (1.05**) and L 804 (0.53**) and the testers GSB 39 (3.02**) and Suvin (2.36**) exhibited the estimates of *gca* effects significant and positive and were found to be good general combiners in hybridization programme for improving 2.5% span length of the fibre.

The tester (69.12%) proportional contribution to the genetic variance was more as compared to the lines (17.49%) and line x tester (13.38%). The estimated components of variance due to *gca* (5.34) was greater in magnitude than *sca* (1.63**). The ratio of general combining ability component of variance to specific combining ability of variance was 3.27, which revealed the operation of additive gene action and the possibility of improvement of this trait through simple selection procedures in recombinant breeding. These results are in agreement with the findings of Karademir *et al.* (2009), Wandhare *et al.* (2010b), Patil *et al.* (2011b), Mohan (2011) and Amir *et al.* (2013).

Out of 40 crosses evaluated, 11 crosses L 1376 x DB 10 (2.24**), L 788 x GSB 41 (2.22**), L 1374 x GSB 39 (2.08**), L 1369 x DB 10 (1.48**), L 1227 x RHCB 011 (1.12**), P 72-9-37 x GSB 41 (1.09**), L 1238 x GSB 39 (0.98**), P 72-9-37 x RHCB 011 (0.94*), L 1376 x GSB 41 (0.91**), L 804 x DB 10 (0.86**) and L 1238 x Suvin (0.84*) showed significant positive *sca* effects. Out of these crosses based on *per se* and *sca* performance the cross L 1238 x GSB 39 (low x high) was found to be superior indicated the role both the non-additive and additive genetic component of variance may be due to the complementary gene action.

4.3.11 Micronaire value (10^{-6} g/inch)

The estimates of *gca* effects were significant and positive for the lines L 1227 (0.13**) and for the testers DB 10 (0.15**) and RHCB 011 (0.47**) which were found to be good general combiners and may be involved in basic breeding programmes for improvement of micronaire value of the fibre.

The proportional contribution of lines, testers and line x tester to the total genetic variance were 5.91%, 78.24% and 15.84% respectively. The testers component was more to genetic variance as compared to lines and line x tester. The estimated components of variance due to *gca* (0.07) was greater than *sca* (0.02*). The ratio of general combining ability component of variance to specific combining ability of variance was 3.37 which revealed the operation of additive gene action. This trait can be improved by hybridization followed by simple selection through pedigree method of breeding. The results are in accordance with the earlier findings of Haritha *et al.* (2012), Natera *et al.* (2012), Venkatesh (2012) and Rao and Gopinath (2013).

Four crosses exhibited significant positive *sca* effects viz., L 804 x GSB 39 (0.46**) P 72-9-37 x RHCB 011 (0.27**), L 1376 x Suvin (0.23**) and L 1374 x SUVIN (0.17*) out of 40 hybrids evaluated.

4.3.12 Bundle strength (g/tex)

The estimates of *gca* effects were significant and positive for the lines L 804 (0.60**), L 788 (0.51*) and L 1374 (0.47*) and for the tester Suvin (1.44**) and GSB 39 (0.99**) which were found to be good general combiners and can be used in hybridization programmes for improving this trait.

The proportional contribution of testers (52.45%) component to the genetic variance was more as compared to lines (14.29%) and line x tester (33.25%). The estimated components of variance due to *gca* (0.08) was lesser than *sca* (0.77*). The ratio of general combining ability component of variance to specific combining ability of variance was 1.04, which revealed the operation of additive gene action which could be easily improved through simple selection procedures in recombination breeding. The results were in agreement with the findings of Kalpande *et al.* (2008), Bhaskaran and Ravikesavan (2008), Basal *et al.* (2009), Wandhare *et al.* (2010b) and Amir *et al.* (2013).

Among the 40 crosses evaluated, 3 crosses viz., P 72-9-37 x DB 10 (2.23**), L 1227 x GSB 39 (1.80**) and L 788 x GSB 41 (1.38**) showed significant positive *sca* effects. Based on *per se* and *sca* performance, the cross L 1227 x GSB 39 (high x low) was identified as superior which indicated the predominance of both non-additive and additive genetic component of variance may be due to complementary gene action.

4.3.13 Uniformity ratio

The estimates of *gca* effects for uniformity ratio were significant and positive for the lines L 1369 (1.28**) and L 1227 (1.02**) and L 1238 (0.75**) and L 804 (0.68**), and for the tester GSB 41 (0.63**) which were found to be good general combiners with favourable genes for improving this character.

The proportional contribution of line x tester (53.73%) to the genetic variance was more as compared to lines (39.98%) and testers (6.28%). The estimated components of variance due to *gca* (0.23) was lower than *sca* (1.55**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.15, which revealed the operation of non-additive gene action. This showed the possibility of improvement of this trait through selection, inter-mating among selected ones reselection besides heterosis breeding. The results are in line with the research findings of Patil *et al.* (2011b), Mohan (2011), Tulasi (2011), Vineela *et al.* (2012b) and Rao and Gopinath (2013).

Seven crosses showed significant positive *sca* effects viz., P 72-9-37 x RHCB 011 (1.98**), L 1238 x GSB 39 (1.96**), L 1376 x Suvin (1.84**), L 1374 x RHCB 011 (1.64**), L 1374 x DB 10 (1.39**), L 1369 x DB 10 (1.26**) and L 1227 x GSB 41 (0.86*). Out of these crosses based on *per se* and *sca* performance L 1369 x DB 10

(high x low) and L 1238 x GSB 39 (high x low) were found to be superior and indicated the role of both non additive and additive genetic component of variance which may be due to complementary gene action and likely to throw transgressive segregants.

4.3.14 Fibre elongation (%)

The estimates of *gca* effects fibre elongation were significant and positive for the lines L 1227 (0.22**) and P 72-9-37 (0.11**) and L 1238 (0.05**) and for the tester DB 10 (0.05**) and GSB 41 (0.04**) which were found to be good general combiners and can be used in hybridization programme for improving this character.

The proportional contribution of line x tester (77.21%) to the genetic variance was more as compared to lines (19.12%) and testers (3.65%). The estimated components of variance due to *gca* (-0.004) was lower than *sca* (-0.01). The ratio of general combining ability component of variance to specific combining ability of variance was -0.05, which revealed the operation of non-additive gene action. This showed the possibility of improvement of this trait through selection, inter-mating among selected ones reselection besides heterosis breeding. The results are in line with the research findings of Haritha *et al.* (2012), Tulasi (2011), Venkatesh (2012) and Rao and Gopinath (2013).

Out of 40 crosses evaluated, 16 crosses The crosses viz., L 1369 x GSB 39 (0.46**), L 1376 x Suvin (0.40), L 804 x Suvin (0.38**), P 72-9-37 x RHCB 011 (0.33**), P 72-9-37 x Suvin (0.29**), L 788 x DB 10 (0.25**), L 1369 x DB 10 (0.24**), L 1374 x GSB 41 (0.21**), L 1238 x RHCB 011 (0.20**), L 788 x GSB 41 (0.19**), L 1238 x GSB 41 (0.14**), P 72-9-37 x GSB 39 (0.13**), L 1238 x DB 10 (0.13**), L 1227 x RHCB 011 (0.12**), L 1376 x GSB 41(0.11**) and L 1227 x DB 10 (0.10**) showed significant positive *sca* effects. Based on the *per se* and *sca* performance, the crosses L1227 x DB 10 (high x high), P 72-9-37 x RHCB011 (low x low) and L 1369 x GSB 39 (low x low) were found to be superior. The cross from high x high general combiners indicated the role of additive genetic component of variance and can be improved through simple selection procedures, while the superiority of the crosses from low x low general combiners may be due to the nicking ability/genetic diversity of their parents.

4.3.15 Lint yield per plant (g)

The estimates of *gca* effects were significant and positive for lint yield per plant the lines L 1238 (14.21**) and L 1227 (5.08**) and L1376 (3.33*), and for the tester RHCB 011 (13.65**) which were found to be good general combiners.

The proportional contribution of testers (36.19%) to the genetic variance was more as compared to lines (27.64%) and line x tester (36.16%). The estimated components of variance due to *gca* (66.61) was lower than *sca* (94.06**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.71, which revealed the operation of additive gene action. The improvement of this trait is possible through simple selection by recombination breeding. Similar results were earlier reported by Pole *et al.* (2008a), Patel *et al.* (2009) and Rao and Gopinath (2013).

Out of 40 cross combinations evaluated, 5 crosses viz., L 1227 x GSB 41 (24.15**), L 1374 x RHCB 011 (23.73**), L 1238 x GSB 41 (19.09**), L 1369 x GSB 39 (15.07**) and L 788 x GSB 41 (12.12**) showed significant positive *sca* effects. Based on *per se* and *sca* performance the crosses L 1374 x RHCB 011 (low x high), L 1227 x GSB 41 (high x low) and L 1227 x GSB 41 (high x low) were found to be superior. These crosses indicated the role of both non-additive and additive genetic component of variance and superiority of crosses may be due to complementary gene action and are likely to produce desirable transgressive segregants.

4.3.16 Seed cotton yield per plant (g)

The estimates of *gca* effects for seed cotton yield per plant were significant and positive for the lines L 1238 (40.68**) and L 1227 (14.71**), and for the tester RHCB 011 (43.52**) which were found to be good general combiners with favourable genes for improving this trait.

The proportional contribution of line x tester (33.73%) to the genetic variance was more as compared to lines (26.38%) and testers (39.88%). The estimated components of variance due to *gca* (668.95) was lower than *sca* (806.54**). The ratio of general combining ability component of variance to specific combining ability of variance was 0.83 which revealed the significance of additive gene action. The improvement of this trait is possible through simple selection by pedigree method. Similar results were earlier reported by Mohan (2011), Tariq and Uzair (2012), Amir *et al.* (2013) and Rao and Gopinath (2013).

Out of 40 crosses evaluated, 5 crosses viz., L 1227 x GSB 41 (73.68**), L 1374 x RHCB 011 (62.33**), L 1238 x GSB 41 (53.58**), L 1369 x GSB 39 (49.66**) and L 788 x GSB 41 (37.40**) showed significant positive *sca* effect. Based on *per se* and *sca* performance, the crosses L 1374 x RHCB 011 (low x high), L 1238 x GSB 41 (high x low) and L 1227 x GSB 41 (high x low) were found superior and indicated the role of both non-additive and additive genetic component of variance which resulted in superior cross combinations may be due to complementary gene action and are likely to throw desirable transgressive segregants.

The ratio of general combining ability components of variance to specific combining ability components of variance indicated the preponderance of additive gene action for days to 50% flowering, 2.5% span length, micronaire, bundle strength, lint yield per plant and seed cotton yield per plant. Whereas, the number of bolls per plant was influenced by both additive and non-additive gene action. Non-additive gene action is important for plant height, number of monopodia per plant, number of sympodia per plant, boll weight, seed index, lint index, ginning out-turn, uniformity ratio and fibre elongation. The traits governed by additive gene action may be exploited through simple selection procedures in recombination breeding or pedigree method of breeding. The traits governed by both additive and non-additive gene action may be improved through biparental mating or diallel selective mating or any form of recurrent selection in the early generations followed by the process of selection. Whereas, the traits governed by non-additive gene action can be improved through breeding methods involving selection, intermating of selected individuals and reselection besides heterosis breeding.

As per the combining ability results, it can be concluded that the choice of the parents for breeding programme should be based not only on the *per se* performance and *gca* effects but also on *sca* effects of the cross combinations. Parents with good individual performance and good *gca* effects may not nick well, on the other hand, parents with poor *gca* effect may nick well in combination due to complementary gene action.

The cross combinations involving high x high general combiners revealed the additive and additive x additive genetic component of variance where the characters could be easily improved through simple selection procedures in recombination breeding.

The cross combinations involving high x low or low x high general combiners with significant *sca* effects which are likely to produce desirable transgressive segregants can be studied through biparental mating or diallel selective mating or any other form of recurrent selection in the early generations followed by single plant selection to exploit both additive and non-additive gene actions.

The cross combinations involving low x low general combiners may be due to nicking ability/genetic diversity of their parents.

The proportional contribution of line x tester towards the genetic variation was maximum to the characters *viz.*, plant height, number of monopodia per plant, number of sympodia per plant, seed index, lint index, ginning out-turn, uniformity ratio and fibre elongation. The lines had shown maximum contribution to the variability in case of boll weight. Whereas, the testers contributed maximum to the characters days to 50% flowering, 2.5% span length, micronaire, bundle strength, lint yield per plant and seed cotton yield per plant (Table 4.6).

The details of promising parents identified with good general combining ability for different yield and yield components traits were presented in Table 4.8. Based on *gca* effects among the lines, L 1227 was identified as good general combiner for the characters *viz.*, days to 50% flowering, seed index, lint index, micronaire, uniformity ratio, fibre elongation, lint yield per plant and seed cotton yield per plant and the line L 1238 was identified as good general combiner for the characters *viz.*, number of monopodia per plant, boll weight, ginning out-turn, uniformity ratio, fibre elongation, lint yield per plant and seed cotton yield per plant. Among the testers, RHCB 011 was identified as good general combiner for the characters *viz.*, days to 50% flowering, micronaire, lint yield per plant and seed cotton yield per plant, followed by the tester Suvin for days to 50% flowering, seed index, lint index, ginning out-turn, 2.5% span length and bundle strength and the tester GSB 41 for days to 50% flowering, seed index, lint index, ginning out –turn, uniformity ratio and fibre elongation.

4.3 HETEROSIS

The phenomenon of heterosis has proved to be the most important genetic tool in boosting the yield of self as well as cross pollinated crops and is considered as the most important breakthrough in the field of crop improvement. Shull (1914) coined the term heterosis and it is the phenomenon in which the F_1 of two genetically dissimilar

parents show increased vigour for various characters over the mid parent (relative heterosis) or better parent (heterobeltiosis) or the superior check (standard heterosis). Studies on the magnitude of heterosis in F_1 s helps in assessing the ability of the lines (test genotypes) to transmit the desirable characters to the F_1 s upon hybridization. This facilitates in identification of lines that exhibit high amount of exploitable heterosis. It also contributes to choose genotypes with desired genetic variance, vigour and maternal effects.

In cotton, Mell (1984) first observed increased fibre length and agronomic characters of F_1 over both the parents in a cross between *G. hirsutum* L. and *G. barbadense* L. Cock (1909) suggested the possibility of commercial exploitation of heterosis in cotton. Later on heterosis it was extensively studied by various workers in diploids and tetraploids, both in intra-specific and inter-specific crosses. In inter-specific crosses, significant heterosis was reported for seed cotton yield and bolls per plant (Balasubramanian and Narayana, 1948; Santhanam, 1951; Krishnaswami and Kothandaraman, 1977; Krishnamurthy and Henry, 1979; Kolte and Thombre, 1984; Amalraj and Gawande, 1986). Some workers also observed heterosis for fibre length (Iyengar and Rangaswamy, 1956; Pandya and Patel, 1957). Heterosis was higher in inter-specific crosses (*G. hirsutum* L. x *G. barbadense* L.) compared to intra-barbadense crosses (Ranganadhacharyulu and Apparao, 1986).

The character-wise results of relative heterosis, heterobeltiosis and standard heterosis are discussed here under and presented in Table 4.9. Based on the overall performance (*per se* performance, high *sca* effects and standard heterosis), the best heterotic combinations identified for yield and yield components are presented in Table 4.10.

4.4.1 Plant height (cm)

Heterosis for plant height over mid parent, better parent and superior check ranged from -0.98 (L 1227 x GSB 41) to 52.11 (L 1369 x GSB 41), -6.46 (L 1227 x GSB 41) to 47.46 (L 788 x GSB 41) and -10.9 (L 1227 x GSB 41) to 25.27 (L 788 x GSB 41) with mean value of 21.06, 6.34 and 3.98 respectively. Thirty crosses, thirty one crosses and eleven crosses had showed positive significant heterosis over parent, better parent and superior check respectively. The best heterotic combinations identified were viz., L 788 x GSB 41, L 788 x GSB 39, L 804 x DB 10, L 804 x GSB 39, P 72-9-37 x RHCB 011, L 1369 x GSB 41, L 1374 x Suvin, L 1374 x DB 10, L 1374 x GSB 39, L 1376 x RHCB 011 and L 1376 x GSB 41 over mid parent, better parent and standard check respectively.

The results are in agreement with the research findings of Deosarkar *et al.* (2009a), Patel *et al.* (2012), Punitha *et al.* (2012) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.2 Days to 50% flowering

The mean value of heterosis for days to 50 % flowering over mid parent, better parent and standard check was found to be 1.50, -6.83 and 7.76 respectively. Heterosis over mid parent ranged from -10.08 (L 1369 x GSB 39) to 10.34 (L 1238 x GSB 41), over better parent -14.50 (L 788 x GSB 39) to 0.10 (P 72-9-37 x DB 10) and over standard check -5.00 (L 788 x GSB 39) to 20.00 (P 72-9-37 x Suvin).

Crosses exhibited significant negative heterosis over mid parent, over better parent and over standard check were five, twenty four and one respectively. The best heterotic combination identified was L 788 x GSB 39 over mid parent, better parent and standard check. Deosarkar *et al.* (2009a) who had reported significant negative heterosis compared to all heterosis.

4.4.3 Number of Monopodia per plant

The mean value of heterosis for number of bolls per plant over mid parent, better parent and standard check was found to be 40.51, 19.51 and -5.48 respectively. Heterosis over mid parent ranged from -35.26 (L 1374 x Suvin) to 285.26 (L 1374 x GSB 39), over better parent -48.00 (P 72-9-37 x GSB 39) to 266.00 (L 1374 x GSB 39) and over standard check -54.44 (L 1374 x Suvin) to 51.67 (L 804 x Suvin). Twenty crosses, three crosses and seven crosses had showed positive significant heterosis over parent, better parent and superior check respectively. The best heterotic combinations identified were viz., L 788 x Suvin, L 804 x Suvin, L 788 x DB 10, L 1238 x GSB 41 and L 1376 x RHCB 011 over mid parent, better parent and standard check respectively.

The results in agreement with the research findings of Maisuria *et al.* (2007), Deosarkar *et al.* (2009a) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.4 Number of Sympodia per plant

Heterosis over mid parent, better parent and superior check ranged from -10.15 (L 1227 x GSB 41) to 53.35 (L 1374 x RHCB 011), -19.11 (L 1369 x GSB 39) to 51.71 (L 1376 x GSB 41) and -14.02 (L 1374 x GSB 41) to 1.07 (L 1376 x GSB 41) with mean value of 13.47, 19.51 and -5.48 respectively. Twenty two, twelve and seven

crosses had exhibited significant positive heterosis over mid parent, better parent and standard check respectively. The best heterotic combinations identified were viz., P-72-9-37 x RHCB 011, L 1374 x RHCB 011, L 1376 x RHCB 011, L 1376 x GSB 41 and L 1376 x DB 10 over mid parent, over better parent and over standard check.

The results in agreement with the research findings of Sekhar *et al.* (2012) and Deosarkar *et al.* (2009a) who had reported significant positive heterosis compared to all heterosis.

4.4.5 Number of Bolls per plant

The mean value of heterosis for number of bolls per plant over mid parent, better parent and standard check was found to be 7.69, -3.72 and 33.88 respectively. Heterosis over mid parent ranged from -34.30 (L 1238 x GSB 39) to 65.81 (L 1374 x Suvin), over better parent -38.66 (L 1238 x GSB 39) to 41.17 (L 1374 x DB 10) and over standard check -26.39 (L 788 x Suvin) to 33.88 (L 1374 x GSB 39). Thirteen crosses over mid parent, five crosses over better parent and twenty crosses over standard check exhibited significant positive heterosis. L 788 x DB 10, L 1369 x DB 10, L 1374 x DB 10, L 1376 x RHCB 011 and L 1376 x DB 10 were identified as best heterotic combinations over mid parent, over better parent and over standard check.

The results are in agreement with the research findings of Ganapathy and Nadarajan (2008), Pole *et al.* (2008b), Deosarkar *et al.* (2009a), Patel *et al.* (2012) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.6 Boll weight (g)

The mean value of heterosis for boll weight over mid parent, better parent and standard check was found to be -4.94, -19.53 and 11.69 respectively. Heterosis over mid parent ranged from -32.41 (P 72-9-37 x GSB 39) to 22.95 (L 1238 x Suvin), over better parent -39.22 (L 1374 x GSB 39) to 2.26 (L 1376 x RHCB 011) and over standard check -16.79 (L 1374 x GSB 39) to 39.36 (L 1238 x DB 10). Crosses exhibited significant positive heterosis over mid parent and over standard check were ten, and twenty one respectively.

The results indicated that hybrids had less boll weight compared to the parents, in particular the *G. barbadense* L. testers. None of the hybrids have recorded significant positive heterosis compared to mid parent, better parent and standard check.

4.4.7 Seed index (g)

Heterosis for seed index over mid parent, better parent and superior check ranged from -29.21 (L 1238 x GSB 39) to 40.15 (L 1369 × GSB 41), -33.55 (L 1374 x GSB 39) to 30.00 (L 1369 × GSB 41) and -42.21 ((L 1374 x GSB 39) to 6.80 (L 1369 × GSB 41) with mean value of 0.37, -6.43 and -20.35 respectively. Nine crosses over mid parent and five crosses over better parent exhibited significant positive heterosis.

The results indicated that the hybrids had less seed index compared to the parents, in particular the *G. barbadense* L. testers. None of the hybrids have recorded significant positive heterosis compared to mid parent, better parent and standard check.

4.4.8 Lint index (g)

The mean value of heterosis for lint index over mid parent, better parent and standard check was found to be -7.22, -10.25 and -15.96 respectively. Heterosis over mid parent ranged from -36.77 (L 1369 x GSB 41) to 28.83 (L 804 x DB 10), over better parent it ranged from -37.91 (L 1376 x RHCB 011) to 23.97 (L 1369 x GSB 41) and over standard check it ranged from -42.14 (L 804 x DB 10) to 13.84 (L 1369 x GSB 41). Seven crosses over mid parent, four crosses over better parent and five crosses over standard check exhibited significant positive heterosis. L 1369 x GSB 41 was identified as the best heterotic combination over mid parent, better parent and standard check.

The findings are in conformity with the results of Sekhar *et al.* (2012) who reported for all the positive significant heterosis.

4.4.9 Ginning out-turn (%)

Heterosis for ginning out-turn over mid parent, better parent and superior check ranged from -12.70 (L 1374 x DB 10) to 0.15 (L 1238 x DB 10), -17.45 (L 1374 x DB 10) to -2.34 (L 1238 x GSB 41) and -3.87 (L 1374 x DB 10) to 8.82 (L 1376 x Suvin) with mean value of -5.42, -9.07 and 3.72 respectively. Twelve crosses exhibited positive significant heterosis over standard check.

The results indicated that hybrids had lower ginning out-turn compared to the parents, in particular the *G. barbadense* L. testers. None of the hybrids have recorded significant positive heterosis compared to mid parent, better parent and standard check.

4.4.10 2.5% Span length (mm)

The mean value of heterosis for 2.5 % span length over mid parent, better parent and standard check was found to be 4.71, -2.74 and 0.75 respectively. Heterosis over mid parent ranged from -9.91 (L 788 x RHCB 011) to 16.31 (L 1376 x DB 10), over better parent it ranged from -12.26 (L 1374 x RHCB 011) to 7.09 (L 1376 x DB 10) and over standard check ranged from -15.96 (L 1374 x RHCB 011) to 14.93 (L 1238 x RHCB 011). Twenty four crosses over mid parent, five crosses over better parent and eighteen crosses over standard check exhibited significant positive heterosis. The best heterotic combinations identified were L 788 x GSB 41, L 1238 x RHCB 011, P 72-9-37 x GSB 41 and L 1376 x GSB 39.

The results are in agreement with the findings of Maisuria *et al.* (2007), Rajamani *et al.* (2009) and Sekhar *et al.* (2012) who reported significant positive heterosis compared to all heterosis.

4.4.11 Micronaire value (10^{-6} g/inch)

Heterosis over mid parent, better parent and superior check ranged from -25.07 (L 804 x Suvin) to 11.72 (P 72-9-37 x DB 10), -36.85 (L 804 x Suvin) to 9.14 (72-9-37 x RHCB 011) and -25.99 (L 804 x Suvin) to 19.38 (L 755 x GSB 41) with mean value of -1.21, 9.69 and -0.30 respectively. Crosses exhibited positive significant heterosis over mid parent, over better parent and standard check were five, four and thirteen respectively. The best heterotic combinations identified were P 72-9-37 x RHCB 011, P 72-9-37 x DB 10, L 1227 x GSB 41 and L 1369 x DB 10 over mid parent, over better parent and over standard check.

The results are in accordance with the research findings of Rajamani *et al.* (2009) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.12 Bundle strength (g/tex)

The mean value of heterosis over mid parent, better parent and standard check was found to be 2.22, -6.42 and 7.09 respectively. Heterosis over mid parent ranged from -7.83 (P 72-9-37 x GSB 39) to 9.46 (L 1374 x GSB 39), over better parent -19.08 (P 72-9-37 x GSB 39) to 2.58 (P 72-9-37 x DB 10) and over standard check -5.59 (L 1369 x GSB 39) to 17.60 (L 788 x Suvin). Four crosses over mid parent and eight

crosses over standard check exhibited significant positive heterosis. The best heterotic combination identified was L 804 x Suvin over mid parent, over better parent and over standard check.

The results are in conformity with the reports of Maisuria *et al.* (2007) and Sekhar *et al.* (2012) who had reported for significant positive heterosis compared to all heterosis.

4.4.13 Uniformity ratio

Heterosis over mid parent, better parent and superior check ranged from -3.91 (L 1376 x GSB 39) to 7.58 (L 1227 x Suvin), -6.80 (L 1376 x GSB 39) to 6.57 (L 1376 x Suvin) and -6.90 (L 1376 x GSB 39) to 4.14 (L 1369 x DB 10) with mean value of 1.77, 0.45 and -1.14 respectively. Seventeen crosses over mid parent, twelve crosses over better parent and eight crosses over standard check exhibited significant positive heterosis. The best heterotic combinations identified were L 804 x GSB 41, L 1227 x Suvin, L 1227 x GSB 41, L 1238 x GSB 41, L 1238 x GSB 39, L 1369 x Suvin, L 1369 x GSB 41 and L 1369 x DB 10 over mid parent, better parent and standard check.

The results were in agreement with the findings of Maisuria *et al.* (2007) and Rajamani *et al.* (2009) who had reported significant positive heterosis compared to all heterosis.

4.4.14 Fibre elongation (%)

The mean value of heterosis over mid parent, better parent and standard check was found to be 5.34, 3.08 and 0.54, respectively. Heterosis over mid parent ranged from -5.85 (L 1376 x GSB 39) to 16.41 (P 72-9-37 x RHCB 011), over better parent from -9.04 (L 1376 x GSB 39) to 16.05 (P 72-9-37 x RHCB 011) and over standard check from -8.52 (L 1376 x GSB 39) to 6.82 (P 72-9-37 x RHCB 011) respectively. Twenty eight crosses over mid parent, twenty three over better parent and eighteen crosses over standard check exhibited significant positive heterosis. Some of the best heterotic combinations were enlisted here viz., L 788 x GSB 41, L 788 x DB 10, L 804 x Suvin, L 1238 x RHCB 011, P 72-9-37 x RHCB 011, P 72-9-37 x GSB 39, L 1227 x RHCB 011, L 1227 x GSB 41, L 1227 x DB 10, L 1227 x GSB 39, P 72-9-37 x Suvin, L 1238 x GSB 41, L 1238 x DB 10, L 1374 x GSB 41, L 1376 x Suvin and L 1376 x GSB 41.

The results are in agreement with the findings of Maisuria *et al.* (2007) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.15 Lint yield per plant (g)

Heterosis over mid parent, better parent and superior check ranged from -23.43 (L 1376 x GSB 39) to 68.05 (L 1374 x RHCB 011), -55.56 (L 804 x Suvin) to 24.31 (P 72-9-37 x RHCB 011) and -38.69 (L 1238 x RHCB 011) to 101.48 (L 1374 x RHCB 011) with mean value of 4.97, -22.15 and 16.92 respectively. Thirteen crosses over mid parent, one crosses over better parent and fourteen crosses over standard check exhibited significant positive heterosis. The best heterotic combinations identified were P-72-9-37 x RHCB 011, L 1238 x GSB 41 and L 1374 x Suvin over mid parent, better parent and standard check.

The results are in agreement with the findings of Pole *et al.* (2008b), Deosarkar *et al.* (2009a), Patel *et al.* (2012) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to all heterosis.

4.4.16 Seed cotton yield per plant (g)

Heterosis over mid parent, better parent and superior check ranged from -23.35 (L 804 x Suvin) to 75.99 (L 1374 x RHCB 011), -51.69 (L 804 x Suvin) to 37.17 (P 72-9-37 x RHCB 011) and -40.52 (L 1238 x RHCB 011) to 87.77 (L 1374 x RHCB 011) with mean value of 12.17, -14.50 and -12.68, respectively. Ten crosses over mid parent, seven crosses over better parent and nine crosses over standard check exhibited significant positive heterosis. The best heterotic combinations identified were L 804 x RHCB 011, L 1238 x GSB 4, L 1369 x GSB 39 and L 1374 x Suvin over mid parent, better parent and standard check.

The results are in agreement with the findings of Maisuria *et al.* (2007), Rajamani *et al.* (2009), Deosarkar *et al.* (2009a), Basamma *et al.* (2010), Balu *et al.* (2012) and Sekhar *et al.* (2012) who had reported significant positive heterosis compared to heterosis.

Thus, in inter-specific crosses significant positive heterosis was observed for plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, lint index, 2.5 span length, micronaire, uniformity ratio bundle strength,

fibre elongation, lint yield per plant and seed cotton yield per plant. In fact, negative heterosis for certain characters like days to 50% flowering is desirable since inter-specific hybrids with negative heterosis produce hybrids which are early in duration compared to their *barbadense* parents.

Thus, in the present study the cross, L 1374 × RHCB 011, L 1238 x GSB 41 and L 1227 X GSB 41 found to be promising for lint yield and seed cotton yield. Based on *per se* performance, heterosis and combining ability effects, these hybrids can be exploited through heterosis breeding for commercial cultivation after thorough testing in wider environments for further confirmation. These crosses can also be utilized for further exploitation in segregating generations and superior segregants to isolate from these cross derivatives.

4.5 CHARACTER ASSOCIATION

Seed cotton yield is a polygenically controlled complex character resulting from multiplicative interaction of yield components. The cumulative effects of such characters which determine the dependent variable yield. These characters play an important role in modifying the system of seed cotton yield as a whole in magnitude as well as in direction. Further, direct selection for seed cotton yield is not effective as it is a complex quantitative character and much influenced by environment. The change in one character brings about a series of changes in other characters, since they are interrelated. Therefore, the study of correlation between yield and yield components are of considerable importance in selection programmes. The phenotypic and genotypic correlation coefficients between seed cotton yield and other related component characters and among themselves were estimated for 13 parents and 40 crosses was presented in Table 4.11. The results of correlation are discussed character wise here under.

4.5.1 Plant height (cm)

Plant height recorded significant positive association with number of monopodia per plant (0.3580** and 0.3054**), number of sympodia per plant (0.4745** and 0.3538**) and number of bolls per plant (0.2786** and 0.2218**) at both genotypic and phenotypic levels, and for uniformity ratio (0.1713*) and fibre elongation (0.1761*) at genotypic level only. The traits which had shown significant negative association at both genotypic and phenotypic levels were boll weight (-0.2152** and -0.1835*) and ginning out turn (-0.5592** and -0.4118**).

The results indicated that this trait had strong association with number of monopodia per plant, number of sympodia per plant and number of bolls per plants. Similar results were reported earlier by Batool *et al.* (2010), and Tulasi *et al.* (2012) for monopodia, Venkateswarulu *et al.* (2010b) and Rajanna *et al.* (2011) for sympodia and Tulasi *et al.* (2012) and Wang *et al.* (2012) for number of bolls.

4.5.2 Days to 50% flowering

Days to 50% flowering had shown significant positive association with bundle strength (0.3173** and 0.2816**) both at genotypic and phenotypic levels and also showed significant negative association with number of bolls per plant (-0.2702** and -0.2074**), boll weight (-0.4870** and -0.4640**), ginning out turn (-0.2999** and -0.2496**), micronaire (-0.5207** and -0.4703**), lint yield per plant (-0.3325** and -0.2710**) and seed cotton yield per plant (-0.3097** and -0.2710**) at both genotypic and phenotypic levels.

It was evident that this trait had strong association with bundle strength and was in accordance with the research findings of An *et al.* (2008), Kumar *et al.* (2010), Bazi (2011) and Venkatesh (2012).

4.5.3 Number of Monopodia per plant

Monopodia per plant showed significant positive association with number of sympodia per plant (0.2933** and 0.2060**), 2.5% span length (0.2486** and 0.2076**), bundle strength (0.2657** and 0.2407**), uniformity ratio (0.2338** and 0.2046**) and fibre elongation (0.3989** and 0.3565**) at both genotypic and phenotypic levels and showed significant negative association with ginning out turn (-0.2307** and -0.1705*) at both genotypic and phenotypic levels whereas showed significant negative association with lint index (-0.1738*) at genotypic level only.

The results indicated that this trait had strong association with number of sympodia per plant, 2.5% span length, bundle strength, uniformity ratio and fibre elongation. These results are in agreement with the findings of Rajanna *et al.* (2011) and Venkatesh (2012) for sympodia per plant, Mohan (2011) for 2.5% span length, Rao and Rajamani (2009) for uniformity ratio and Muraleedhar (2005) and Mohan (2011) for bundle strength and fibre elongation.

4.5.4 Number of Sympodia per plant

The character, number of sympodia per plant exhibited significant positive correlation with number of bolls per plant (0.3337** and 0.1954*), 2.5% span length (0.3447** and 0.2760**) and fibre elongation (0.1937* and 0.1609*) both at genotypic and phenotypic levels, while seed index (0.2235**) and bundle strength (0.1853**) at genotypic level only. This trait also showed negative significant association with ginning out-turn (-0.3179** and -0.1746*) at genotypic and phenotypic levels.

Similar trends were also evident from the studies of Mohan (2011), Rajanna *et al.* (2011), Wang *et al.* (2012) for number of bolls per plant, Tulasi *et al.* (2012) and Venkatesh (2012) for seed index, Thiyagu *et al.* (2010) and Mohan (2011) for 2.5% span length, and Haritha (2011) for bundle strength and fibre elongation.

4.5.5 Number of Bolls per plant

Phenotypic and genotypic correlation indicated that number of bolls per plant had shown significant positive correlation with micronaire (0.4657** and 0.3843**) lint yield per plant (0.2482** and 0.1648*) and seed cotton yield per plant (0.392** and 0.2996**) and significant negative association with 2.5% span length (-0.2826** and -0.254**), bundle strength (-0.2706** and -0.2026**) and uniformity ratio (-0.2375** and -0.1918*) at both at genotypic and phenotypic levels.

These results indicated that number of bolls had significant positive association with micronaire, lint yield per plant and seed cotton yield per plant at both the levels. These results were in broad agreement with the findings of Thiyagu *et al.* (2010), Venkateswarlu *et al.* (2010b) and Venkatesh (2012) for micronaire, Venkateswarlu *et al.* (2010b), Rajanna *et al.* (2011) and Venkatesh (2012) for lint yield per plant and Venkatesh (2012), Vineela *et al.* (2012a) and Wang *et al.* (2012) for seed cotton yield per plant.

4.5.6 Boll weight (g)

At both phenotypic and genotypic level, boll weight had recorded significant positive association with ginning out turn (0.5128** and 0.4003**), micronaire (0.2686* and 0.2520**), lint yield per plant (0.4171** and 0.3737**) and seed cotton yield per plant (0.3196** and 0.2873**), and significant negative association with seed index (-0.2995** and -0.2692**), 2.5% span length (-0.2582** and -0.2400**), bundle strength (-0.3857** and -0.3299**), while with the uniformity ratio (-0.1800*) at genotypic level only.

This character exhibited significant positive correlation with ginning out turn, micronaire, lint yield per plant and seed cotton yield per plant at both the levels. These results were in agreement with the reports of Kumar and Ravikesavan (2010), Mohan (2011) and Venkatesh (2012) for ginning out turn, Rao and Rajamani (2009), Kumar and Ravikesavan (2010) and Venkateswarulu *et al.* (2010b) for micronaire, Rao (2008), Rajanna *et al.* (2011) and Venkatesh (2012) for lint yield per plant and Venkatesh (2012), Vineela *et al.* (2012a) and Wang *et al.* (2012) for seed cotton yield per plant.

4.5.7 Seed index (g)

Seed index had shown significant positive correlation with lint index (0.9007** and 0.8849 **) and uniformity ratio (0.2555** and 0.1812*) and significant negative correlation with lint yield per plant (-0.236** and -0.1846*) and seed cotton yield per plant (-0.3138** and -0.2528**) both at genotypic and phenotypic levels. It showed significant negative association with ginning out turn (-0.1710*) and micronaire (-0.1754*) at genotypic level only.

The significant positive correlation of seed index with lint index and uniformity ratio at genotypic level are in conformity with the findings of Rajanna *et al.* (2011), Mohan (2011) and Venkatesh (2012) for lint index and Venkateswarulu *et al.* (2010b) and Venkatesh (2012) for uniformity ratio.

4.5.8 Lint index (g)

Both at phenotypic and genotypic level, lint had shown significant positive correlation with ginning out turn (0.2771** and 0.4205**) and significant negative association with bundle strength bundle strength (-0.1707*), fibre elongation (-0.1701*) and seed cotton yield per plant (-0.1887*) at genotypic level only.

Significant positive association of lint index with ginning out-turn at phenotypic and genotypic the levels are in agreement with the reports of Haritha (2011), Mohan (2011), Rajanna *et al.* (2011) and Venkatesh (2012).

4.5.9 Ginning out-turn (%)

Ginning out-turn had recorded significant positive correlation with lint yield per plant (0.4315** and 0.3564**) and seed cotton yield per plant (0.2566** and 0.1894*) and significant negative correlation with 2.5% span length (-0.2485** and -0.2062**),

bundle strength (-0.4511** and -0.3655**) and fibre elongation (-0.2151** and -0.1652*) both at the phenotypic and genotypic levels and significant negative correlation with uniformity ratio (-0.2103**) at genotypic level only.

Thus the improvement of ginning out-turn is possible through lint yield per plant and seed cotton yield per plant and results are in accordance with the reports of Rao (2008), Rajanna *et al.* (2011) and Venkatesh (2012) for lint yield per plant and Haritha (2011), Tulasi *et al.* (2012) and Venkatesh (2012) for seed cotton yield per plant.

4.5.10 2.5% Span length (mm)

There was a strong association of 2.5% span length with bundle strength (0.6710**and 0.6110**) and negative correlation with micronaire (-0.5645**and -0.5224**), lint yield per plant (-0.4123**and -0.3748**) and seed cotton yield per plant (-0.5964**and -0.5392**) at both genotypic and phenotypic levels.

This character exhibited significant positive association with bundle strength at both the levels. Similar findings were observed by Venkateswarlu *et al.* (2010b), Rajanna *et al.* (2011), Mohan (2011) and Venkatesh (2012).

4.5.11 Micronaire value (10^{-6} g/inch)

Micronaire recorded significant positive correlation with lint yield per plant (0.4056** and 0.3313**) and seed cotton yield per plant (0.6088** and 0.5020**) and significant negative correlation with bundle strength (-0.5864**and -0.4966**) at both the levels.

Similar trends were also evident from the studies of Rao (2008) and Venkateswarulu *et al.* (2010b) for lint yield per plant and Kumar and Ravikesavan (2010), Venkateswarlu *et al.* (2010b) and Vineela *et al.* (2012a) for seed cotton yield per plant.

4.5.12 Bundle strength (g/tex)

Both at phenotypic and genotypic levels, bundle strength had shown significant positive correlation with lint yield per plant (-0.5381**and -0.4827**) and seed cotton yield per plant (-0.4882** and -0.4283**). The results are in conformity with the earlier reports of Venkatesh (2012) for lint yield per plant and Kumar *et al.* (2010), Thiyagu *et al.* (2010) and Bazi (2011) for seed cotton yield per plant.

4.5.13 Uniformity ratio

Uniformity ratio had exhibited significant positive correlation with fibre elongation (0.1548**) and seed cotton yield per plant (0.1691*) at genotypic level only and the results are similar to previous findings of Sakthi *et al.* (2007), Mohan (2011) and Venkatesh (2012) for fibre elongation and Neelima *et al.* (2005) for seed cotton yield per plant.

4.5.14 Fibre elongation (%)

Fibre elongation had shown significant positive correlation with lint yield per plant (0.1801* and 0.1604*) and seed cotton yield per plant (0.1817* and 0.1665*) both at genotypic and phenotypic levels. This positive correlation indicates the scope for simultaneous improvements of these characters. Rao (2008) and Venkatesh (2012) for lint yield per plant and Rao (2008), Mohan (2011) and Venkatesh (2012) for seed cotton yield per plant reported similar observations.

4.5.15 Lint yield per plant (g)

The character, lint yield per plant exhibited significant positive correlation with seed cotton yield per plant (0.7680** and 0.7692**) at both the levels. This indicated that any improvement in lint yield would have a positive effect on seed cotton yield. Pratap *et al.* (2007), Vijayalaxmi *et al.* (2008), Rao (2008), Mahantesh (2009), Rajanna *et al.* (2011) and Venkatesh (2012) recorded similar results for this trait.

The character association analysis revealed that number of bolls plant⁻¹, boll weight (g), ginning out-turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ were found to have significant positive association with seed cotton yield plant⁻¹ at both phenotypic and genotypic levels. Hence, the above characters may be considered in selection programmes while improving seed cotton yield per plant.

4.6 Path Coefficient Analysis

Yield being a complex character, is composed of several components some of which affect yield directly while others contribute towards it indirectly. Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. To accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the amplification of interrelationship of various characters with standard partial correlation or regression.

Through path analysis, the direct and indirect effects of different yield component traits on seed cotton yield were worked out at genotypic and phenotypic levels and presented in Tables 4.12 and 4.13 respectively. The phenotypic and genotypic path diagrams were given in Fig 1 and 2. The results are discussed character wise here under.

4.6.1 Plant height (cm)

At phenotypic level, the direct contribution of this character on seed cotton yield per plant was low and negative (-0.0336). The indirect effect of this trait through number of monopodia per plant (0.0425), number of sympodia per plant (0.0236), number of bolls per plant (0.0172), boll weight (0.0167), seed index (0.0155), lint index (0.0589), micronaire value (0.0091), bundle strength (0.0134), uniformity ratio (0.0129) and fibre elongation (0.0013) were positive. While, ginning out-turn (-0.0718), 2.5% span length (-0.0352) and lint yield per plant (-0.0976) were negative.

At genotypic level, the direct contribution of this character on seed cotton yield per plant was low and negative (-0.0383). The indirect effect of this trait through number of monopodia per plant (0.0543), number of sympodia per plant (0.0420), number of bolls per plant (0.0373), boll weight (0.0280), seed index (0.0319), lint index (0.0660), micronaire value (0.0070), bundle strength (0.0180), uniformity ratio (0.0281) and fibre elongation (0.0023) were positive. While, ginning out-turn (-0.1460), 2.5% span length (-0.0518) and lint yield per plant (-0.0823) were negative. This trait expressed non- significant negative correlation with seed cotton yield per plant (-0.0270 and -0.0026) at phenotypic and genotypic level only.

From the above results, this trait recorded low non-significant negative correlation with seed cotton yield per plant at both phenotypic and genotypic levels. This trait exerted positive indirect effects on seed cotton yield per plant *via* monopodia per plant, no. of sympodia per plant, no of bolls per plant, boll weight, seed index, lint index, micronaire value, bundle strength, uniformity ratio and fibre elongation at both the levels. These findings were in agreement with the results of Venkateswarulu *et al.* (2010b), Haritha (2011), Rajanna *et al.* (2011), Saravanan and Koodalingam (2011), Venkatesh (2012) and Wang *et al.* (2012).

4.6.2 Days to 50% flowering

At phenotypic level, the direct contribution of this character on seed cotton yield per plant was low and negative (-0.0730). The indirect effect of this trait through boll weight (0.0423), seed index (0.0363) bundle strength (0.0322) and uniformity ratio (0.0115) were positive. While, number of monopodia (-0.0110), number of sympodia per plant (-0.0027), number of bolls per plant (-0.0161), lint index (-0.0023), ginning out-turn (-0.0435), 2.5% span length (-0.0019), micronaire value (-0.0556) and lint yield per plant (-0.1876) showed negative indirect effects.

At genotypic level, the direct contribution of this character on seed cotton yield per plant was low and negative (-0.118). The indirect effect of this trait through boll weight (0.0634), seed index (0.0419) bundle strength (0.0510) and uniformity ratio (0.0235) were positive. While, number of monopodia (-0.0165), number of sympodia per plant (-0.0046), number of bolls per plant (-0.0362), lint index (-0.0071), ginning out-turn (-0.0783), 2.5% span length (-0.0042), micronaire value (-0.0437) and lint yield per plant (-0.1814) showed negative indirect effects.

This trait expressed significant negative correlation with seed cotton yield per plant (-0.2710**and -0.3097**) both at phenotypic and genotypic levels.

From the above results, this trait recorded low negative direct effect at both phenotypic and genotypic levels and also exerted positive indirect effects on seed cotton yield per plant via through boll weight, seed index, bundle strength and uniformity ratio both the levels. Rao *et al.* (2009a), Kumar *et al.* (2010), Venkateswarulu *et al.* (2010b), and Rajanna *et al.* (2011) also reported similar results.

4.6.3 Number of Monopodia per plant

At phenotypic level, the direct contribution of this character on seed cotton yield per plant was low and positive (0.1390). The indirect effect of this trait through days to 50% flowering (0.0058), no. of sympodia per plant (0.0137), number of bolls per plant (0.0076), lint index (0.0503), bundle strength (0.0275), uniformity ratio (0.0187) and fibre elongation (0.0031) were positive. While plant height (-0.0103), boll weight (-0.0040), seed index (-0.0117), ginning out-turn (-0.0297), 2.5% span length (-0.0718), micronaire value (-0.0067) and lint yield per plant (-0.0320) were negative.

The direct contribution of this character on seed cotton yield per plant was positive and low (0.1517) at genotypic level. The indirect effect of this trait through days to 50% flowering (0.0128), number of sympodia per plant (0.0260), number of bolls per plant (0.0101), lint index (0.0821), bundle strength (0.0427), uniformity ratio (0.0384) and fibre elongation (0.0052) were positive. While plant height (-0.0137), boll weight (-0.0067), seed index (-0.0190), ginning out-turn (-0.0602), 2.5% span length (-0.1120), micronaire value (-0.0033) and lint yield per plant (-0.0366) were negative.

This trait expressed non-significant positive correlation with seed cotton yield per plant (0.0995 and 0.1175) both at phenotypic and genotypic levels.

From the above results, this trait recorded low positive direct effect with seed cotton yield per plant both at phenotypic and genotypic levels. This trait exerted positive indirect effect on seed cotton yield per plant via number of sympodia per plant, number of bolls per plant, lint index, bundle strength, uniformity ratio and fibre elongation at both the levels. These findings are in agreement with the results of Shazia *et al* (2010), Ekinci *et al.* (2010), Rajanna *et al.* (2011) and Mohan (2011), Venkatesh (2012) and Vineela *et al.* (2012a).

4.6.4 Number of Sympodia per plant

Direct effect of this trait on seed cotton yield per plant was positive and low (0.0666) at phenotypic level and its indirect effect through number of monopodia per plant (0.0286), days to 50% flowering (0.0029), number of bolls per plant (0.0152), boll weight (0.0003), seed index (0.042), micronaire value (0.0008), bundle strength (0.0161), uniformity ratio (0.0048), fibre elongation (0.0014), lint yield per plant (0.0300) were positive. Whereas, plant height (-0.0119), lint index (-0.0251), ginning out-turn (-0.0304) and 2.5% span length (-0.0955) were negative indirect effects.

This trait showed a positive (0.0885) and low direct effect on seed cotton yield per plant at genotypic level. The indirect effects via days to 50% flowering (0.0061), no. of monopodia per plant (0.0445), no. of bolls per plant (0.0447), seed index (0.0645), micronaire value (0.0057), bundle strength (0.0298), uniformity ratio (0.0101), fibre elongation (0.0025) and lint yield per plant (0.0276) were positive. While, the characters plant height (-0.0182) boll weight (-0.0004), lint index (-0.0365), ginning out-turn (-0.0830) and 2.5% span length (-0.1553) exhibited negative indirect effects through this character.

This trait expressed non-significant positive correlation with seed cotton yield per plant (0.0457 and 0.0307) both at phenotypic and genotypic levels.

It had positive indirect effects through days to 50% flowering, number of monopodia per plant, number of bolls per plant, seed index, micronaire value, bundle strength, uniformity ratio, fibre elongation and lint yield per plant. Similar trends were also evident from the studies of Ekinci *et al.* (2010), Haritha (2011), Saravanan and Koodalingam (2011), Venkatesh (2012) and Wang *et al.* (2012).

4.6.5 Number of Bolls per plant

The direct effect of number of bolls per plant was positive and low (0.0776). The indirect effects contributed through, days to 50% flowering(0.0151), number of monopodia per plant (0.0136), number of sympodia per plant (0.0130), lint index (0.0164), 2.5% span length (0.0880), micronaire value (0.0454), fibre elongation (0.0007) and lint yield per plant (0.1050) were positive whereas, through plant height (-0.0075), boll weight (-0.0125), seed index (-0.0075), ginning out-turn (-0.0072), bundle strength (-0.0231) and uniformity ratio (-0.0175) were negative.

The direct effect of this trait was positive and low (0.1338). The positive indirect effects were via days to 50% flowering (0.0319), number of monopodia per plant (0.0115), number of sympodia per plant (0.0295), 2.5% span length (0.1273), micronaire value (0.0391), fibre elongation (0.0013) and lint yield per plant (0.1354). While, the negative indirect effects of this trait were *via* plant height (-0.0107), boll weight (-0.0211), seed index (-0.0007), lint index (-0.0025), ginning out-turn (-0.0004), bundle strength (-0.0435) and uniformity ratio (-0.0390).

This trait had shown significant positive correlation (0.2996** and 0.3920**) both at genotypic and phenotypic levels on seed cotton yield per plant. Therefore, the positive direct effect of number of bolls per plant on seed cotton yield gives an idea for selection of number of bolls per plant for the improvement of seed cotton yield. These results were in agreement with the findings of Saravanan and Koodalingam (2011), Dhanalakshmi *et al.* (2012), Tulasi *et al.* (2012), Venkatesh (2012) and Wang *et al.* (2012).

4.6.6 Boll weight (g)

At phenotypic level the direct effect was negative (-0.0911) and low. The positive indirect effects contributed through plant height (0.0062), days to 50% flowering (0.0339), number of monopodia per plant (0.0061), number of bolls per plant (0.0106), lint index (0.0300), ginning out-turn (0.0698), 2.5% span length (0.0831), micronaire value (0.0298) and lint yield per plant (0.2382). The negative indirect effects produced through number of sympodia per plant (-0.0002), seed index (-0.0767), bundle strength (-0.0377), uniformity ratio (-0.0141) and fibre elongation (-0.0003).

At genotypic level the direct effect was negative and low (-0.1302). The indirect effect via seed index (-0.0864), bundle strength (-0.0620), uniformity ratio (-0.0296) and fibre elongation (-0.0002) were negative, and plant height (0.0082), days to 50% flowering (0.0574), number of monopodia per plant (0.0078), number of sympodia per plant (0.0002), number of bolls per plant (0.0217), lint index (0.0323), ginning out-turn (0.1339), 2.5% span length (0.1163), micronaire value (0.0226), lint yield per plant (0.2276) were positive.

It exhibited significant positive correlation with seed cotton yield per plant (0.2873** and 0.3196**) both at phenotypic and genotypic levels.

Similar trends were also evident from the studies of Rao *et al.* (2009), Karademir *et al.* (2009), Rasheed *et al.* (2009), Patnaik and Sial (2010) and Tulasi *et al.* (2012).

4.6.7 Seed index (g)

Seed index exhibited significant negative correlation with seed cotton yield per plant (-0.2528**) at phenotypic level. The direct effect was positive and moderate (0.2850). The indirect effects through number of sympodia per plant (0.0098), boll weight (0.0245), bundle strength (0.0027) and uniformity ratio (0.0166) were positive. While, plant height (-0.0018), days to 50% flowering (-0.0093), number of monopodia per plant (-0.0057), number of bolls per plant (-0.002), lint index (-0.3905), ginning out-turn (-0.0070), 2.5% span length (-0.0413), micronaire value (-0.0156) and fibre elongation (-0.0005) and lint yield per plant (-0.1176) were negative in their indirect effects.

At genotypic level, this trait expressed significant negative correlation with seed cotton yield (-0.3138**). The direct effect of seed index on seed cotton yield was positive and moderate (0.2886). The indirect effects through number of sympodia per plant (0.0198), boll weight (0.0390), bundle strength (0.0044) and uniformity ratio (0.0420) were positive. While, plant height (-0.0042), days to 50% flowering (-0.0171), number of monopodia per plant (-0.0100), number of bolls per plant (-0.0003), lint index (-0.4251), ginning out-turn (-0.0446), 2.5% span length (-0.0617), micronaire value (-0.0147) and fibre elongation (-0.0009) and lint yield per plant (-0.1287) were negative in their indirect effects.

The trait exhibited significant negative correlation of this trait on seed cotton yield at phenotypic level and negative significant correlation at genotypic level along with moderate direct effect both at phenotypic and genotypic levels. It had positive indirect effects through number of sympodia per plant, boll weight, bundle strength and uniformity ratio at both phenotypic and genotypic levels. These results are in agreement with the findings of Gururajan and Sundar (2004), Raju (2005), Kale *et al.* (2007), Rasheed *et al.* (2009) and Haritha (2011).

4.6.8 Lint index (g)

The direct effect of seed index on seed cotton yield was negative and high (-0.4413). The indirect effect through days to 50% flowering (-0.0004), number of monopodia per plant (-0.0159), number of bolls per plant (-0.0029), 2.5% span length, (-0.0034), micronaire value (-0.0081), bundle strength (-0.0157), fibre elongation (-0.0011) and lint yield per plant (-0.0040) were negative. While, via plant height (0.0045), number of sympodia per plant (0.0038), boll weight (0.0062), seed index (0.2522), ginning out-turn (0.0733) and uniformity ratio (0.0083) were positive.

The direct effect of seed index on seed cotton yield was negative and high (-0.4720). The indirect effect through plant height (0.0054), number of sympodia per plant (0.0068), number of bolls per plant (0.0007), boll weight (0.0089), seed index (0.2599), ginning out-turn (0.0724), uniformity ratio (0.0252) were positive. While, the indirect effects of this trait via days to 50% flowering (-0.0018), number of monopodia per plant (-0.0264), 2.5% span length (-0.0083), micronaire value (-0.0097), bundle strength (-0.0274), fibre elongation (-0.0022) and lint yield per plant (-0.0201) were low and negative.

Lint index expressed non-significant negative correlation (-0.1443) at phenotypic level and significant negative correlation (-0.1887*) at genotypic level. This trait showed negative direct effects both at phenotypic and genotypic levels. Similar trends were also evident from the studies of Padmavathi (2008), Sarada *et al.* (2010), Venkateswarlu *et al.* (2010b), Tulasi *et al.* (2012) and Venkatesh (2012).

4.6.9 Ginning out-turn (%)

Ginning out turn showed moderate and positive direct effect (0.1742) at phenotypic level. At phenotypic level, this trait had significant positive correlation (0.1894*) with seed cotton yield per plant. However, the indirect effect of this trait via plant height (0.0138), days to 50% flowering (0.0182), 2.5% span length (0.0714), micronaire value (0.0135) and lint yield per plant (0.2271) were positive. While, indirect effect of this trait through number of monopodia per plant (-0.0237), number of sympodia per plant (-0.0116), number of bolls per plant (-0.0032), boll weight (-0.0365), seed index (-0.0114), lint index (-0.1856), bundle strength (-0.0417), uniformity ratio (-0.0137), fibre elongation (-0.0014) were negative and low.

It showed positive and moderate direct effect (0.2611) on seed cotton yield per plant. At genotypic level, this trait exhibited significant positive correlation with seed cotton yield per plant (0.2566**). The indirect effects via plant height (0.0214), days to 50% flowering (0.0354), 2.5% span length (0.1120), micronaire value (0.0115) and lint yield per plant (0.2354) were positive. While, the characters viz., number of monopodia per plant (-0.0350), number of sympodia per plant (-0.0281), number of bolls per plant (-0.0002), boll weight (-0.0667), seed index (-0.0493), lint index (-0.1308), bundle strength (-0.0725), uniformity ratio (-0.0345) and fibre elongation (-0.0028) showed negative indirect effects.

This trait showed positive direct effect at both the levels. These results are in agreement with the findings of Sarada (2010), Mohan (2011), Saravanan and Koodalingam (2011), Tulasi *et al.* (2012) and Wang *et al.* (2012).

4.6.10 2.5% Span length (mm)

At phenotypic level, the direct contribution of this character on seed cotton yield per plant was negative and moderate (-0.3461). The indirect effects through number of monopodia per plant (0.0289), number of sympodia per plant (0.0184), boll weight (0.0219), seed index (0.0340), bundle strength (0.0698) and fibre elongation (0.0009)

were positive. Whereas, the characters viz., plant height (-0.0034), days to 50% flowering (-0.0004), number of bolls per plant (-0.0197), lint index (-0.0043), ginning out-turn (-0.0359), micronaire value (-0.0617), uniformity ratio (-0.0025) and lint yield per plant (-0.2389) exhibited negative indirect effects.

This trait expressed negative and high (-0.4506) direct effect on seed cotton yield per plant at genotypic level. The indirect effect through number of monopodia per plant (0.0377), number of sympodia per plant (0.0305), boll weight (0.0336), seed index (0.0395), bundle strength (0.1079), fibre elongation (0.0013) were positive. While, the characters plant height (-0.0044), days to 50% flowering (-0.0011), number of bolls per plant (-0.0378), lint index (-0.0087), ginning out-turn (-0.0649), micronaire value (-0.0474), uniformity ratio (-0.0071) and lint yield per plant (-0.2249) have shown negative indirect effects.

This trait had significant negative correlation (-0.5392** and -0.5964**) with seed cotton yield per plant both at phenotypic and genotypic levels. This trait had exhibited negative direct effects both at phenotypic and genotypic levels. Similar trends were also evident from the studies of Padmavathi (2008), Rao *et al.* (2009a), Venkateswarlu *et al.* (2010b), Haritha (2011) and Venkatesh (2012).

4.6.11 Micronaire value (10^{-6} g/inch)

At phenotypic level, the direct contribution of this character on seed cotton yield per plant was positive and low (0.1181). The indirect effects of this trait through days to 50% flowering (0.0343), number of sympodia per plant (0.0004), number of bolls per plant (0.0298), lint index (0.0302), ginning out-turn (0.0199), 2.5% span length (0.1808), uniformity ratio (0.0047), fibre elongation (0.0003) and lint yield per plant (0.2112) were positive whereas, plant height (-0.0026), number of monopodia per plant (-0.0079), boll weight (-0.0230), seed index (-0.0376) and bundle strength (-0.0567) exhibited negative indirect effects.

Direct effect of micronaire was positive and low (0.0840) at genotypic level. The indirect effects of this trait through days to 50% flowering (0.0614), number of sympodia per plant (0.0060), number of bolls per plant (0.0623), lint index (0.0543), ginning out-turn (0.0356), 2.5% span length (0.2543), uniformity ratio (0.0179), fibre elongation (0.0005) and lint yield per plant (0.2213) were positive whereas, plant height (-0.0032), number of monopodia per plant (-0.0060), boll weight (-0.0350) seed index (-0.0506) and bundle strength (-0.0943) exhibited negative and indirect effects.

This trait exhibited positive significant correlation (0.5020** and 0.6088**) both at phenotypic and genotypic levels. These results are in agreement with the findings of Sakthi *et al.* (2007), Vijayalaxmi *et al.* (2008), Kumar *et al.* (2010), Sarada (2010), Rajanna *et al.* (2011) and Mohan (2011).

4.6.12 Bundle strength (g/tex)

This trait showed low and positive direct effect (0.1142) on seed cotton yield per plant at phenotypic level. The indirect effects via number of monopodia per plant (0.0335), number of sympodia per plant (0.0094), boll weight (0.0301), seed index (0.0067) and lint index (0.0606) were positive in their indirect effects. While, the characters plant height (-0.0039), days to 50% flowering (-0.0206), number of bolls per plant (-0.0157), ginning out-turn (-0.0637), 2.5% span length (-0.2115), micronaire value (-0.0587), uniformity ratio (-0.0011) and lint yield per plant (-0.3076) expressed negative and indirect effects.

At genotypic level, the direct contribution of this character on seed cotton yield per plant was positive and moderate (0.1608). The indirect influence of this character through number of monopodia per plant (0.0403), number of sympodia per plant (0.0164), boll weight (0.0502), seed index (0.0080) and lint index (0.0806) were positive. While, the characters number of bolls per plant (-0.0362), plant height (-0.0043), days to 50% flowering (-0.0374), number of bolls per plant (-0.0362), ginning out-turn (-0.1178), 2.5% span length (-0.3023), micronaire value (-0.0493), uniformity ratio (-0.0034), lint yield per plant (-0.2936) were negative in their indirect effects.

This trait showed significant negative (-0.4283** and -0.4882**) association with seed cotton yield per plant both at phenotypic and genotypic levels. The trait exhibited positive indirect effect through number of monopodia, number of sympodia, boll weight, seed index and lint index at phenotypic and genotypic levels. Similar trends were also evident from the studies of Murthy *et al.* (2006), Sakthi *et al.* (2007), Padmavathi (2008), Sarada (2010) and Rajanna *et al.* (2011).

4.6.13 Uniformity ratio

At phenotypic level, the direct effect of this character on seed cotton yield per plant was positive and low (0.0915). The indirect effects via number of monopodia per plant (0.0285), number of sympodia per plant (0.0035), boll weight (0.0140), seed

index (0.0516), 2.5% span length (0.0094), micronaire value (0.0061), fibre elongation (0.0011) and lint yield per plant (0.0210) were positive. While, the characters, plant height (-0.0047), days to 50% flowering (-0.0092), number of bolls per plant (-0.0149), lint index (-0.0403), ginning out-turn (-0.0261) and bundle strength (-0.0014) showed negative indirect effects.

Direct effect of uniformity ratio on seed cotton yield was positive and moderate (0.1642) at genotypic level. The indirect effects via number of monopodia per plant (0.0355), number of sympodia per plant (0.0054), boll weight (0.0234), seed index (0.0737), 2.5% span length (0.0195), micronaire value (0.0091), fibre elongation (0.0020), lint yield per plant (0.0220) were positive. While, the characters, viz., plant height (-0.0066), days to 50% flowering (-0.0169), number of bolls per plant (-0.0318), bundle strength (-0.0034), lint index (-0.0723) and ginning out-turn (-0.0549) had shown negative indirect effects.

Uniformity ratio had positive and significant correlation (0.1691*) at genotypic level only. The trait showed positive indirect effects *via* monopodia per plant, number of sympodia per plant, boll weight, seed index, 2.5% span length, micronaire value, fibre elongation and lint yield per plant. These positive indirect effects nullify the negative indirect effects and thus gave high significant positive correlation with seed cotton yield. These results are in agreement with the findings of Murthy *et al.* (2006), Vijayalaxmi *et al.* (2008), Srinivasulu *et al.* (2010b), Rajanna *et al.* (2011) and Mohan (2011)

4.6.14 Fibre elongation (%)

The phenotypic correlation of fibre elongation with seed cotton yield was positive (0.1665*) and non-significant and its direct effect on seed cotton yield per plant was very less (0.0086). It was further observed that positive indirect effects contributed by number of monopodia per plant (0.0496), number of sympodia per plant (0.0107), number of bolls per plant (0.0065), boll weight (0.0034), lint index (0.0553), micronaire value (0.0045), uniformity ratio (0.0122) and lint yield per plant (0.1022). The negative indirect effects produced via plant height (-0.0049), days to 50% flowering (-0.0018), seed index (-0.0156) ginning out-turn (-0.0288), 2.5% span length (-0.0349) and bundle strength (-0.0004).

At genotypic level, the correlation of fibre elongation with seed cotton yield per plant was positive and significant (0.1817*) and its direct effect was positive and low (0.0131) and its indirect effects through number of monopodia per plant (0.0605), number of sympodia per plant (0.0171), number of bolls per plant (0.0130), boll weight (0.0024), lint index (0.0803), micronaire value (0.0034), uniformity ratio (0.0254) and lint yield per plant (0.0983) were positive. The negative indirect effects were produced through plant height (-0.0067), days to 50% flowering (-0.0031), seed index (-0.0206), ginning out-turn (-0.0562), 2.5% span length (-0.0441) and bundle strength (-0.0012).

The positive direct effect of fibre elongation reflects its effectiveness in a selection procedure. Selection can be made directly on the basis of fibre elongation in the present plant material. These results are in agreement with the findings of Sakthi *et al.* (2007), Vijayalaxmi *et al.* (2008), Srinivasulu *et al.* (2010b), Mohan (2011) and Venkatesh (2012).

4.6.15 Lint yield per plant (g)

This trait recorded significant positive (0.7692**) correlation with seed cotton yield per plant at phenotypic level. The direct influence of this character was positive and high (0.6373). The indirect contribution of this character via., plant height (0.0051), days to 50% flowering (0.0215), number of sympodia per plant (0.0031), number of bolls per plant (0.0128), lint index (0.0027), ginning out-turn (0.0621), 2.5% span length (0.1297), micronaire value (0.0391), uniformity ratio (0.0030) and fibre elongation (0.0014) were positive. Negative indirect effects produced through number of monopodia per plant (-0.007), boll weight (-0.0341), seed index (-0.0526) and bundle strength (-0.0551).

A critical view revealed that the correlation of lint yield per plant with seed cotton yield per plant was positive and significant (0.7680**) at genotypic level. The direct effect of lint yield per plant on seed cotton yield per plant was positive and high (0.5456). The indirect effects via., plant height (0.0058), days to 50% flowering (0.0392), number of sympodia per plant (0.0045), number of bolls per plant (0.0332), lint index (0.0174), ginning out-turn (0.1127), 2.5% span length (0.1858), micronaire value (0.0341), uniformity ratio (0.0066) and fibre elongation (0.0024) were positive. The negative indirect effects were contributed through number of monopodia per plant (-0.0102), boll weight (-0.0543), seed index (0.0681) and bundle strength (-0.0865).

Correlation (0.7692** and 0.7680**) and direct effects (0.6373 and 0.5456) on seed cotton yield per plant both at phenotypic and genotypic levels were positive, which indicated the true relationship between these traits. Selection through this trait will be effective on the seed cotton yield positively. These results were in conformity with the findings of Pratap *et al.* (2007), Vijayalaxmi *et al.* (2008), Rajanna *et al.* (2011), Venkatesh (2012) and Vineela *et al.* (2012a).

In plant breeding, it is very difficult to have complete knowledge of all component traits of yield. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield. In other words, residual effect measures the role of the possible independent variables which were not included in the study on the dependent variable. In the present study, the residual effect observed at phenotypic (0.49) and genotypic (0.419) explains that the characters taken in study contribute only about 60 percent to the seed cotton yield.

The path analysis indicated that number of bolls plant⁻¹, boll weight (g), ginning out turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ (g) showed direct positive effects and significant correlation with seed cotton yield plant⁻¹ (g). The present study revealed that major emphasis should be laid on selection process with lint yield per plant without sacrificing desirable fibre quality by adopting restricted selection model.

Table 4.1. Analysis of variance for seed cotton yield and yield components of 40 crosses and 13 parents of cotton

Source	d.f.	Plant height (cm)	Days to 50% flowering	No. of Monopodia / plant	No. of Sympodia / plant	No. of Bolls/plant	Boll weight (g)	Seed index (g)	Lint index (g)
Mean squares									
Replications	2	18.59	0.79	0.01	0.75	69.80	0.001	0.07	0.11
Treatments	53	754.93**	67.20**	0.83**	15.47**	317.91**	0.98**	4.59**	1.16**
Error	106	47.10	1.73	0.05	2.03	26.18	0.03	0.42	0.17

Source	d.f.	Ginning out- turn %	2.5% Span length (mm)	Micronaire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Seed cotton yield /plant (g)	Lint yield /plant (g)
Mean squares									
Replications	2	1.12	0.05	0.03	0.41	0.08	0.01	215.02	10.17
Treatments	53	6.10**	29.19**	0.44**	10.49**	6.33**	0.22**	6807.00**	805.62**
Error	106	0.90	0.39	0.02	0.58	0.53	0.004	350.81	39.68

**** Significant at 1% level**

Table 4.2. Estimates of variability, heritability ($\hat{h}^2_{(ns)}$) and genetic advance as per cent of mean for seed cotton yield and its component characters for 40 crosses and 13 parents of cotton.

Sl. no.	Character	Mean	Range		Coefficient of variation		Heritability (narrow sense) (%)	Genetic advance as percent of mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Plant height (cm)	137.80	108.63	173.20	12.20	11.14	27.41	12.54
2	Days to 50 % flowering	64.00	55.00	73.66	7.58	7.29	78.79	5.47
3	Number of Monopodia/plant	1.60	0.60	2.73	34.90	31.91	31.32	23.05
4	Number of Sympodia/plant	17.73	13.26	23.66	14.39	11.93	19.61	5.36
5	Number of Bolls/plant	55.33	30.86	82.10	20.07	17.82	54.17	22.63
6	Boll weight (g)	3.55	2.46	4.70	16.63	15.87	45.69	13.24
7	Seed index (g)	9.38	6.80	12.56	14.33	12.56	30.83	9.71
8	Lint index (g)	4.55	3.06	6.03	15.61	12.59	31.21	10.49
9	Ginning out-turn (%)	32.65	29.79	36.10	4.97	4.03	24.08	1.45
10	2.5% Span length (mm)	32.10	27.20	37.20	9.84	9.64	86.38	19.94
11	Micronaire value (10^{-6} g/inch)	3.54	2.60	4.21	11.33	10.61	84.56	21.56
12	Bundle strength (g/tex)	25.26	21.79	30.56	7.80	7.19	65.52	8.96
13	Uniformity ratio	47.58	45.00	50.33	3.30	2.92	35.55	2.52
14	Fibre elongation (%)	5.83	5.26	6.26	4.79	4.67	16.51	1.75
15	Lint yield/plant (g)	53.52	20.74	91.64	32.09	29.85	60.15	38.02
16	Seed cotton yield/plant (g)	163.40	64.40	275.40	30.60	28.38	63.17	39.89

PCV = Phenotypic coefficient of variation

GCV = Genotypic coefficient of variation

Table 4.3. Analysis of variance for combining ability for seed cotton yield and its components in inter-specific hybrids of cotton

Source of variation	df	Plant height (cm)	Days to 50 % flowering	No. of Monopodia / plant	No. of Sympodia / plant	No. of Bolls/plant	Boll weight (g)	Seed index (g)	Lint index (g)
Mean sum of squares									
Replicates	2	24.34	0.98	0.01	0.81	66.94	0.002	0.03	0.09
Genotypes	52	769.44*	67.54**	0.85*	15.77*	313.47**	0.99**	4.34**	1.15**
Parents	12	244.82*	124.64*	0.48*	13.71**	303.97**	1.75**	2.61**	0.33
Parents vs Crosses	1	17444.16*	155.62*	5.18*	140.60**	149.49*	3.49**	0.47	3.84**
Crosses	39	503.30**	47.72*	0.85**	13.19**	320.59**	0.69**	4.98**	1.34**
Line Effect	7	868.34	46.03	1.96*	13.29	709.001**	2.21**	7.25	1.84
Tester Effect	4	307.11	288.69**	0.14	11.93	673.91*	0.08	5.97	1.88
Line x Tester Effect	28	440.07**	13.71**	0.67**	13.35**	173.02**	0.41*	4.27**	1.14**
Error	104	47.41	1.74	0.05	2.02	26.58	0.03	0.42	0.17

Source of variation	df	Ginning out-turn %	2.5% span length (mm)	Micronaire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Seed cotton yield /plant (g)	Lint yield /plant (g)
Mean sum of squares									
Replicates	2	1.05	0.07	0.03	0.39	0.11	0.01	6.55	162.99
Genotypes	52	6.07*	29.75**	0.45**	10.58**	6.42**	0.23**	817.32*	6921.34**
Parents	12	7.07*	26.27**	0.62*	22.51**	3.45**	0.13**	1452.82**	10712.72**
Parents vs Crosses	1	137.91**	124.96**	0.39*	35.46**	21.78**	2.31**	119.36	1104.14
Crosses	39	2.38*	28.38*	0.40**	6.27**	6.95**	0.21*	639.68*	5903.93**
Line Effect	7	3.42	27.66**	0.13	4.99	15.48*	0.22	985.16*	8679.31*
Tester Effect	4	2.68	191.27*	3.08*	32.09*	4.25	0.07	2257.16**	22957.57*
Line x Tester Effect	28	2.07**	5.29*	0.09*	2.91*	5.20**	0.22**	322.23**	2773.85**
Error	104	0.91	0.39	0.02	0.59	0.54	0.004	40.04	354.21

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

Table 4.4. Estimates of general combining ability (*gca*) effects of lines (*G. hirsutum* L.) and testers (*G. barbadense* L.) for seed cotton yield and its components in inter-specific hybrids of cotton

Lines								
Parents	Plant height (cm)	Days to 50 % Flowering	No. of Monopodia /plant	No. of Sympodia /plant	No. of Bolls /plant	Boll weight (g)	Seed Index (g)	Lint Index (g)
L 788	10.82**	-1.13 **	0.29**	-0.06	-5.73 **	0.31**	-0.21	-0.16
L 804	2.40	-1.52 **	0.26**	-0.75*	-8.41**	-0.40**	-0.45**	-0.36**
P72-9-37	-3.12	2.94**	-0.48**	0.30	-3.19*	-0.24**	0.31	0.25 *
L 1227	-13.14**	2.08**	-0.14 *	-1.02 **	-2.86*	-0.20**	0.43*	0.27 *
L 1238	-6.62 **	0.01	0.42 **	-0.78 *	-1.36	0.67**	-1.05**	-0.41**
L 1369	0.36	0.14	0.02	-0.27	1.77	0.01	1.20**	0.51**
L 1374	2.16	-0.32	-0.56 **	0.81*	7.84 **	0.25 **	-0.49**	-0.30 **
L 1376	7.15**	-2.19 **	0.19**	1.78 **	11.94**	-0.40**	0.26	0.21
SE(gi)	1.78	0.34	0.06	0.37	1.33	0.05	0.17	0.11
CD at 5%	3.54	0.68	0.12	0.73	2.65	0.09	0.33	0.22
Testers								
RHCB 011	0.94	3.30**	-0.08	0.22	0.41	0.06	-0.54**	-0.28**
Suvin	-6.16**	2.63**	-0.03	-0.89**	-4.90**	-0.09*	0.57**	0.36 **
GSB 41	2.80	1.42 **	-0.03	-0.42	0.03	-0.01	0.45**	0.23 **
DB 10	2.10	-2.91 **	0.02	0.11	8.48 **	0.00	-0.07	-0.13
GSB 39	0.32	-4.45**	0.12 **	0.98**	-4.02 **	0.05	-0.42**	-0.18 *
SE(gi)	1.41	0.27	0.05	0.29	1.05	0.04	0.13	0.09
CD at 5%	2.80	0.54	0.09	0.58	2.10	0.07	0.26	0.17

Table 4.4 (cont.)

Parents	Ginning out-turn (%)	2.5% Span length (mm)	Micronaire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Seed cotton yield/ plant (g)	Lint yield/ plant (g)
L 788	-0.27	0.24	-0.15**	0.51 *	-0.98 **	-0.03	-32.48**	-10.85**
L 804	-0.77**	0.53**	0.00	0.60**	0.68 **	-0.10**	-11.94 *	-5.10 **
P72-9-37	0.53 *	2.00**	-0.11**	-0.81**	-0.85 **	0.11**	-29.21**	-8.67 **
L 1227	0.27	-2.04**	0.13**	-0.82**	1.02 **	0.22**	14.71**	5.08**
L 1238	0.50 *	0.22	0.001	-0.22	0.75 **	0.05**	40.68**	14.21**
L 1369	-0.23	-0.22	0.01	-0.06	1.28 **	-0.15**	4.43	0.91
L 1374	-0.38	-1.78 **	0.07	0.47*	-0.85 **	-0.05**	4.28	1.08
L 1376	0.35	1.05**	0.07	0.33	-1.05 **	-0.05**	9.52	3.33*
SE(gi)	0.25	0.16	0.04	0.20	0.19	0.02	4.86	1.63
CD at 5%	0.49	0.32	0.07	0.39	0.38	0.03	9.67	3.25
Testers								
RHCB 011	-0.16	-3.92**	0.15**	-0.74**	-0.24	-0.07**	43.52**	13.65**
Suin	0.43*	2.36**	-0.52**	1.44**	0.09	-0.04**	-43.48**	-13.50**
GSB 41	0.05	-1.34**	-0.08**	-1.25**	0.63**	0.04**	3.91	1.48
DB 10	-0.46 *	-0.13	0.47**	-0.44**	0.01	0.05**	-5.06	-2.24
GSB 39	0.14	3.02**	-0.02	0.99**	-0.49**	0.02	1.11	0.60
SE(gi)	0.20	0.13	0.03	0.16	0.15	0.01	3.84	1.29
CD at 5%	0.39	0.26	0.06	0.31	0.30	0.03	7.65	2.57

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

Table 4.5. Estimates of specific combining ability (sca) effects of inter-specific hybrids for yield and yield components in cotton (*G.hirsutum* L. × *G. barbadense* L.)

Crosses	Plant height (cm)	Days to 50 % Flowering	No. of Monopodia /plant	No. of Sympodia /plant	No. of Bolls /plant	Boll weight (g)	Seed Index (g)	Lint Index (g)
	1	2	3	4	5	6	7	8
L 788 x RHCB 011	-9.36*	-0.83	-0.82**	-0.09	1.91	0.12	0.84*	0.42
L 788 x Suvin	-6.06	0.83	0.64**	-0.44	-14.64**	0.06	-0.10	0.01
L 788 x GSB 41	6.98	0.04	-0.02	-1.58	-0.81	-0.22*	-1.45**	-0.66**
L 788 x DB 10	-9.85*	2.04**	0.34*	-0.37	8.54**	-0.17	-0.56	-0.33
L 788 x GSB 39	18.29**	-2.08**	-0.14	2.48**	5.00	0.21*	1.26**	0.55*
L 804 x RHCB 011	-8.44 *	-3.10**	-0.32*	-1.93*	3.09	0.38**	1.18**	0.52*
L 804 x Suvin	-3.37	-2.10**	0.80**	0.85	4.27	-0.13	-0.26	-0.12
L 804 x GSB 41	-6.13	2.44**	-0.05	0.84	-2.33	-0.05	0.26	0.14
L 804 x DB 10	11.20**	-0.56	-0.61**	0.39	-7.98**	-0.10	-1.88**	-0.90**
L 804 x GSB 39	6.74	3.32**	0.19	-0.15	2.95	-0.10	0.70	0.35
P72-9-37 x RHCB 011	10.05*	-2.90**	0.75**	1.69*	-3.72	0.21*	0.25	0.14
P72-9-37 x Suvin	0.39	-0.30	-0.24	-0.17	-2.86	-0.06	0.45	0.08
P72-9-37 x GSB 41	-13.87**	-1.36	-0.27*	-0.14	10.63**	0.02	-0.34	-0.34
P72-9-37 x DB 10	-3.68	0.64	-0.12	-2.20**	-12.76**	0.05	0.35	0.42
P72-9-37 x GSB 39	8.17*	1.85*	-0.20	0.39	7.94**	-0.53**	-0.30	-0.06
L 1227 x RHCB 011	-1.59	0.63	-0.38**	1.14	-7.92**	-0.04	-0.13	-0.04
L 1227 x Suvin	4.71	0.63	-0.41**	1.18	-0.54	-0.06	1.06**	0.58*
L 1227 x GSB 41	-8.69*	-0.16	0.17	-0.68	5.20	-0.36**	-0.96*	-0.42
L 1227 x DB 10	-2.75	-2.16**	-0.11	-0.89	0.99	0.14	-0.59	-0.42
L 1227 x GSB 39	8.32*	1.05	0.72**	-0.75	2.27	0.33**	0.62	0.29

Table 4.5 (cont.)

Crosses	1	2	3	4	5	6	7	8
L 1238 x RHCB 011	-0.68	1.77*	-0.16	0.26	-2.08	0.24*	0.04	-0.17
L 1238 x Suvin	0.95	-2.30**	-0.17	-0.12	2.62	0.23*	-0.36	-0.40
L 1238 x GSB 41	-2.94	3.24**	0.39**	1.54	-1.41	-0.27**	0.46	0.36
L 1238 x DB 10	2.36	1.58*	0.25	-0.45	9.50**	0.19	-0.08	0.16
L 1238 x GSB 39	-0.76	-2.22**	-0.23	-0.80	-7.86**	-0.09	-0.47	-0.19
L 1369 x RHCB 011	-11.13**	1.23	0.07	-1.67*	-0.36	0.33**	-2.87**	-1.28**
L 1369 x Suvin	-4.93	2.57**	-0.68**	1.10	-4.38	-0.35**	0.19	0.14
L 1369 x GSB 41	25.34**	0.44	0.18	-0.70	2.23	-0.59**	1.54**	0.84**
L 1369 x DB 10	-3.13	-1.89*	0.29*	3.31**	1.70	0.55**	1.09**	0.36
L 1369 x GSB 39	-6.15	-2.35**	0.15	-2.04*	0.80	0.05	0.05	-0.05
L 1374 x RHCB 011	0.43	2.03**	0.32*	2.68**	-3.76	-0.39**	1.42**	1.03**
L 1374 x Suvin	10.70**	-1.30	-0.29*	-0.41	11.89**	0.17	0.51	0.35
L 1374 x GSB 41	-14.29**	-1.09	-0.14	-3.12**	-7.71*	0.33**	-1.37**	-0.78**
L 1374 x DB 10	19.50**	-0.43	-0.16	-2.64**	0.01	-0.56**	1.11**	0.21
L 1374 x GSB 39	-16.35**	0.78	0.27*	3.49**	-0.43	0.45**	-1.67**	-0.81**
L 1376 x RHCB 011	19.65**	3.23**	0.63**	-1.66*	13.61**	-0.54**	-1.13**	-0.88**
L 1376 x Suvin	-1.32	-0.10	0.27*	-2.42**	2.86	-0.16	-1.10**	-0.39
L 1376 x GSB 41	7.66	-1.56*	0.01	4.05**	-1.61	0.63**	1.48**	0.84**
L 1376 x DB 10	-7.72	-1.23	-0.16	2.65**	-4.20	0.39**	0.93*	0.50*
L 1376 x GSB 39	-18.27**	-0.35	-0.75**	-2.62**	-10.66**	-0.32**	-0.18	-0.08
SE(S _{ij})	3.98	0.76	0.13	0.82	2.98	0.10	0.38	0.24
CD at 5%	7.91	1.52	0.26	1.63	5.93	0.20	0.75	0.48

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

Crosses	Ginning out-turn (%)	2.5% span length (mm)	Micronaire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Seed Cotton yield/ plant (g)	Lint yield/ plant (g)
	9	10	11	12	13	14	15	16
L 788 x RHCB 011	0.18	-1.13**	-0.05	-1.23**	-0.22	-0.33**	-1.71	-0.27
L 788 x Suvin	0.32	0.62	0.04	0.56	0.77	0.04	5.25	2.01
L 788 x GSB 41	0.17	2.22**	0.06	1.38**	0.57	0.19**	37.40**	12.12**
L 788 x DB 10	-0.45	-1.88**	-0.03	0.11	-1.48**	0.25**	-10.63	-3.88
L 788 x GSB 39	-0.22	0.16	-0.03	-0.82	0.36	-0.16**	-30.30**	-9.98**
L 804 x RHCB 011	-0.05	0.41	-0.09	0.15	-0.56	-0.13**	16.71	4.87
L 804 x Suvin	0.12	0.20	-0.39**	-0.13	-1.23**	0.38**	8.98	3.21
L 804 x GSB 41	0.20	0.13	0.13	0.76	0.57	-0.11**	-5.24	-1.35
L 804 x DB 10	-0.42	0.86*	-0.12	0.38	0.52	-0.19**	-8.61	-3.15
L 804 x GSB 39	0.14	-1.60**	0.46**	-1.15*	0.69	0.04	-11.84	-3.58
P72-9-37 x RHCB 011	0.11	0.94*	0.27**	-0.18	1.98**	0.33**	-3.54	-0.60
P72-9-37 x Suvin	-0.76	-0.38	-0.03	0.83	0.04	0.29**	-30.77**	-11.58**
P72-9-37 x GSB 41	-0.80	1.09**	-0.13	0.07	-1.23**	-0.22**	-1.06	-1.59
P72-9-37 x DB 10	1.22*	-1.45**	0.13	2.23**	0.39	-0.43**	-8.29	-1.17
P72-9-37 x GSB 39	0.41	-0.80*	-0.05	-1.00*	0.22	0.13**	18.24	6.49
L 1227 x RHCB 011	0.23	1.12**	0.02	-0.67	-0.89*	0.12**	-37.57**	-11.56**
L 1227 x Suvin	0.21	-0.66	-0.05	0.36	0.77	-0.14**	2.50	1.15
L 1227 x GSB 41	0.27	-0.64	0.10	-0.87	0.86*	-0.01	73.68**	24.15**
L 1227 x DB 10	-0.61	-0.13	-0.02	-0.62	-0.10	0.10**	-12.52	-5.21
L 1227 x GSB 39	-0.10	0.31	-0.06	1.80**	-0.64	-0.08*	-26.09*	-8.53*

Table 4.5 (cont.)

Crosses	9	10	11	12	13	14	15	16
L 1238 x RHCB 011	-0.94	0.23	-0.23**	-1.12*	-1.36**	0.20**	-5.34	-3.12
L 1238 x Suvin	-1.18*	0.84*	0.13	0.02	0.38	-0.44**	-13.80	-6.38
L 1238 x GSB 41	0.70	-2.10**	0.02	0.21	0.50	0.14**	53.58**	19.09**
L 1238 x DB 10	1.04	0.66	0.01	-0.90*	-2.88**	0.13**	-12.12	-2.44
L 1238 x GSB 39	0.20	0.98**	-0.12	-0.16	1.96**	-0.14**	3.11	1.31
L 1369 x RHCB 011	0.40	0.50	-0.17*	0.61	-1.16**	-0.04	-11.19	-2.84
L 1369 x Suvin	0.11	0.18	0.08	0.80	0.51	-0.24**	4.84	2.05
L 1369 x GSB 41	0.42	-1.28**	-0.04	-1.72**	0.63	-0.42**	-44.21**	-13.59**
L 1369 x DB 10	-0.53	1.48**	0.12	-0.56	1.26**	0.24**	0.89	-0.68
L 1369 x GSB 39	-0.40	-0.88*	0.02	0.88	-1.24**	0.46**	49.66**	15.07**
L 1374 x RHCB 011	1.72**	0.29	0.03	-0.39	1.64**	-0.04	62.33**	23.73**
L 1374 x Suvin	0.56	-0.26	0.17*	0.07	-1.69**	-0.20**	-0.34	0.54
L 1374 x GSB 41	-0.66	-0.86*	-0.06	0.36	-1.23**	0.21**	-15.36	-6.49
L 1374 x DB 10	-1.84**	-1.74**	0.03	0.88	-0.82	-0.21**	5.73	-1.75
L 1374 x GSB 39	-1.51**	-1.26**	-0.01	-0.12	1.39**	0.07	-23.19*	-9.84**
L 1376 x RHCB 011	-0.12	2.08**	-0.12	0.08	-0.11	-0.04	-23.43*	-7.94*
L 1376 x Suvin	0.80	-1.15**	0.23**	-0.56	1.84**	0.40**	-2.08	0.55
L 1376 x GSB 41	0.58	0.91*	0.04	-0.44	0.30	0.11**	-12.56	-2.97
L 1376 x DB 10	0.39	2.24**	-0.20*	-0.26	-0.08	-0.06	-11.73	-2.99
L 1376 x GSB 39	0.08	-0.25	-0.10	0.38	-1.24**	-0.24**	20.64	7.16
SE(S _{ij})	0.55	0.36	0.08	0.44	0.43	0.04	10.87	3.65
CD at 5%	1.10	0.72	0.16	0.88	0.85	0.07	21.63	7.27

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

Table 4.6. Estimates of genetic components of variance and proportional contribution of lines, testers and line x tester interaction to total variance for seed cotton yield and its components in inter-specific hybrids of cotton

	Plant height (cm)	Days to 50 % flowering	No. of Monopodia/plant	No. of Sympodia/plant	No. of Bolls/ plant	Boll weight (g)	Seed Index (g)	Lint Index (g)
Cov.H.S (line)	28.55**	2.15**	0.08*	-0.004	35.73**	0.12*	0.19*	0.04*
Cov.H.S (tester)	-5.54	11.45**	-0.02	-0.05	20.87**	-0.01	0.07*	0.03*
Cov.H.S (average)	7.57**	7.87**	0.01*	-0.03	26.58**	0.03*	0.12*	0.03*
Cov.F.S	161.09	36.73	0.28	3.62	157.94	0.27	1.77	0.47
σ^2 gca	7.57	7.87	0.01	-0.03	26.58	0.03	0.12	0.03
σ^2 sca	130.88**	3.99**	0.20*	3.77**	53.17**	0.12*	1.28**	0.32*
σ^2 gca/ σ^2sca	0.06	1.97	0.09	-0.01	0.54	0.30	0.09	0.11
contribution of								
Line (%)	30.96	17.31	41.33	18.07	39.69	56.93	26.14	24.60
Tester(%)	6.25	62.05	1.73	9.27	21.56	1.14	12.28	14.36
Line x Tester(%)	62.77	20.63	56.93	72.65	38.74	41.92	61.57	61.03

	Ginning out- turn (%)	2.5% Span length (mm)	Micronaire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Seed Cotton yield/ plant (g)	Lint yield/ plant (g)
Cov.H.S (line)	0.09*	1.49**	0.003*	0.13*	0.68*	0.001*	393.69**	44.19**
Cov.H.S (tester)	0.02*	7.74**	0.12*	1.21*	-0.03	-0.006	840.98**	80.62**
Cov.H.S (average)	0.05*	5.34**	0.07*	0.80*	0.23*	-0.004	668.95**	66.61**
Cov.F.S	0.59	23.83	0.34	4.10	2.51	0.05	3576.51	369.64
σ^2 gca	0.05	5.34	0.07	0.80	0.23	-0.004	668.95	66.61
σ^2 sca	0.38*	1.63**	0.02*	0.77*	1.55**	-0.01	806.54**	94.06**
σ^2 gca/ σ^2sca	0.13	3.27	3.37	1.04	0.15	-0.05	0.83	0.71
contribution of								
Line (%)	25.82	17.49	5.91	14.29	39.98	19.12	26.38	27.64
Tester(%)	11.57	69.12	78.24	52.45	6.28	3.65	39.88	36.19
Line x Tester(%)	62.59	13.38	15.84	33.25	53.73	77.21	33.73	36.16

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

Table 4.7. Gene actions for seed cotton yield and component characters in inter-specific hybrids of cotton.

S. No.	Character	GCA/SCA	Type of Gene Action
1	Plant height (cm)	0.06	Non-Additive
2	Days to 50 % flowering	1.97	Additive
3	No. of Monopodia per plant	0.09	Non-Additive
4	No. of Sympodia per plant	-0.01	Non-Additive
5	No. of Bolls per plant	0.54	Non-Additive and Additive
6	Boll weight (g)	0.30	Non-Additive
7	Seed Index (g)	0.09	Non-Additive
8	Lint Index (g)	0.11	Non-Additive
9	Ginning out-turn (%)	0.13	Non-Additive
10	2.5% Span length (mm)	3.27	Additive
11	Micronaire (10^{-6} g/inch)	3.37	Additive
12	Bundle strength (g/tex)	1.04	Additive
13	Uniformity ratio	0.15	Non-Additive
14	Fibre elongation (%)	-0.05	Non-Additive
15	Seed cotton yield per plant (g)	0.83	Additive
16	Lint yield per plant (g)	0.71	Additive

Table 4.8. Good general combiners in lines (*G. hirsutum* L.) and testers (*G. barbadense* L.) for seed cotton yield and its component traits in cotton

S. No.	Characters	Lines								Testers				
		L 788	L 804	P72-9-37	L 1227	L 1238	L 1369	L 1374	L 1376	RHCB 011	Suvin	GSB 41	DB 10	GSB 39
1.	Plant height (cm)	+							+					
2.	Days to 50% flowering			+	+					+	+	+		
3.	No. of Monopodia/plant	+	+			+			+					+
4.	No. of Sympodia/plant							+	+					+
5.	No. of Bolls/plant							+	+				+	
6.	Boll weight (g)	+				+		+						
7.	Seed Index(g)				+		+				+	+		
8.	Lint Index (g)			+	+		+				+	+		
9.	Ginning out-turn (%)			+		+					+	+		
10.	2.5% Span length (mm)		+	+					+		+			+
11.	Micronaire (10 ⁻⁶ g/inch)				+					+			+	
12.	Bundle strength (g/tex)	+	+					+			+			+
13.	Uniformity ratio				+	+	+					+		
14.	Fibre elongation (%)			+	+	+						+	+	
15.	Seed cotton yield/plant (g)				+	+				+				
16.	Lint yield/plant (g)				+	+			+	+				

Table 4.9. Estimates of heterosis over mid parent (MP), better parent (BP) and standard heterosis (SH) for seed cotton yield and component characters in inter-specific cotton hybrids (*G. hirsutum* L. × *G. barbadense* L.)

	Plant height (cm)			Days to 50%flowering			No. of Monopodia/plant			No. of Sympodia/plant		
	1			2			3			4		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 788*RHCB 011	22.90**	15.64**	5.71	2.59	-7.04**	10.00**	5.81	-21.90	-39.26**	22.77**	19.05*	1.48
L 788*Suvin	28.61**	27.72 **	2.97	2.03	-9.05**	11.67**	100.00**	85.71**	44.44**	17.67*	9.52	-6.64
L 788*GSB 41	49.36**	47.46**	18.88**	1.56	-7.58**	8.33**	56.76**	38.10**	7.41	4.52	3.85	-10.33
L 788*DB 10	28.02**	24.51**	6.20	1.90	-4.08*	4.44*	80.77**	67.86**	30.56**	2.18	-8.97	-0.74
L 788*GSB 39	46.39**	38.38**	25.27**	-8.31**	-14.50**	-5.00**	9.81	-10.15	9.81	19.27**	3.5	19.93**
L 804*RHCB 011	17.55**	9.70*	0.29	0.53	-10.80**	5.56**	56.00**	17.00	-13.33	5.57	2.16	-12.55
L 804*Suvin	24.51**	24.29**	-1.18	-1.04	-13.57**	6.11**	115.53**	104.75**	51.67**	21.58**	12.93	-3.32
L 804*GSB 41	30.94**	30.40**	3.30	6.91	-4.74**	11.67**	56.11**	40.50**	4.07	15.45*	14.96*	-0.74
L 804*DB 10	40.21**	35.22**	15.33**	-0.83	-8.67**	-0.56	7.89	2.50	-24.07*	2.37	-8.63	-0.37
L 804*GSB 39	30.58**	22.42**	10.82**	1.92	-7.00**	3.33	28.49**	3.18	26.11*	0.73	-12.42*	1.48
P72-9-37*RHCB 011	23.92**	19.96**	9.67*	2.77	-4.23**	13.33**	96.55**	50.00**	5.56	42.46**	41.47**	13.28*
P72-9-37*Suvin	16.26**	9.55*	0.14	7.12**	-4.69**	12.78**	58.53**	12.29	-0.19	17.15*	13.36	-2.95
P72-9-37*GSB 41	14.17**	9.49*	-6.29	2.78	-3.79*	12.78**	-21.14	-27.37	-48.89**	20.54**	15.38**	-0.37
P72-9-37*DB 10	17.72**	17.52**	0.58	3.16*	0.001	8.89**	-8.65	-11.05	-37.41**	-3.04	-16.41**	-8.86
P72-9-37*GSB 39	22.49**	19.15**	7.86	1.56	-2.50	8.33**	-34.04**	-48.03**	-36.48**	13.26*	-4.78	10.33
L 1227*RHCB 011	0.36	-1.99	-6.00	9.00**	-0.47	17.78**	0.61	-27.83*	-38.52**	16.74*	6.9	2.95
L 1227*Suvin	6.51	-2.59	-6.58	5.79**	-4.98**	16.67**	-17.80	-26.74*	-37.59**	14.35	0.77	-2.95
L 1227*GSB 41	-0.98	-6.46	-10.29*	2.69	-2.55	6.11**	28.78**	14.78	-2.22	-10.15	-15.4*	-7.75
L 1227*DB 10	8.33*	-1.46	-5.50	2.33	-6.16**	10.00**	9.49	-7.17	-20.93*	-3.43*	-8.43	-11.81
L 1227*GSB 39	8.06*	5.03	0.72	1.06	-5.00**	5.56**	29.11**	9.55	33.89**	-8.87	-16.56**	-3.32

Table 4.9 (cont.)

	1			2			3			4		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 1238*RHCB 011	17.23**	13.07**	-3.23	6.67**	-2.26	20.00**	-16.22	-18.42	-42.59**	30.27**	25.7**	-0.74
L 1238*Suvín	19.00**	18.01**	-4.58	0.78	-11.76**	8.33**	36.67**	19.58	6.30	14.62*	6.47	-8.86
L 1238*GSB 41	24.30**	22.54**	-0.92	10.34**	-1.42	15.56**	85.75**	54.79**	37.59**	19.74**	19.23*	2.95
L 1238*DB 10	23.27**	20.07**	2.41	4.97**	-3.06	5.56	70.71	49.37	32.78**	-2.56	-13.03	-5.17
L 1238*GSB 39	15.37**	9.21*	-1.13	-4.92**	-13.00	-3.33	5.61	-8.79	11.48	-2.93	-15.61	-2.21
L 1369*RHCB 011	9.66*	5.96	-3.13	4.00**	-2.35	15.56**	76.55	34.74	-5.19	7.36	1.22	-8.49
L 1369*Suvín	16.80**	12.87**	-3.78	2.94*	-4.98	16.67**	-18.92	-21.05	-44.44**	22.97**	11.43	0.74
L 1369*GSB 41	52.11**	46.15**	24.59**	0.50	-5.21	11.11**	60.00**	47.37**	3.70	5.64	3.27	-6.64
L 1369*DB 10	21.37**	21.34**	3.50	-6.01**	-8.16	0.001	64.05**	59.74**	12.41	18.78**	8.63	18.45**
L 1369*GSB 39	13.81**	10.49*	0.02	-10.08**	-13.00	-3.33	14.62	-9.70	10.37	-9.12	-19.11**	-6.27
L 1374*RHCB 011	13.54**	10.70*	6.53	9.14**	-1.88	16.11**	38.33*	3.75	-23.15**	47.1**	42.64**	21.59**
L 1374*Suvín	23.84**	13.08**	8.82*	0.77	-10.86**	9.44**	-35.26**	-38.50**	-54.44**	23.95**	15.37*	-1.66
L 1374*GSB 41	11.24**	1.03	-2.77	1.84	-8.06**	7.78**	-18.61	-26.75	-45.74**	0.22	-0.43	-14.02*
L 1374*DB 10	33.49**	25.90**	21.17**	0.001	-6.63**	1.67	-20.53	-24.50	-44.07**	-5.79	-16.07**	-8.49
L 1374*GSB 39	0.61	-2.38	-6.05	-1.62	-9.00**	1.11	-12.83	-30.00**	-14.44	29.54**	12.42*	30.26**
L 1376*RHCB 011	33.91**	32.19**	24.04**	8.09**	-2.82	15.00**	285.26**	266.00**	35.56**	25.11**	21.83**	2.95
L 1376*Suvín	19.69**	10.56*	3.74	-0.26	-11.76**	8.33**	136.67**	77.50**	18.33	17.29*	9.61	-7.38
L 1376*GSB 41	35.39**	24.38**	16.71**	-1.84	-11.37**	3.89*	124.80**	75.62**	4.07	53.35**	51.71**	31.00**
L 1376*DB 10	17.34**	12.00**	5.09	-4.37**	-10.71**	-2.78	94.81**	46.11**	-2.59	30.41**	15.74**	26.2**
L 1376*GSB 39	4.33	2.49	-3.83	-6.49	-13.50	-3.89	-9.52	-42.42**	-29.63**	1.66	-12.1*	1.85
MEAN	21.06	6.34	3.98	1.50	-6.83	7.76	40.51	19.51	-5.48	13.47	19.51	-5.48
RANGE	-0.98 to 52.11	-6.46 to 47.46	-10.9 to 25.27	-10.08 to 10.34	-14.50 to 0.10	-5.00 to 20.00	-35.26 to 285.26	-48.0 to 266.00	-54.44 to 51.67	-10.15 to 53.35	-19.11 to 51.71	-14.02 to 1.07

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

	No. of Bolls per plant			Boll weight (g)			Seed index (g)			Lint index (g)		
	5			6			7			8		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 788*RHCB 011	17.36*	7.33	25.76*	8.77*	-12.43**	27.38**	3.84	0.001	-19.55**	-5.00	-9.52	-16.35*
L 788*Suvín	-25.98**	-37.18**	-26.39*	7.52*	-16.99**	20.75**	2.85	-3.34	-18.13**	-3.45	-4.76	-11.95
L 788*GSB 41	-5.7	-11.58	18.36	-2.37	-21.40**	14.33**	-11.39*	-15.52**	-30.59**	-20.82**	-21.09**	-27.04**
L 788*DB 10	38.37**	37.25**	60.81**	-8.19*	-20.00**	16.36**	-10.80*	-17.68**	-27.48**	-21.77**	-21.77**	-27.67**
L 788*GSB 39	-6.38	-15.27*	22.58*	-1.70	-10.74**	29.84**	5.26	-2.28	-15.01**	-6.67	-8.50	-11.95
L 804*RHCB 011	3.5	-12.07	22.18*	8.31*	-5.71	12.94**	3.24	1.06	-18.70**	-6.14	-9.72	-18.24**
L 804*Suvín	1.8	-19.16**	12.32	-7.63	-23.30**	-8.13	-2.98	-7.36	-21.53**	-9.41	-9.72	-18.24**
L 804*GSB 41	-20.57**	-22.03**	8.35	-6.97	-19.02**	-2.99	2.85	-0.34	-18.13**	-7.59	-8.22	-15.72*
L 804*DB 10	-9.51	-17.22*	15.02	-16.06**	-20.18**	-4.39	-28.30**	-32.80**	-40.79**	-36.77**	-37.41**	-42.14**
L 804*GSB 39	-21.52**	-23.08**	11.29	-18.48**	-18.84**	-2.78	-4.66	-10.10	-21.81**	-13.80*	-16.34*	-19.50**
P72-9-37*RHCB 011	9.65	-0.33	18.36	-3.04	-21.49**	12.51**	6.62	-0.70	-20.11**	1.11	-0.72	-13.84*
P72-9-37*Suvín	-5.42	-25.17**	24.80*	13.70**	-8.46**	33.16**	-18.62**	-23.53**	-30.03***	-23.59**	-31.55**	-27.67**
P72-9-37*GSB 41	20.08**	13.3	51.67**	-10.32**	-27.39**	4.06	9.91	1.38	-16.71**	-2.82	-5.48	-13.21*
P72-9-37*DB 10	-0.82	-2.28	16.06	-16.00**	-26.34**	5.56	7.55	-3.86	-15.30**	5.26	2.04	-5.66
P72-9-37*GSB 39	2.96	-6.26	35.61**	-32.41**	-38.21**	-11.44*	-2.54	-12.38*	-23.80**	-7.90	-12.42	-15.72*
L 1227*RHCB 011	-16.33*	-33.35**	9.14	-11.79**	-29.93**	5.67	3.01	-3.52	-22.38**	-1.86	-2.94	-16.98*
L 1227*Suvín	-7.06	-30.34**	14.07	-12.56**	-33.33**	0.53	25.41**	14.72**	-2.83	21.86**	18.88	6.92
L 1227*GSB 41	14.47*	-2.48	59.70**	-27.77**	-38.01**	-6.52	-5.90	-15.43**	-25.50**	-11.66	-14.97	-21.38**
L 1227*DB 10	-12.98*	-20.92**	29.49**	-8.75*	-27.52**	9.30*	7.81	0.001	-17.85**	-3.55	-6.85	-14.47*
L 1227*GSB 39	-20.31**	-24.95**	22.89*	-13.02**	-22.27**	17.22**	8.11	-2.28	-15.01**	0.35	-5.23	-8.81

Table 4.9 (cont.)

	5			6			7			8		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 1238*RHCB 011	9.36	-7.7	9.62	-2.02	-23.96**	8.98	13.60**	3.34	-12.46**	4.63	2.80	-7.55
L 1238*Suvín	0.77	-24.93**	25.20*	22.95**	-5.07	38.07**	-17.68**	-20.74**	-27.48**	-22.83**	-28.57**	-24.53**
L 1238*GSB 41	-15.28**	-23.64	27.34**	5.94	-14.71**	24.06**	-9.62*	-14.24**	-21.53**	-11.46*	-17.26**	-12.58
L 1238*DB 10	23.06**	4.05	73.53**	9.96**	-4.19	39.36**	-22.71**	-24.15**	-30.59**	-22.54**	-27.38**	-23.27**
L 1238*GSB 39	-34.3**	-38.66	2.31	-0.16	-9.34**	31.87**	-29.21**	-30.96**	-36.83**	-31.46**	-34.52**	-30.82**
L 1369*RHCB 011	23.07**	8.42	38.24**	9.62**	-9.92**	24.28	-19.17**	-24.30**	-39.09**	-23.88**	-24.44*	-35.85**
L 1369*Suvín	10.87	-9.04	15.98	-9.66*	-28.91**	-1.93	24.31**	13.71*	-3.68	17.99**	14.69**	3.14
L 1369*GSB 41	9.79	7.19	43.48**	-18.30**	-32.87**	-7.38	40.15**	30.00**	6.80	28.83**	23.97**	13.84*
L 1369*DB 10	33.79**	27.37**	62.40**	5.39	-6.05	29.63**	24.51**	11.90*	-1.42	10.64	6.12	-1.89
L 1369*GSB 39	31.72**	18.12	44.59**	-1.64	-17.90**	8.88	12.48*	3.17	-17.00**	10.11	9.70	-7.55
L 1374*RHCB 011	-4.15	-9.84	30.45**	-10.33**	-16.59**	15.08**	10.27*	-0.33	-13.31**	-1.39	-7.19	-10.69
L 1374*Suvín	65.81**	38.25	69.24**	15.45**	-7.82	22.25**	11.57*	0.001	-15.30**	5.42	2.10	-8.18
L 1374*GSB 41	4.78	0.3	34.26**	17.39**	-2.02	29.95**	-9.30	-17.59**	-32.29**	-22.86**	-26.03**	-32.08**
L 1374*DB 10	45.42**	41.17**	72.81**	-15.47**	-23.31**	1.71	8.76	-4.18	-15.58**	-9.61	-13.61	-20.13**
L 1374*GSB 39	6.31	-1.87	41.97**	7.91**	2.26	35.61**	-25.00**	-33.55**	-42.21**	-33.80**	-37.91**	-40.25**
L 1376*RHCB 011	63.33**	37.29**	95.79**	-26.26**	-39.22**	-16.79**	-15.10**	-15.85**	-32.29**	-26.83**	-31.82**	-33.96**
L 1376*Suvín	40.4**	10.42	57.47**	-15.84**	-33.59**	-9.09	-5.54	-8.70	-22.66**	-6.40	-9.74	-12.58
L 1376*GSB 41	14.72	11.2	58.59**	4.93	-13.52**	18.40**	21.97**	19.66**	-1.70	14.67*	11.69	8.18
L 1376*DB 10	33.85**	21.01**	72.58**	-9.08**	-18.67**	11.34*	6.78	1.29	-10.76*	0.33	-1.95	-5.03
L 1376*GSB 39	-11.34	-11.98	27.34**	-29.62**	-34.30**	-10.05*	-7.51	-11.73*	-23.23**	-14.01*	-14.29*	-16.98*
MEAN	7.69	-3.72	33.88	-4.94	-19.53	11.69	0.37	-6.43	-20.35	-7.22	-10.25	-15.96
RANGE	-34.30 to 65.81	-38.66 to 41.17	-26.39 to 33.88	-32.41 to 22.95	-39.22 to 2.26	-16.79 to 39.36	-29.21 to 40.15	-33.55 to 30.00	-42.21 to 6.80	-36.77 to 28.83	-37.91 to 23.97	-42.14 to 13.84

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

	Ginning out-turn (%)			2.5% Span length (mm)			Micronaire (10 ⁻⁶ g/inch)			Bundle strength (g/tex)		
	9			10			11			12		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 788*RHCB 011	-5.81**	-10.98**	2.90	-9.98**	-10.32**	-14.11**	-1.52	-1.98	-1.80	-0.62	-6.47**	0.98
L 788*Savin	-4.25*	-8.93**	5.27*	8.59**	1.70	10.71**	-9.32**	-18.30**	-18.15**	8.93**	-2.55	17.60**
L 788*GSB 41	-7.40**	-10.42**	3.55	7.95**	6.30**	4.22**	2.97	-5.28	-5.10	7.75**	1.16	9.78**
L 788*DB 10	-8.92**	-13.58**	-0.11	-3.90**	-7.68**	-4.74**	4.02	0.80	7.66*	5.90*	-0.52	7.82**
L 788*GSB 39	-7.96**	-11.26**	2.58	7.88**	0.001	11.33**	0.40	-6.23	-6.05	-1.56	-14.18**	9.92**
L 804*RHCB 011	-6.27**	-9.92**	0.54	-0.45	-4.41**	-8.44**	-6.29*	-13.47**	1.42	4.42*	-0.78	7.12**
L 804*Savin	-4.58*	-7.71**	3.01	11.97**	1.32	10.30**	-25.07**	-36.85**	-25.99**	5.64**	-4.63*	15.08**
L 804*GSB 41	-7.10**	-8.57**	2.04	5.97**	0.63	-1.34	0.56	-13.63**	1.23	4.55*	-0.90	7.54**
L 804*DB 10	-8.64**	-11.85**	-1.61	9.36**	1.40	4.63**	-2.36	-6.69*	9.36**	6.39**	0.90	9.36**
L 804*GSB 39	-6.68**	-8.48**	2.15	7.07**	-4.07**	6.80**	9.72**	-4.44	12.00**	-3.29	-14.94**	8.94**
P72-9-37*RHCB 011	-3.93	-9.44**	5.27*	1.33	0.64	-2.27	10.72**	9.14**	8.32*	-2.46	-7.50**	-0.14
P72-9-37*Savin	-3.98	-7.21**	2.37	-2.67	-7.96**	-11.84**	-3.63	-10.00**	2.93	6.05**	-1.29	6.56*
P72-9-37*GSB 41	-8.15**	-11.38**	3.01	8.81**	8.30**	6.18**	0.42	-5.98	-9.36**	-3.81	-9.01**	-1.26
P72-9-37*DB 10	-1.96	-7.22**	7.85**	1.90	-1.10	2.06	11.72**	6.28*	13.52**	8.37**	2.58	11.17**
P72-9-37*GSB 39	-4.09*	-7.77**	7.20**	9.19**	2.22	13.80**	3.09	-1.96	-5.48	-7.83**	-19.08**	3.63
L 1227*RHCB 011	-3.47	-8.28**	4.84	-4.69**	-10.43**	-14.21**	2.14	-3.87	8.13*	-3.18	-9.44**	-2.23
L 1227*Savin	-2.41	-6.68**	6.67**	3.25*	-8.42**	-0.31	-9.41**	-22.35**	-12.67**	3.58	-7.87**	11.17**
L 1227*GSB 41	-4.64	-9.03**	3.98	-1.76	-10.78**	-7.93**	8.88**	6.13*	19.38**	-2.97	-9.41**	-1.82
L 1227*DB 10	-7.54**	-10.07**	2.80	-1.36	-8.30**	-10.09**	2.31	-10.59**	0.57	-5.38*	-11.71**	-4.19
L 1227*GSB 39	-5.48**	-8.37**	4.73	7.11**	-5.92**	4.74**	1.33	-10.17**	1.04	3.90	-9.92**	15.36**

Table 4.9 (cont.)

	9			10			11			12		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 1238*RHCB 011	-5.90**	-10.73**	3.76	11.60**	5.58**	14.93**	-14.65**	-21.76**	-24.57**	-3.40	-12.96**	5.03
L 1238*Suvín	-4.11*	-6.73**	2.90	14.63**	2.27	11.33**	-8.83**	-22.40**	-11.25**	5.10*	-6.94**	12.29**
L 1238*GSB 41	-1.33	-2.34	7.74**	-0.95	-7.35**	-9.17**	-1.33	-14.38**	-2.08	1.04	-6.18*	1.82
L 1238*DB 10	0.15	-2.83	7.20**	9.34**	-0.10	3.09	2.22	-1.16	13.04**	-0.14	-7.22**	0.56
L 1238*GSB 39	-2.17	-3.51	6.45*	15.71**	2.22	13.80**	-5.07	-16.45**	-4.44	-0.82	-14.39**	9.64**
L 1369*RHCB 011	-4.12*	-8.62**	3.76	-1.31	-6.56**	-10.50**	-4.36	-8.52**	-0.57	4.82*	-1.55	6.28*
L 1369*Suvín	-3.85	-7.77**	4.73	11.02**	-0.85	7.93**	-7.40*	-19.48**	-12.48**	7.84**	-3.70	16.20**
L 1369*GSB 41	-5.68**	-7.95**	4.52	0.17	-6.20**	-8.03**	0.20	-11.13**	-3.40	-7.14**	-13.00**	-5.59
L 1369*DB 10	-8.16**	-12.12**	-0.22	10.42**	1.00	4.22**	8.33**	7.39*	16.73**	1.03	-5.28*	2.65
L 1369*GSB 39	-1.96	-7.66**	7.53**	-8.26**	-12.26**	-15.96**	-1.48	-9.03**	6.62*	2.12	-3.36	4.33
L 1374*RHCB 011	-7.50**	-10.04**	2.15	8.37**	-4.16**	6.69**	2.13	-8.09**	-0.09	2.88	-10.47**	14.66**
L 1374*Suvín	-4.24*	-9.23**	5.70*	3.67*	-6.53**	1.75	-6.99*	-21.61**	-8.13*	6.31**	-4.40*	15.36**
L 1374*GSB 41	-10.44**	-13.67**	0.54	-4.61**	-9.77**	-11.53**	-3.00	-16.69**	-2.36	2.79	-2.96	5.31*
L 1374*DB 10	-12.70**	-17.45**	-3.87	-4.59**	-11.88**	-9.06**	2.19	-2.34	14.46**	4.23	-1.55	6.70*
L 1374*GSB 39	-8.31**	-11.91**	2.58	11.71**	-0.28	11.02**	-4.54	-16.85**	-2.55	1.18	-11.34**	13.55**
L 1376*RHCB 011	-9.58**	-14.25**	-1.61	-5.25**	-9.68**	-13.49**	-0.18	-6.78*	6.62*	9.46**	1.03	9.08**
L 1376*Suvín	-0.64	-5.15*	8.82**	10.11**	-1.04	7.72**	-3.88	-18.18**	-6.43	5.80**	-7.06**	12.15**
L 1376*GSB 41	-4.05*	-6.84**	6.88**	11.09**	4.73**	2.68	1.43	-11.98**	0.66	1.47	-6.56**	1.40
L 1376*DB 10	-4.23*	-8.81**	4.62	16.31**	7.09**	10.50**	-1.37	-4.63	9.07**	5.73*	-2.58	5.59*
L 1376*GSB 39	-4.89*	-7.97**	5.59*	13.62**	1.11	12.56**	-2.54	-14.21**	-1.89	4.14*	-10.80**	14.25**
MEAN	-5.42	-9.07	3.72	4.71	-2.74	0.75	-1.21	9.69	-0.30	2.22	-6.42	7.09
RANGE	-12.70 to 0.15	-17.45 to -2.34	-3.87 to 8.82	-9.91 to 16.31	-12.26 to 7.09	-15.96 to 14.93	-25.07 to 11.72	-36.85 to 9.14	-25.99 to 19.38	-7.83 to 9.46	-19.08 to 2.58	-5.59 to 17.60

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

	Uniformity ratio			Fibre elongation (%)			Seed cotton yield per plant (g)			Lint yieldper plant (g)		
	13			14			15			16		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 788*RHCB 011	-3.81**	-5.44**	-4.14**	0.001	-1.20	-6.82	39.70**	13.38	19.05	29.87**	0.94	22.50
L 788*Suvín	2.51*	0.70	-1.38	4.45**	2.92**	0.001	-13.40	-38.59**	-35.52**	-18.77	-44.12**	-32.19**
L 788*GSB 41	2.13	1.41	-0.69	10.57**	10.24**	3.98**	28.69**	13.05	18.70	18.69	1.33	22.98*
L 788*DB 10	-3.20**	-4.23**	-6.21**	14.20**	11.45**	5.11**	-9.47	-23.96*	-20.16	-18.38	-34.39**	-20.37
L 788*GSB 39	-2.10	-2.78*	-3.45**	0.88	-1.71	-2.27*	-20.79*	-32.73**	-29.36**	-27.63**	-40.30**	-27.55*
L 804*RHCB 011	-1.38	-2.72*	-1.38	1.20	-1.18	-4.55**	24.90**	-13.18**	45.61**	15.19	-21.67**	46.41**
L 804*Suvín	1.43	-0.70	-2.07	7.92**	7.60**	4.55**	-23.43**	-51.69**	-18.98	-28.55**	-55.56**	-16.93
L 804*GSB 41	5.30**	4.20**	2.76*	2.69**	1.18	-2.27*	-16.15*	-38.21**	3.64	-22.29**	-43.29**	5.99
L 804*DB 10	4.26**	2.80*	1.38	3.66**	0.001	-3.41**	-20.35**	-43.22**	-4.77	-27.99**	-49.79**	-6.14
L 804*GSB 39	1.74	1.39	0.69	2.03*	0.57	0.001	-19.34*	-42.03**	-2.77	-25.38**	-46.95**	-0.84
P72-9-37*RHCB 011	3.18**	-0.68	0.69	16.41**	16.05**	6.82**	56.96**	37.17**	20.02	49.68**	24.31*	26.55*
P72-9-37*Suvín	1.40	-1.36	0.001	9.79**	5.71**	5.11**	43.58**	4.81	49.11**	36.19**	-2.71	52.72**
P72-9-37*GSB 41	0.72	-0.71	-4.14**	7.36**	6.06**	-0.57	13.43	8.23	-5.30	4.03	-4.11	-2.38
P72-9-37*DB 10	3.27**	2.16	-2.07	5.96**	4.97**	-3.98**	5.31	-4.39	-16.34	2.95	-11.23	-9.63
P72-9-37*GSB 39	0.001	-2.78*	-3.45**	10.12**	5.71**	5.11**	31.75**	21.09	5.95	25.60*	11.45	13.46
L 1227*RHCB 011	-0.35	-2.72*	-1.38	12.12**	10.12**	5.11**	14.79	-18.45**	26.77*	8.33	-25.32**	32.69**
L 1227*Suvín	7.58**	6.43**	2.76*	5.01**	4.09**	1.14	-4.92	-39.04**	-5.23	-9.59	-43.19**	0.93
L 1227*GSB 41	6.81**	6.43**	2.76*	13.50**	10.12**	5.11**	49.44**	9.04	69.50**	40.22**	-0.79	76.27**
L 1227*DB 10	5.71**	5.71**	2.07	12.91**	11.90**	6.82**	-0.53	-24.84**	16.84	-9.00	-32.51**	19.90
L 1227*GSB 39	0.70	-0.69	-1.38	6.12**	4.00**	3.41**	-7.62	-32.02**	5.68	-13.72	-37.71**	10.66

Table 4.9 (cont.)

	13			14			15			16		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
L 1238*RHCB 011	0.37	0.001	-5.52**	11.45**	8.19**	5.11**	-9.48	-32.03**	-40.52**	-16.81	-39.77**	-38.69**
L 1238*Suvín	6.52**	5.76**	1.38	-5.20**	-6.29**	-6.82**	8.89	-28.75**	1.36	3.13	-33.45**	4.46
L 1238*GSB 41	6.81**	6.43**	2.76*	8.24**	5.14**	4.55**	62.00**	26.25**	79.61**	59.28**	23.20**	93.40**
L 1238*DB 10	-1.44	-1.44	-5.52**	10.51**	5.14**	4.55**	20.48*	-9.54	28.70**	19.53*	-12.15	37.90**
L 1238*GSB 39	6.01**	4.17**	3.45**	0.001	0.001	-0.57	32.92**	0.72	43.30**	29.22**	-2.93	52.37**
L 1369*RHCB 011	-1.38	-2.72*	-1.38	-0.29	-4.52**	-3.98**	42.29**	7.46	37.75**	34.31**	-1.72	42.70**
L 1369*Suvín	6.43**	4.20**	2.76*	-5.75**	-7.34**	-6.82**	3.86	-30.28**	-10.64	-1.75	-35.44**	-6.27
L 1369*GSB 41	6.71**	5.59**	4.14**	-5.85**	-9.04**	-8.52**	-15.03	-31.17**	-11.77	-20.11*	-36.43**	-7.70
L 1369*DB 10	7.09**	5.59**	4.14**	8.06**	2.26*	2.84**	13.11	-11.95	12.86	2.76	-22.52**	12.50
L 1369*GSB 39	-1.05	-1.39	-2.07	6.25**	5.65**	6.25**	49.18**	17.27*	50.32**	36.90**	5.63	53.37**
L 1374*RHCB 011	0.001	-1.36	0.001	1.47	-2.82**	-2.27**	75.99**	26.91**	87.77**	68.05**	16.80*	101.48**
L 1374*Suvín	-2.86*	-4.90**	-6.21**	-3.45**	-5.08**	-4.55**	-10.64	-42.06**	-14.27	-16.75	-47.37**	-9.21
L 1374*GSB 41	-1.77	-2.80*	-4.14**	7.02**	3.39**	3.98*	-5.21	-27.14**	7.80	-16.18*	-37.23**	8.28
L 1374*DB 10	2.84*	1.40	0.001	6.87**	1.13	1.70	-12.15	-34.88**	-3.66	-24.68**	-46.24**	-7.26
L 1374*GSB 39	-3.14**	-3.47**	-4.14**	-0.57	-1.13	-0.57	-9.27	-32.15**	0.39	-17.92*	-40.20**	3.16
L 1376*RHCB 011	-3.52**	-6.80**	-5.52**	1.83*	0.60	-5.11**	46.60**	6.85	52.75**	30.22**	-8.12	50.41**
L 1376*Suvín	6.57**	6.57**	0.69	10.39**	8.77**	5.68**	-5.69	-38.36**	-11.89	-8.49	-41.50**	-4.23
L 1376*GSB 41	3.25**	2.14	-1.38	8.76**	8.43**	2.27*	1.85	-20.76**	13.27	-3.05	-26.10**	20.98
L 1376*DB 10	1.45	0.72	-3.45**	8.02**	5.42**	-0.57	0.52	-24.64**	7.73	-5.03	-31.12**	12.77
L 1376*GSB 39	-3.91**	-6.25**	-6.90**	-0.88	-3.43**	-3.98**	23.90**	-6.26	34.00**	16.52*	-13.68	41.32**
MEAN	1.77	0.45	-1.14	5.34	3.08	0.54	12.17	-14.50	12.68	4.97	-22.15	16.92
RANGE	-3.91 to 7.58	-6.80 to 6.57	-6.90 to 4.14	-5.85 to 16.41	-9.04 to 16.05	-8.52 to 6.82	-23.43 to 75.99	-51.69 to 37.17	-40.52 to 87.77	-28.55 to 68.05	-55.56 to 24.31	-38.69 to 101.48

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

Table 4.10. The best heterotic combinations identified for seed cotton yield and yield components based on overall performance

S. No	Character	Cross combination	<i>Per se</i> performance	SCA effect	Standard heterosis
1	Plant height (cm)	L 788 x GSB 39 L 1369 x GSB 41 L 1376 x RHCB 011	173.20 172.27 171.50	18.29** 25.34** 19.65**	25.27** 24.59** 24.04**
2	Days to 50% flowering	L 788 x GSB 39	57.00	-2.08**	-5.00**
3	No. of Monopodia/plant	L 804 x Suvin L 788 x Suvin	2.73 2.60	0.80** 0.64**	51.67** 44.44**
4	No. of Sympodia/plant	L 1376 x GSB 41 L 1376 x DB 10	23.66 22.80	4.05** 2.65**	31.00** 26.20**
5	No. of Bolls/plant	L 1376 x RHCB 011 L 1238 x DB 10	82.10 72.77	13.61** 9.50**	95.79** 75.33**
6	Boll weight (g)	L 1238 x Suvin	4.30	0.23*	39.36**
7	Seed Index (g)	L 1369 x GSB 41	12.56	1.54**	6.80

Table 4.10 (cont.)

S. No	Character	Cross combination	<i>Per se</i> performance	SCA effect	Standard heterosis
8	Lint Index (g)	L 1369 x GSB 41	6.03	0.84**	13.84*
9	Ginning out-turn (%)	P72-9-37 x DB 10	33.43	1.22**	7.85**
10	2.5% Span length (mm)	L 1238 x GSB 39	36.83	0.98**	13.80**
11	Micronaire (10⁻⁶g/inch)	-	-	-	-
12	Bundle strength (g/tex)	L 1227 x GSB 39	27.53	1.80**	15.36**
13	Uniformity ratio	L 1369 x DB 10	50.33	1.26**	4.14**
		L 1238 x GSB 39	50.00	1.96**	3.45**
14	Fibre elongation (%)	L1227 x DB 10	6.27	0.10**	6.82**
		P 72-9-37 x RHCB 011	6.26	0.33**	6.82**
		L 1369 x GSB 39	6.23	0.46**	6.25**
15	Seed cotton yield/plant (g)	L 1374 x RHCB 011	275.40	62.33**	87.77**
		L 1238 x GSB 41	263.43	53.58**	79.61**
		L 1227 x GSB 41	248.60	73.68**	69.50**
16	Lint yield/plant (g)	L 1374 x RHCB 011	91.64	23.73**	101.48**
		L 1238 x GSB 41	87.96	19.09**	93.40**
		L 1227 x GSB 41	80.17	24.15**	76.27**

Table 4.11. Phenotypic (below diagonal) and genotypic (above diagonal) correlations of 16 characters in 40 crosses and 13 parents of cotton

Character	Plant height (cm)	Days to 50% flowering	No. of Monopodia /plant	No. of Sympodia /plant	No. of Bolls /plant	Boll weight (g)	Seed Index (g)	Lint Index (g)	Ginning out-turn (%)	2.5% Span length (mm)	Micro naire (10 ⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Lint yield /plant (g)	Seed cotton yield /plant (g)
Plant height (cm)	—	-0.0063	0.3580**	0.4745**	0.2786**	-0.2152**	0.1106	-0.1398	-0.5592**	0.1149	0.0829	0.1122	0.1713*	0.1761*	-0.1508	-0.0026
Days to 50 % flowering	-0.0002	—	-0.1088	-0.0520	-0.2702**	-0.4870**	0.1453	0.0151	-0.2999**	0.0093	-0.5207**	0.3173**	0.1429	0.0259	-0.3325**	-0.3097**
No. of Monopodia/plant	0.3054**	-0.0791	—	0.2933**	0.0758	0.0513	-0.0659	-0.1738*	-0.2307**	0.2486**	-0.0396	0.2657**	0.2338**	0.3989**	-0.0671	0.1175
No. of Sympodia/plant	0.3538**	-0.0400	0.2060 **	—	0.3337**	0.0027	0.2235**	0.0773	-0.3179**	0.3447**	0.0680	0.1853*	0.0615	0.1937*	0.0505	0.0307
No. of Bolls/plant	0.2218**	-0.2074**	0.0975	0.1954*	—	0.1618*	-0.0026	0.0053	-0.0014	-0.2826**	0.4657**	-0.2706**	-0.2375**	0.0969	0.2482**	0.3920**
Boll weight (g)	-0.1835*	-0.4640**	0.0437	-0.0029	0.1366	—	-0.2995**	-0.0683	0.5128**	-0.2582**	0.2686**	-0.3857**	-0.1800*	-0.0183	0.4171**	0.3196**
Seed Index(g)	0.0542	0.1274	-0.0412	0.1474	-0.0261	-0.2692**	—	0.9007**	-0.1710*	0.1369	-0.1754*	0.0276	0.2555**	-0.0714	-0.2360**	-0.3138**
Lint Index (g)	-0.1336	0.0051	-0.1140	0.0568	-0.0371	-0.0680	0.8849 **	—	0.2771**	0.0184	-0.1151	-0.1707*	0.1532	-0.1701*	-0.0368	-0.1887*
Ginning out-turn (%)	-0.4118**	-0.2496**	-0.1705*	-0.1746*	-0.0416	0.4003**	-0.0401	0.4205**	—	-0.2485**	0.1365	-0.4511**	-0.2103**	-0.2151**	0.4315**	0.2566**
2.5% Span length (mm)	0.1016	0.0054	0.2076**	0.2760**	-0.254**	-0.2400**	0.1194	0.0097	-0.2062**	—	-0.5645**	0.6710**	-0.0432	0.0979	-0.4123**	-0.5964**
Micronaire (10 ⁶ g/inch)	0.0774	-0.4703**	-0.0569	0.0066	0.3843**	0.2520**	-0.1321	-0.0684	0.1142	-0.5224**	—	-0.5864**	0.1089	0.0407	0.4056**	0.6088**
Bundle strength (g/tex)	0.1173	0.2816**	0.2407**	0.1412	-0.2026**	-0.3299**	0.0236	-0.1374	-0.3655**	0.6110**	-0.4966**	—	-0.0209	-0.0072	-0.5381**	-0.4882**
Uniformity ratio	0.1411	0.1257	0.2046**	0.0524	-0.1918*	-0.1537	0.1812*	0.0913	-0.1496	-0.0272	0.0518	-0.0123	—	0.1548*	0.0402	0.1691*
Fibre elongation (%)	0.1470	0.0242	0.3565**	0.1609*	0.0843	-0.0374	-0.0548	-0.1253	-0.1652*	0.1009	0.0378	-0.0038	0.1334	—	0.1801*	0.1817*
Lint yield/plant (g)	-0.1532	-0.2944**	-0.0502	0.0471	0.1648*	0.3737**	-0.1846*	-0.0062	0.3564**	-0.3748**	0.3313**	-0.4827**	0.0330	0.1604*	—	0.7680**
Seed cotton yield/plant (g)	-0.0270	-0.2710**	0.0995	0.0457	0.2996**	0.2873**	-0.2528**	-0.1443	0.1894*	-0.5392**	0.5020**	-0.4283**	0.1302	0.1665*	0.7692**	—

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

Table 4.12. Direct and indirect effects (phenotypic) of 15 characters on seed cotton yield in 40 hybrids and 13 parents of cotton

Character	Plant height (cm)	Days to 50% flowering	No. of Monopodia /plant	No. of Sympodia /plant	No. of Bolls /plant	Boll weight (g)	Seed Index (g)	Lint index (g)	Ginning out-turn (%)	2.5% Span length (mm)	Micro naire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Lint yield /plant (g)
Plant height (cm)	-0.0336	0.0001	-0.0103	-0.0119	-0.0075	0.0062	-0.0018	0.0045	0.0138	-0.0034	-0.0026	-0.0039	-0.0047	-0.0049	0.0051
Days to 50 % flowering	0.0001	-0.0730	0.0058	0.0029	0.0151	0.0339	-0.0093	-0.0004	0.0182	-0.0004	0.0343	-0.0206	-0.0092	-0.0018	0.0215
No. of Monopodia/plant	0.0425	-0.0110	0.1390	0.0286	0.0136	0.0061	-0.0057	-0.0159	-0.0237	0.0289	-0.0079	0.0335	0.0285	0.0496	-0.0070
No. of Sympodia/plant	0.0236	-0.0027	0.0137	0.0666	0.0130	-0.0002	0.0098	0.0038	-0.0116	0.0184	0.0004	0.0094	0.0035	0.0107	0.0031
No. of Bolls/plant	0.0172	-0.0161	0.0076	0.0152	0.0776	0.0106	-0.002	-0.0029	-0.0032	-0.0197	0.0298	-0.0157	-0.0149	0.0065	0.0128
Boll weight (g)	0.0167	0.0423	-0.0040	0.0003	-0.0125	-0.0911	0.0245	0.0062	-0.0365	0.0219	-0.0230	0.0301	0.0140	0.0034	-0.0341
Seed Index(g)	0.0155	0.0363	-0.0117	0.0420	-0.0075	-0.0767	0.2850	0.2522	-0.0114	0.0340	-0.0376	0.0067	0.0516	-0.0156	-0.0526
Lint Index (g)	0.0589	-0.0023	0.0503	-0.0251	0.0164	0.0300	-0.3905	-0.4413	-0.1856	-0.0043	0.0302	0.0606	-0.0403	0.0553	0.0027
Ginning out turn (%)	-0.0718	-0.0435	-0.0297	-0.0304	-0.0072	0.0698	-0.0070	0.0733	0.1742	-0.0359	0.0199	-0.0637	-0.0261	-0.0288	0.0621
2.5% Span length (mm)	-0.0352	-0.0019	-0.0718	-0.0955	0.0880	0.0831	-0.0413	-0.0034	0.0714	-0.3461	0.1808	-0.2115	0.0094	-0.0349	0.1297
Micronaire (10 ⁻⁶ g/inch)	0.0091	-0.0556	-0.0067	0.0008	0.0454	0.0298	-0.0156	-0.0081	0.0135	-0.0617	0.1181	-0.0587	0.0061	0.0045	0.0391
Bundle strength (g/tex)	0.0134	0.0322	0.0275	0.0161	-0.0231	-0.0377	0.0027	-0.0157	-0.0417	0.0698	-0.0567	0.1142	-0.0014	-0.0004	-0.0551
Uniformity ratio	0.0129	0.0115	0.0187	0.0048	-0.0175	-0.0141	0.0166	0.0083	-0.0137	-0.0025	0.0047	-0.0011	0.0915	0.0122	0.0030
Fibre elongation (%)	0.0013	0.0002	0.0031	0.0014	0.0007	-0.0003	-0.0005	-0.0011	-0.0014	0.0009	0.0003	0.0001	0.0011	0.0086	0.0014
Lint yield/plant (g)	-0.0976	-0.1876	-0.0320	0.0300	0.1050	0.2382	-0.1176	-0.0040	0.2271	-0.2389	0.2112	-0.3076	0.0210	0.1022	0.6373
Seed cotton yield/plant (g)	-0.0270	-0.2710**	0.0995	0.0457	0.2996**	0.2873**	-0.2528**	-0.1443	0.1894*	-0.5392**	0.5020**	-0.4283**	0.1302	0.1665*	0.7692**

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

Bold and diagonal values indicate direct effects, residual effect = 0.49

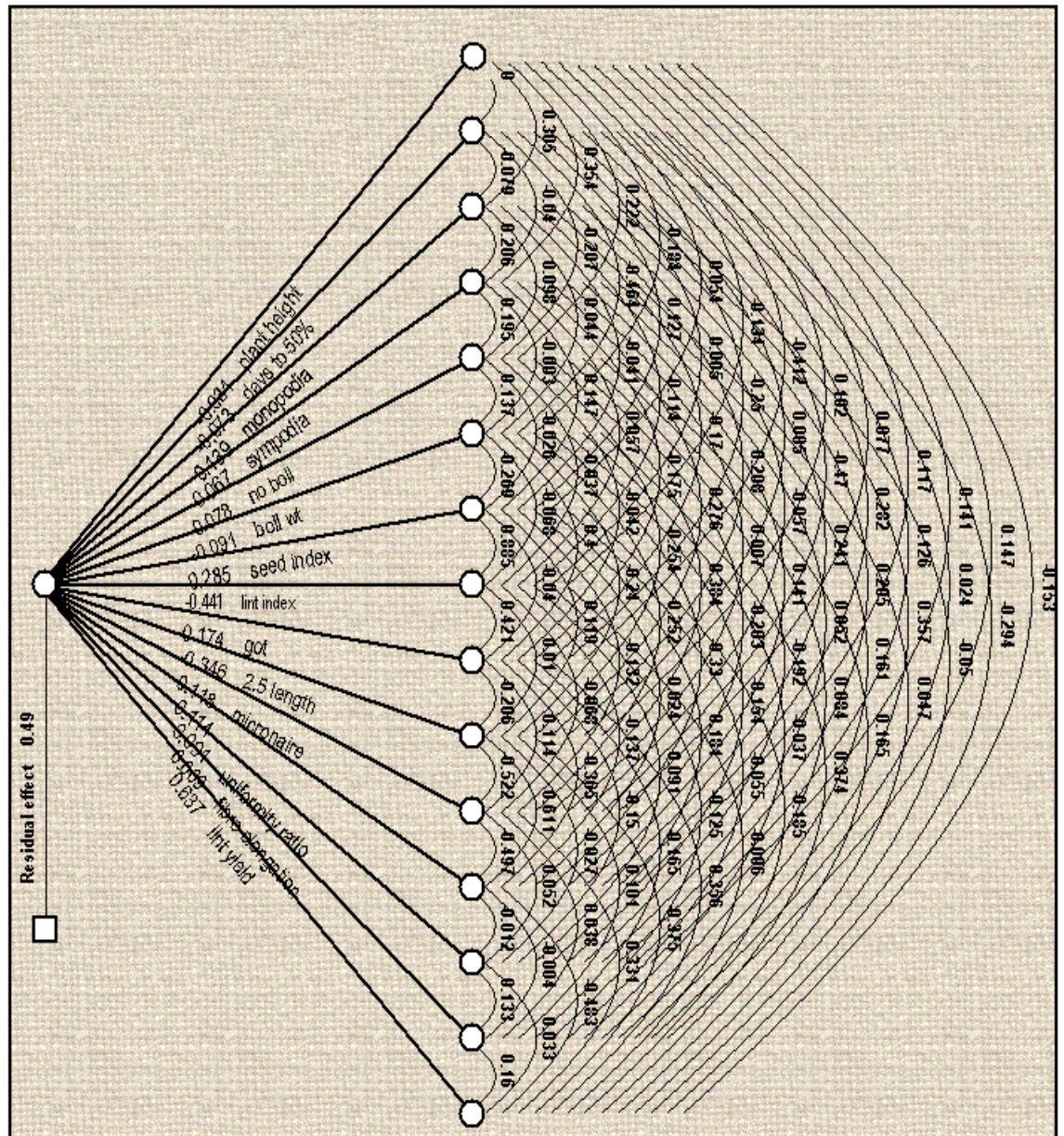


Fig. 1. Phenotypic path diagram showing the cause and effect relationship of yield components with seed cotton yield in cotton.

Table 4.13. Direct and indirect effects (genotypic) of 15 characters on seed cotton yield in 40 hybrids and 13 parents of cotton

Character	Plant height (cm)	Days to 50% flowering	No. of monopodia /plant	No. of sympodia /plant	No. of bolls /plant	Boll weight (g)	Seed Index (g)	Lint index (g)	Ginning out-turn (%)	2.5% Span length (mm)	Micro naire (10 ⁻⁶ g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Lint yield /plant (g)
Plant height (cm)	-0.0383	0.0002	-0.0137	-0.0182	-0.0107	0.0082	-0.0042	0.0054	0.0214	-0.0044	-0.0032	-0.0043	-0.0066	-0.0067	0.0058
Days to 50 % flowering	0.0007	-0.1180	0.0128	0.0061	0.0319	0.0574	-0.0171	-0.0018	0.0354	-0.0011	0.0614	-0.0374	-0.0169	-0.0031	0.0392
No. of Monopodia/plant	0.0543	-0.0165	0.1517	0.0445	0.0115	0.0078	-0.0100	-0.0264	-0.0350	0.0377	-0.0060	0.0403	0.0355	0.0605	-0.0102
No. of Sympodia/plant	0.0420	-0.0046	0.0260	0.0885	0.0295	0.0002	0.0198	0.0068	-0.0281	0.0305	0.0060	0.0164	0.0054	0.0171	0.0045
No. of bolls/plant	0.0373	-0.0362	0.0101	0.0447	0.1338	0.0217	-0.0003	0.0007	-0.0002	-0.0378	0.0623	-0.0362	-0.0318	0.0130	0.0332
Boll weight (g)	0.0280	0.0634	-0.0067	-0.0004	-0.0211	-0.1302	0.0390	0.0089	-0.0667	0.0336	-0.0350	0.0502	0.0234	0.0024	-0.0543
Seed Index(g)	0.0319	0.0419	-0.0190	0.0645	-0.0007	-0.0864	0.2886	0.2599	-0.0493	0.0395	-0.0506	0.0080	0.0737	-0.0206	-0.0681
Lint Index (g)	0.0660	-0.0071	0.0821	-0.0365	-0.0025	0.0323	-0.4251	-0.4720	-0.1308	-0.0087	0.0543	0.0806	-0.0723	0.0803	0.0174
Ginning out turn (%)	-0.1460	-0.0783	-0.0602	-0.0830	-0.0004	0.1339	-0.0446	0.0724	0.2611	-0.0649	0.0356	-0.1178	-0.0549	-0.0562	0.1127
2.5% Span length (mm)	-0.0518	-0.0042	-0.1120	-0.1553	0.1273	0.1163	-0.0617	-0.0083	0.1120	-0.4506	0.2543	-0.3023	0.0195	-0.0441	0.1858
Micronaire (10 ⁻⁶ g/inch)	0.0070	-0.0437	-0.0033	0.0057	0.0391	0.0226	-0.0147	-0.0097	0.0115	-0.0474	0.0840	-0.0493	0.0091	0.0034	0.0341
Bundle strength (g/tex)	0.0180	0.0510	0.0427	0.0298	-0.0435	-0.0620	0.0044	-0.0274	-0.0725	0.1079	-0.0943	0.1608	-0.0034	-0.0012	-0.0865
Uniformity ratio	0.0281	0.0235	0.0384	0.0101	-0.0390	-0.0296	0.0420	0.0252	-0.0345	-0.0071	0.0179	-0.0034	0.1642	0.0254	0.0066
Fibre elongation (%)	0.0023	0.0003	0.0052	0.0025	0.0013	-0.0002	-0.0009	-0.0022	-0.0028	0.0013	0.0005	-0.0001	0.0020	0.0131	0.0024
Lint yield/plant (g)	-0.0823	-0.1814	-0.0366	0.0276	0.1354	0.2276	-0.1287	-0.0201	0.2354	-0.2249	0.2213	-0.2936	0.0220	0.0983	0.5456
Seed cotton yield/plant (g)	-0.0026	-0.3097**	0.1175	0.0307	0.3920**	0.3196**	-0.3138**	-0.1887*	0.2566**	-0.5964**	0.6088**	-0.4882**	0.1691*	0.1817*	0.7680**

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

Bold and diagonal values indicate direct effects, residual effect = 0.419

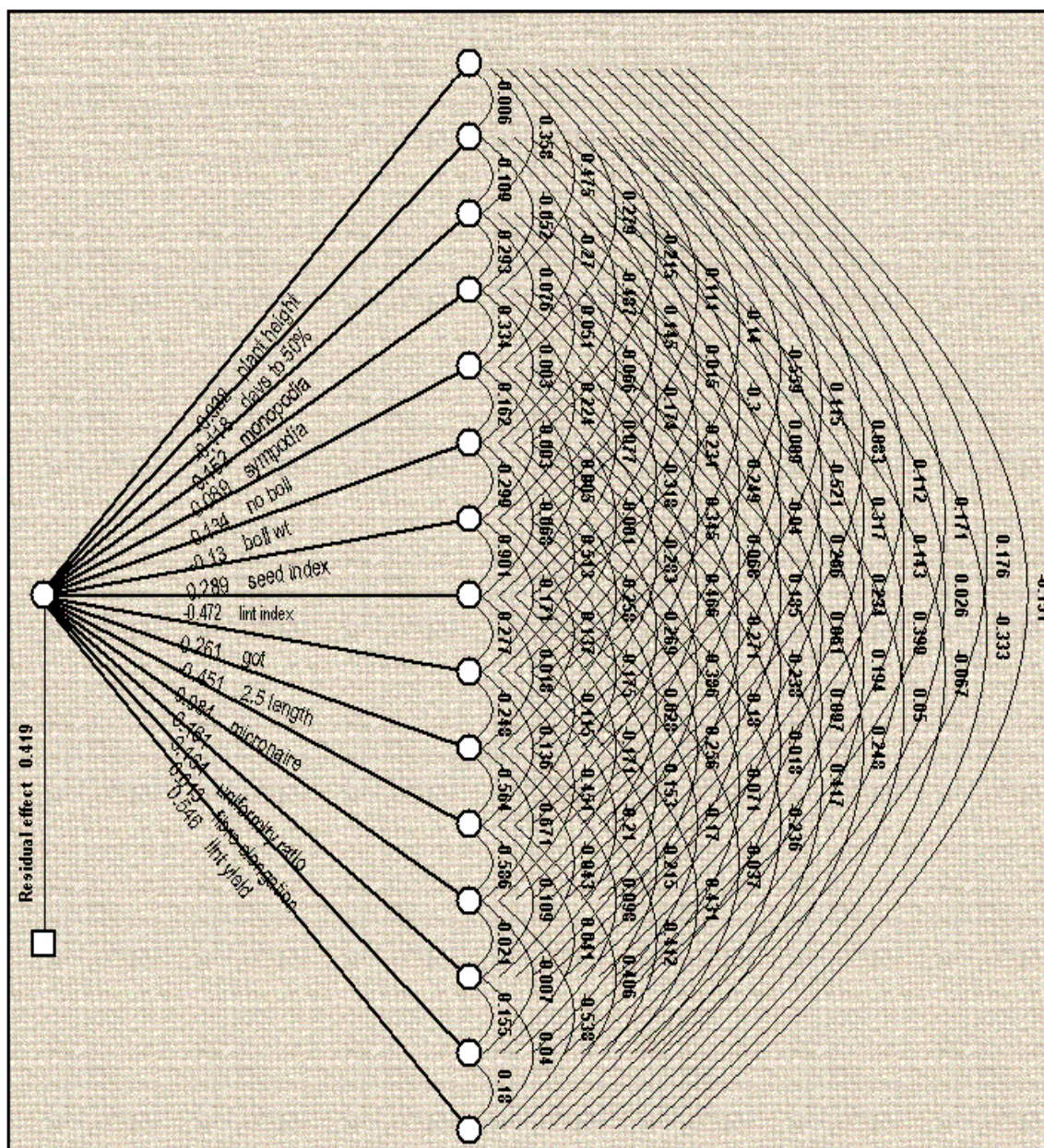


Fig. 2. Genotypic path diagram showing the cause and effect relationship of yield components with seed cotton yield per plant in cotton

Chapter - V

SUMMARY AND CONCLUSIONS

The present investigation was carried out at Regional Agricultural Research Station, Lam Farm, Guntur, Andhra Pradesh. The experimental material for the present investigation comprised of 40 hybrids involving 8 lines and 5 testers crossed in a line $\times$ tester fashion during *kharif* 2011-2012. The hybrids along with their parents and one standard check (DCH 32) were evaluated in a randomized block design with three replications during *kharif* 2012-2013 mainly (i) to assess the genetic variability present in the investigated breeding material for their yield and yield contributing characters, (ii) to study the type of gene action and combining ability effects in inter-specific hybrids of cotton, (iii) to study the heterosis of hybrids and identification of promising high yielding inter-specific hybrids possess desirable fibre qualities and (iv) to study the character association, direct and indirect effects of yield components and fibre quality parameters.

To fulfill the above objectives, the data were recorded on plant height (cm), days to 50% flowering, number of monopodia plant⁻¹, number of sympodia plant⁻¹, number of bolls plant⁻¹, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire value (10⁻⁶g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g). The mean data recorded on five plants were subjected to statistical analysis for estimating genetic variability, heritability ($\hat{h}_{(ns)}^2$), combining ability, heterosis and character association.

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the material used in the present investigation possessed sufficient variability. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation indicating the influence of the environment on the expression of the traits. High variability coupled with high heritability and high genetic advance as per cent of mean was observed for lint yield plant⁻¹(g) and seed cotton yield plant⁻¹(g) indicating the operation of additive gene action in the inheritance of the trait.

The analysis of variance for combining ability revealed significant differences among the crosses and line x tester effects for all the characters suggesting the scope for the improvement of different characters by selecting better parents. The analysis of variance also revealed significant differences among the lines for number of monopodia plant⁻¹, number of bolls plant⁻¹, boll weight (g), 2.5% span length (mm), uniformity ratio, lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) and in testers for days to 50% flowering, number of bolls plant⁻¹, 2.5% span length (mm), micronaire value (10⁻⁶ g/inch), bundle strength, lint yield plant⁻¹ (g) and seed cotton yield per plant⁻¹ (g).

In the present study, wide genetic variability was observed for number of monopodia plant⁻¹, lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g), where as it was moderate for plant height (cm), number of sympodia plant⁻¹, number of bolls plant⁻¹, boll weight (g), lint index (g) and micronaire (10⁻⁶ g/inch) and low for other parameters. The characters viz., days to 50% flowering, 2.5% span length (mm), micronaire value (10⁻⁶ g/inch), bundle strength (g/tex), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) recorded high heritability. Number of monopodia per plant, number of bolls plant⁻¹, boll weight (g), seed index (g), lint index and uniformity ratio recorded moderate heritability while, plant height (cm), number of sympodia plant⁻¹, fibre elongation (%) and ginning out-turn (%) recorded low heritability values.

High heritability in conjunction with high genetic advance as per cent of mean were recorded in case of micronaire value (10⁻⁶ g/inch), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) indicating the preponderance of additive gene action in the inheritance of these traits and offers the scope for further improvement through simple selection procedures.

Moderate heritability coupled with high genetic advance as per cent of mean was observed for number of monopodia plant⁻¹, and number of bolls plant⁻¹ indicating the operation of both additive and non-additive gene action in the inheritance of these traits. High heritability coupled with low to moderate genetic advance as per cent of mean was observed for days to 50% flowering, 2.5% span length (mm) and bundle strength (g/tex) indicating the role of both additive and

non-additive gene action and further improvement of these traits would be possible through cyclic hybridization, diallel selective mating and biparental mating.

Low heritability and low genetic advance as percent of mean were recorded in case of number of sympodia plant⁻¹, ginning out-turn (%) and fibre elongation (%) indicating preponderance of non-additive gene action. Low heritability and moderate genetic advance as percent of mean was recorded in case of plant height (cm). However, the characters which are governed by non-additive gene action need to be exploited by heterosis breeding or population improvement through various forms of recurrent selection.

Thus, in inter-specific crosses significant positive heterosis was observed for plant height (cm), number of monopodia plant⁻¹, number of sympodia plant⁻¹, number of bolls plant⁻¹, lint index (g), 2.5% span length (mm), micronaire 10⁻⁶ (g/inch), uniformity ratio, bundle strength (g/tex), fibre elongation, lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g). In fact, negative heterosis for certain characters like days to 50% flowering is very much desirable since inter-specific hybrids with negative heterosis produce hybrids which are extra early or early in duration compared to their *barbadense* parents.

In the present study the crosses viz., L 1374 x RHCB 011, L 1238 x GSB 41 and L 1227 x GSB 41 were found superior with good yield performance which is on par with check. Based on per se performance, heterosis and combining ability effects, these hybrids can be exploited through heterosis breeding for commercial cultivation after thorough testing in wider environments for their conformity. These crosses can also be studied for further exploitation in segregating generations and superior segregants can be isolated from these cross derivatives.

Based on *gca* effects among the lines, L 1227 was identified as good general combiner for the characters viz., days to 50% flowering, seed index (g), lint index (g), micronaire (10⁻⁶ g/inch), uniformity ratio, fibre elongation (%), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) and the line L 1238 was identified as good general combiner for the characters viz., number of monopodia plant⁻¹, boll weight (g), ginning out-turn, uniformity ratio, fibre elongation (%), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g). Among the testers, RHCB 011 was identified as good general combiner for the characters viz., days to 50% flowering, micronaire (10⁻¹ g/inch), lint

yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g), followed by the tester Suvin for days to 50% flowering, seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm) and bundle strength (g/tex) and the tester GSB 41 for days to 50% flowering, seed index (g), lint index (g), ginning out-turn (%), uniformity ratio and fibre elongation (%).

The character association analysis revealed that number of bolls plant⁻¹, boll weight (g), ginning out-turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ were found to have significant positive association with seed cotton yield plant⁻¹ both at phenotypic and genotypic levels. Hence, the above characters may be considered in selection programmes while improving the seed cotton yield per plant.

In the present study, the residual effect observed at phenotypic (0.49) and genotypic (0.419) explains that the characters taken in this study contribute only about 60 percent to the seed cotton yield. The path analysis indicated that number of bolls plant⁻¹, boll weight (g), ginning out turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ (g) showed direct positive effects and significant correlation with seed cotton yield plant⁻¹ (g). The present study revealed that the major emphasis should be laid on selection process with lint yield plant⁻¹ without sacrificing desirable fibre qualities by adopting restriction selection model.

Based on overall performance *i.e.*, heterosis, combining ability studies and *per se* performance the hybrid combinations L 1374 × RHCB 011, L 1227 × GSB 41 and L 1238 × GSB 41 were found superior to check for seed cotton yield plant⁻¹ (g) and lint yield plant⁻¹ (g). These hybrids may be commercially exploited after thorough testing over wide range of environments.

CONCLUSIONS

The following conclusions were drawn from the results and discussion on various aspects of the present study.

- The studies on variability indicated that the material possessed considerable genetic variability. High variability coupled with high heritability and high genetic advance as per cent of mean was observed for lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g) indicating the operation of additive gene action in the inheritance of the trait.

- The ratio of *gca* variance to *sca* variance indicated the preponderance of additive gene action for days to 50% flowering, 2.5% span length (mm), micronaire value (10^{-6} g/inch), bundle strength (g/tex), lint yield plant⁻¹ (g) and seed cotton yield plant⁻¹ (g). While, the role of both additive and non-additive gene action was for number bolls plant⁻¹. Whereas, non-additive gene action is important for plant height (cm), number of monopodia plant⁻¹, number of sympodia plant⁻¹, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), uniformity ratio and fibre elongation (%).
- Heterosis study revealed that majority of the crosses showed positive heterosis for number of bolls plant⁻¹, 2.5% span length, uniformity ratio, fibre elongation, lint yield plant⁻¹ and seed cotton yield plant⁻¹ over mid parent, better parent and standard check.
- The character association and path analysis studies revealed that number of bolls plant⁻¹, boll weight (g), ginning out-turn (%), micronaire, fibre elongation (%) and lint yield plant⁻¹ were found to have significant positive association with seed cotton yield plant⁻¹. Major emphasis should be laid on selecting for lint yield per plant for the improvement of seed cotton yield.
- Based on *sca* effects, *per se* performance and heterosis the crosses, L 1374 x RHCB 011, L 1227 x GSB 41 and L 1238 x GSB 41 are found to be promising for seed cotton yield per plant and lint yield per plant.

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*** Original not seen**

Note: The literature is cited according to thesis guidelines prescribed by Acharya N G Ranga Agricultural University, Hyderabad.

S.NO.	chapters	Corrections	Page no.	Corrections done
1	Abstract	GCV higher than PCV	xi	Year of submission, pcv variation higher than gcv
2	Abstract	was identified and combiner	xii	Were identified and combiners
3	Table 2.3	Patel 2006	21	Removed Patel 2006
4	Materials and methods	Phenotypic variance formula	77	Formula corrected
5	Results and discussion	indicated	90	indicating
6	Results and discussion	PCV and GCV values in table 4.2	91	Corrected
7	Results and discussion	In coupled with	92	Coupled with
8	Summary and conclusions	GCV higher than PCV	163	PCV higher than GCV
9	Literature cited	Gourav et al 2007	IV	Gourav <i>et al.</i> 2007 removed
10	Literature cited	Patel spelling		Patil speliing corrected

Table 2.2. Review of literature on heritability ($\hat{h}^2_{(ns)}$) and genetic advance (GA) in cotton

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
1.	Plant height (cm)	Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Ravikesavan <i>et al.</i> (2008) Muhammad <i>et al.</i> (2009) Sabir <i>et al.</i> (2010) Kulkarni <i>et al.</i> (2011) Vineela (2011) Dhanalakshmi <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Ranganatha <i>et al.</i> (2013)	Kaushik and Kapoor (2006) Verma <i>et al.</i> (2006) Vijayalaxmi (2007) Venkatesh (2012)		Kumari and Chamundeswari (2005) Rao (2008) Rajanna (2010)
2.	Days to 50% flowering	Batool <i>et al.</i> (2010) Vineela (2011)	Muraleedhar (2005) Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Ravikesavan <i>et al.</i> (2008) Mahantesh (2009) Rajanna (2010) Kulkarni <i>et al.</i> (2011) Dhanalakshmi (2011) Haritha (2011) Venkatesh (2012)	Vijayalaxmi (2007)	Sivaprasad <i>et al.</i> (2004a) Raju (2005) Rao (2008)
3.	Number of Monopodia per plant	Pratap (2006) Verma <i>et al.</i> (2006) Vijayalaxmi (2007) Abbas <i>et al.</i> (2008) Muhammad <i>et al.</i> (2009) Haritha (2011)	Muhammad <i>et al.</i> (2010)	Sivaprasad <i>et al.</i> (2004a)	Kale <i>et al.</i> (2007) Rao and Rajamani (2009) Rajanna (2010)

Table 2.2 (cont.)

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
		Vineela (2011) Tulasi (2011) Dhanalakshmi <i>et al.</i> (2012) Venkatesh (2012)			
4.	Number of Sympodia per plant	Verma <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Ravikesavan <i>et al.</i> (2008) Muhammad <i>et al.</i> (2009) Rajanna (2010) Bazi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Dhanalakshmi <i>et al.</i> (2012)	Vijayalaxmi (2007) Srinivasulu (2009) Muhammad <i>et al.</i> (2010) Kulkarni <i>et al.</i> (2011) Venkatesh (2012)	Mahantesh (2009)	Sivaprasad <i>et al.</i> (2004a) Kumari and Chamundeswari (2005) Ahmed <i>et al.</i> (2006) Murthy <i>et al.</i> (2006) Rao and Rajamani (2009) Bazi (2011)
5.	Number of Bolls per plant	Pratap (2006) Roy (2006) Kale <i>et al.</i> (2007) Manzoor <i>et al.</i> (2009) Muhammad <i>et al.</i> (2009) Rajanna (2010) Bazi (2011) Iqbal <i>et al.</i> (2011) Vineela (2011) Dhanalakshmi <i>et al.</i> (2012) Venkatesh (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Gururajan and Sundar (2004) Muhammad <i>et al.</i> (2010)	Lu and Myers (2011)	Rao and Rajamani (2009)
6.	Boll weight (g)	Sakthi <i>et al.</i> (2007) Abbas <i>et al.</i> (2008)	Gururajan and Sundar (2004) Hafiz <i>et al.</i> (2006)	Sivaprasad <i>et al.</i> (2004a)	Kumari and Chamundeswari (2005)

Table 2.2 (cont.)

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
		Manzoor <i>et al.</i> (2009) Muhammad <i>et al.</i> (2010) Patnaik and Sial (2010) Iqbal <i>et al.</i> (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012) Venkatesh (2012) Dhanalakshmi <i>et al.</i> (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Kale <i>et al.</i> (2007) Lu and Myers (2011)		Rao and Rajamani (2009)
7.	Seed index (g)	Vijayalaxmi (2007) Ravikesavan <i>et al.</i> (2008) Naqib <i>et al.</i> (2010) Lu and Myers (2011) Haritha (2011) Vineela (2011)	Sivaprasad <i>et al.</i> (2004a) Sakthi <i>et al.</i> (2007)	Choudki <i>et al.</i> (2012)	Gururajan and Sundar (2004) Srinivasulu (2009) Venkatesh (2012)
8.	Lint index (g)	Murthy <i>et al.</i> (2006) Vijayalaxmi (2007) Ravikesavan <i>et al.</i> (2008) Naqib <i>et al.</i> (2010) Lu and Myers (2011) Vineela (2011) Dhanalakshmi <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012)	Sakthi <i>et al.</i> (2007) Rajanna (2010)		Srinivasulu (2009) Venkatesh (2012)
9.	Ginning out-turn (%)	Gururajan and Sundar (2004) Ravikesavan <i>et al.</i> (2008)	Raju (2005) Pratap (2006)	Choudki <i>et al.</i> (2012)	Gururajan and Sundar (2004)

Table 2.2 (cont.)

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
		Vineela (2011) Haritha <i>et al.</i> (2012) Rao and Gopinath (2013)	Verma <i>et al.</i> (2006) Kale <i>et al.</i> (2007) Vijayalaxmi (2007) Rajanna (2010) Bazi (2011) Tulasi (2011)		Sivaprasad <i>et al.</i> (2004a) Murthy <i>et al.</i> (2006) Srinivasulu (2009) Venkatesh (2012)
10.	2.5% Span length (mm)	Gururajan and Sundar (2004) Bazi (2011) Venkatesh (2012)	Tuteja <i>et al.</i> (2005a) Kaushik and Kapoor (2006) Verma <i>et al.</i> (2006) Kale <i>et al.</i> (2007) Vijayalaxmi (2007) Sakthi <i>et al.</i> (2007) Ravikesavan <i>et al.</i> (2008) Rajanna (2010) Vineela (2011) Choudki <i>et al.</i> (2012)		Haritha (2011)
11.	Micronaire value (10 ⁻⁶ g/in)	Abbas <i>et al.</i> (2008) Muhammad <i>et al.</i> (2008) Ravikesavan <i>et al.</i> (2008) Muhammad <i>et al.</i> (2010) Bazi (2011) Haritha (2011) Vineela (2011) Venkatesh (2012)	Hafiz <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Vijayalaxmi (2007) Mahantesh (2009) Dhanalakshmi (2011)	Choudki <i>et al.</i> (2012)	Sivaprasad <i>et al.</i> (2004a) Srinivasulu (2009) Rajanna (2010)
12.	Bundle strength (g/tex)	Murthy <i>et al.</i> (2006) Abbas <i>et al.</i> (2008) Muhammad <i>et al.</i> (2008) Ravikesavan <i>et al.</i> (2008)	Sakthi <i>et al.</i> (2007) Muhammad <i>et al.</i> (2010) Rajanna (2010) Haritha (2011)		Gururajan and Sundar (2004) Sivaprasad <i>et al.</i> (2004a) Muraleedhar (2005)

Table 2.2 (cont.)

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
		Muhammad <i>et al.</i> (2009) Iqbal <i>et al.</i> (2011) Venkatesh (2012)	Kulkarni <i>et al.</i> (2011) Vineela (2011) Choudki <i>et al.</i> (2012)		Vijayalaxmi (2007) Rao (2008) Mahantesh (2009) Rao and Rajamani (2009) Bazi (2011) Tulasi (2011)
13.	Uniformity ratio	Muhammad <i>et al.</i> (2008) Haritha (2011)	Sakthi <i>et al.</i> (2007) Dhanalakshmi (2011) Bazi (2011) Vineela (2011) Venkatesh (2012)	Raju (2005)	Sivaprasad <i>et al.</i> (2004a) Muraleedhar (2005) Vijayalaxmi (2007) Rajanna (2010) Tulasi (2011) Choudki <i>et al.</i> (2012) Rao and Gopinath (2013)
14.	Fibre elongation (%)	Sakthi <i>et al.</i> (2007) Preetha and Raveendran (2008) Haritha (2011) Tulasi (2011)	Vijayalaxmi (2007) Muhammad <i>et al.</i> (2008) Srinivasulu (2009) Dhanalakshmi (2011) Vineela (2011) Venkatesh (2012)		Rao (2008) Rajanna (2010) Bazi (2011) Choudki <i>et al.</i> (2012)
15.	Lint yield/ plant (g)	Pratap (2006) Gamal <i>et al.</i> (2009) Muhammad <i>et al.</i> (2010) Rajanna (2010) Lu and Myers (2011) Iqbal <i>et al.</i> (2011)	Abbas <i>et al.</i> (2008) Muhammad <i>et al.</i> (2009)		

Table 2.2 (cont.)

S. No.	Character	High heritability and high genetic advance	High heritability and low genetic advance	Low heritability and high genetic advance	Low heritability and low genetic advance
		Vineela (2011) Venkatesh (2012) Rao and Gopinath (2013)			
16.	Seed cotton yield/plant (g)	Kaushik and Kapoor (2006) Sakthi <i>et al.</i> (2007) Abbas <i>et al.</i> (2008) Manzoor <i>et al.</i> (2009) Muhammad <i>et al.</i> (2010) Patnaik and Sial (2010) Iqbal <i>et al.</i> (2011) Vineela (2011) Choudki <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Venkatesh (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Gururajan and Sundar (2004) Kale <i>et al.</i> (2007) Muhammad <i>et al.</i> (2009)		

Table 2.3. Review of literature on gene action governing yield and yield components in cotton hybrids.

S.No.	Character	Additive	Non-additive	Additive and Non-additive
1.	Plant height (cm)	Kalpande <i>et al.</i> (2008) Bhaskaran and Ravikesavan (2008) Soomro <i>et al.</i> (2010) Dhanalakshmi <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Tariq and Uzair (2012)	Verma <i>et al.</i> (2004) Patel <i>et al.</i> (2005) Subramanian <i>et al.</i> (2005) Ilyas <i>et al.</i> (2007) Kamboh <i>et al.</i> (2008) Deosarkar <i>et al.</i> (2009b) Mohammad <i>et al.</i> (2010) Rajanna (2010) Tulasi (2011) Patil <i>et al.</i> (2011b) Patel <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012b) Simon <i>et al.</i> (2013)	Rathore <i>et al.</i> (2004b) Sundaravadivelu <i>et al.</i> (2005a) Gibri <i>et al.</i> (2006a) Kiani <i>et al.</i> (2007)
2.	Days to 50% flowering	Reshmi <i>et al.</i> (2007) Kalpande <i>et al.</i> (2008) Wankhade <i>et al.</i> (2008) Shinde <i>et al.</i> (2012)	Subramanian <i>et al.</i> (2005) Patel <i>et al.</i> (2005) Kiani <i>et al.</i> (2007) Preetha and Raveendran (2008) Kamboh <i>et al.</i> (2008) Deosarkar <i>et al.</i> (2009b) Rajanna (2010) Tulasi (2011) Patil <i>et al.</i> (2011b) Amir <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Simon <i>et al.</i> (2013)	Sivaprasad <i>et al.</i> (2004a) Gibri <i>et al.</i> (2006a) Dhanalakshmi (2011) Venkatesh (2012)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
3.	Number of monopodia per plant	Raju (2005) Kiani <i>et al.</i> (2007) Mohammad <i>et al.</i> (2010) Mohan (2011) Dhanalakshmi <i>et al.</i> (2012)	Narisireddy and Satyanarayana (2004) Patel <i>et al.</i> (2005) Deosarkar <i>et al.</i> (2009b) Mahantesh <i>et al.</i> (2010) Rajanna (2010) Tulasi (2011) Patil <i>et al.</i> (2011b) Shinde <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)	Sundaravadivelu <i>et al.</i> (2005a) Gibri <i>et al.</i> (2006a) Patel <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010a) Tariq and Uzair (2012) Venkatesh (2012)
4.	Number of sympodia per plant	Bhaskaran and Ravikesavan (2008) Jatoi <i>et al.</i> (2011) Mohan (2011) Dhanalakshmi <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Tariq and Uzair (2012)	Sivaprasad <i>et al.</i> (2004a) Subramanian <i>et al.</i> (2005) Patel <i>et al.</i> (2005) Kiani <i>et al.</i> (2007) Wankhade <i>et al.</i> (2008) Kamboh <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009b) Mohammad <i>et al.</i> (2010) Mahantesh <i>et al.</i> (2010) Senthilkumar <i>et al.</i> (2010) Rajanna (2010) Tulasi (2011) Patil <i>et al.</i> (2011b) Vineela <i>et al.</i> (2012b)	Rathore <i>et al.</i> (2004b) Sundaravadivelu <i>et al.</i> (2005a) Gibri <i>et al.</i> (2006a) Patel <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010a) Venkatesh (2012)
5.	Number of bolls per plant	Sivaprasad <i>et al.</i> (2004a) Bhaskaran and Ravikesavan (2008) Pole <i>et al.</i> (2008a)	Verma <i>et al.</i> (2004) Subramanian <i>et al.</i> (2005) Ilyas <i>et al.</i> (2007)	Narisireddy and Satyanarayana (2004) Rathore <i>et al.</i> (2004b)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
		Kalpande <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Soomro <i>et al.</i> (2010) Jatoi <i>et al.</i> (2011) Mohan (2011) Dhanalakshmi <i>et al.</i> (2012) Tariq and Uzair (2012) Rao and Gopinath (2013)	Wankhade <i>et al.</i> (2008) Kamboh <i>et al.</i> (2008) Naqib <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009b) Mohammad <i>et al.</i> (2010) Mahantesh <i>et al.</i> (2010) Rajanna (2010) Tulasi (2011) Patil <i>et al.</i> (2011b) Amir <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012b) Nassar (2013) Simon <i>et al.</i> (2013)	Sundaravadivelu <i>et al.</i> (2005a) Singh and Singh (2006) Gibri <i>et al.</i> (2006a) Kiani <i>et al.</i> (2007) Panhwar <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Bbebe <i>et al.</i> (2010) Wandhare <i>et al.</i> (2010a)
6.	Boll weight (g)	Raju (2005) Reshmi <i>et al.</i> (2007) Kalpande <i>et al.</i> (2008) Bhaskaran and Ravikesavan (2008) Kamboh <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Mohammad <i>et al.</i> (2010) Singh <i>et al.</i> (2010) Dhanalakshmi (2011)	Verma <i>et al.</i> (2004) Subramanian <i>et al.</i> (2005) Ilyas <i>et al.</i> (2007) Wankhade <i>et al.</i> (2008) Basal <i>et al.</i> (2009) Naqib <i>et al.</i> (2009) Vemanna and Kajjidoni (2009) Deosarkar <i>et al.</i> (2009b) Senthilkumar <i>et al.</i> (2010) Patil <i>et al.</i> (2011b) Mohan (2011)	Gururajan and Sundar (2004) Narisireddy and Satyanarayana (2004) Gibri <i>et al.</i> (2006a) Panhwar <i>et al.</i> (2008) Kiani <i>et al.</i> (2007) Gamal <i>et al.</i> (2009) Patel <i>et al.</i> (2009) Bbebe <i>et al.</i> (2010)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
		Amir <i>et al.</i> (2012) Haritha <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012) Venkatesh (2012) Tariq and Uzair (2012) Nassar (2013) Rao and Gopinath (2013)	Soomro <i>et al.</i> (2010) Rajanna (2010) Mohan (2011) Patil <i>et al.</i> (2011b) Shinde <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)	Wandhare <i>et al.</i> (2010a) Tulasi (2011) Rajamani <i>et al.</i> (2012)
7.	Seed index (g)	Raju (2005) Kalpande <i>et al.</i> (2008) Pole <i>et al.</i> (2008a) Patel <i>et al.</i> (2009) Mohammad <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010b) Nassar (2013)	Manickam and Gururajan (2004) Vemanna and Kajjidoni (2009) Deosarkar <i>et al.</i> (2009b) Mahantesh <i>et al.</i> (2010) Soomro <i>et al.</i> (2010) Rajanna (2010) Mohan (2011) Patil <i>et al.</i> (2011b) Venkatesh (2012) Vineela <i>et al.</i> (2012b)	Sivaprasad <i>et al.</i> (2004a) Sundaravadivelu <i>et al.</i> (2005a) Gibri <i>et al.</i> (2006a) Panhwar <i>et al.</i> (2008) Dhanalakshmi (2011) Tulasi (2011) Haritha <i>et al.</i> (2012)
8.	Lint index (g)	Rathore <i>et al.</i> (2004b) Raju (2005) Kalpande <i>et al.</i> (2008) Mohammad <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010b) Dhanalakshmi <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012)	Manickam and Gururajan (2004) Sivaprasad <i>et al.</i> (2004a) Subramanian <i>et al.</i> (2005) Preetha and Raveendran (2008) Basal <i>et al.</i> (2009) Vemanna and Kajjidoni (2009) Mahantesh <i>et al.</i> (2010) Rajanna (2010) Mohan (2011)	Sundaravadivelu <i>et al.</i> (2005a) Gibri <i>et al.</i> (2006a) Gamal <i>et al.</i> (2009) Tulasi (2011)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
			Patil <i>et al.</i> (2011b) Haritha <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012b)	
9.	Ginning out-turn (%)	Verma <i>et al.</i> (2004) Rathore <i>et al.</i> (2004b) Bhaskaran and Ravikesavan (2008) Kalpande <i>et al.</i> (2008) Pole <i>et al.</i> (2008a) Patel <i>et al.</i> (2009) Deshmukh <i>et al.</i> (2010) Wandhare <i>et al.</i> (2010b) Haritha <i>et al.</i> (2012) Rao and Gopinath (2013)	Subramanian <i>et al.</i> (2005) Preetha and Raveendran (2008) Kamboh <i>et al.</i> (2008) Faqir and Naeem (2008) Karademir <i>et al.</i> (2009) Vemanna and Kajjidoni (2009) Deosarkar <i>et al.</i> (2009b) Mahantesh <i>et al.</i> (2010) Singh <i>et al.</i> (2010) Rajanna (2010) Mohan (2011) Patil <i>et al.</i> (2011b) Patel <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012b)	Sivaprasad <i>et al.</i> (2004a) Sundaravadivelu <i>et al.</i> (2005a) Singh and Singh (2006) Gibri <i>et al.</i> (2006a) Panhwar <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Bbebe <i>et al.</i> (2010) Dhanalakshmi (2011) Tulasi (2011)
10.	2.5% span length (mm)	Naphade <i>et al.</i> (2004) Subramanian <i>et al.</i> (2005) Kalpande <i>et al.</i> (2008) Kamboh <i>et al.</i> (2008) Naqib <i>et al.</i> (2009) Karademir <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010b) Mohan (2011)	Manickam and Gururajan (2004) Ilyas <i>et al.</i> (2007) Lukange <i>et al.</i> (2007) Kumar and Ravikesavan (2008) Faqir and Naeem (2008) Vemanna and Kajjidoni (2009) Rajanna (2010) Mahantesh <i>et al.</i> (2010)	Sivaprasad <i>et al.</i> (2004a) Sundaravadivelu <i>et al.</i> (2005 a,b) Dhanalakshmi (2011) Natera <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
		Patil <i>et al.</i> (2011b) Amir <i>et al.</i> (2012)	Singh <i>et al.</i> (2010) Tulasi (2011) Haritha <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)	
11.	Micronaire value (10 ⁻⁶ g/in)	Naphade <i>et al.</i> (2004) Verma <i>et al.</i> (2004) Subramanian <i>et al.</i> (2005) Kalpande <i>et al.</i> (2008) Kamboh <i>et al.</i> (2008) Wandhare <i>et al.</i> (2010b)	Manickam and Gururajan (2004) Lukange <i>et al.</i> (2007) Kumar and Ravikesavan (2008) Basal <i>et al.</i> (2009) Vemanna and Kajjidoni (2009) Mahantesh <i>et al.</i> (2010) Singh <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Mohan (2011) Tulasi (2011) Patil <i>et al.</i> (2011b) Vineela <i>et al.</i> (2012b) Amir <i>et al.</i> (2012)	Haritha <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)
12.	Bundle strength (g/tex)	Naphade <i>et al.</i> (2004) Sivaprasad <i>et al.</i> (2004a) Subramanian <i>et al.</i> (2005) Karademir <i>et al.</i> (2007) Kalpande <i>et al.</i> (2008) Bhaskaran and Ravikesavan (2008) Basal <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010b) Amir <i>et al.</i> (2012)	Manickam and Gururajan (2004) Ilyas <i>et al.</i> (2007) Lukange <i>et al.</i> (2007) Kumar and Ravikesavan (2008) Faqir and Naeem (2008) Karademir <i>et al.</i> (2009) Mahantesh <i>et al.</i> (2010) Hussain <i>et al.</i> (2010) Rajanna (2010)	Dhanalakshmi (2011) Natera <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
			Mohan (2011) Tulasi (2011) Haritha <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)	
13.	Uniformity ratio	Mohammad <i>et al.</i> (2009) Deshmukh <i>et al.</i> (2010) Wandhare <i>et al.</i> (2010b)	Manickam and Gururajan (2004) Kumar and Ravikesavan (2008) Preetha and Raveendran (2008) Basal <i>et al.</i> (2009) Karademir <i>et al.</i> (2009) Vemanna and Kajjidoni (2009) Hussain <i>et al.</i> (2010) Dhanalakshmi (2011) Mohan (2011) Patil <i>et al.</i> (2011b) Tulasi (2011) Vineela <i>et al.</i> (2012b) Rao and Gopinath (2013)	Karademir <i>et al.</i> (2007) Haritha <i>et al.</i> (2012) Venkatesh (2012)
14.	Fibre elongation (%)	Karademir <i>et al.</i> (2007) Bhaskaran and Ravikesavan (2008) Karademir <i>et al.</i> (2009) Singh <i>et al.</i> (2010) Mohan (2011)	Manickam and Gururajan (2004) Preetha and Raveendran (2008) Kumar and Ravikesavan (2008) Basal <i>et al.</i> (2009) Mahantesh <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Vineela <i>et al.</i> (2012b)	Tulasi (2011) Haritha <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)
15.	Lint yield per plant (g)	Pole <i>et al.</i> (2008a) Patel <i>et al.</i> (2009) Rao and Gopinath (2013)	Karademir <i>et al.</i> (2007) Karademir <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009b)	Gamal <i>et al.</i> (2009) Dhanalakshmi (2011) Venkatesh (2012)

Table 2.3 (cont.)

S.No.	Character	Additive	Non-additive	Additive and Non-additive
			Rajanna (2010) Patel <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Nassar (2013) Simon <i>et al.</i> (2013)	
16.	Seed cotton yield per plant (g)	Raju (2005) Karademir <i>et al.</i> (2007) Reshmi <i>et al.</i> (2007) Bhaskaran and Ravikesavan (2008) Naqib <i>et al.</i> (2009) Patel <i>et al.</i> (2009) Bbebe <i>et al.</i> (2010) Mohammad <i>et al.</i> (2010) Singh <i>et al.</i> (2010) Soomro <i>et al.</i> (2010) Wandhare <i>et al.</i> (2010b) Haritha (2011) Jatoi <i>et al.</i> (2011) Mohan (2011) Amir <i>et al.</i> (2012) Tariq and Uzair (2012) Rao and Gopinath (2013)	Verma <i>et al.</i> (2004) Ilyas <i>et al.</i> (2007) Kalpande <i>et al.</i> (2008) Kamboh <i>et al.</i> (2008) Karademir <i>et al.</i> (2009) Kumar and Ravikesavan (2008) Deosarkar <i>et al.</i> (2009b) Mahantesh <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Tulasi (2011) Patil <i>et al.</i> (2011b) Patel <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Nassar (2013)	Narisireddy and Satyanarayana (2004) Sivaprasad <i>et al.</i> (2004a) Rathore <i>et al.</i> (2004b) Sundaravadivelu <i>et al.</i> (2005 a,b) Singh and Singh (2006) Gibri <i>et al.</i> (2006a) Panhwar <i>et al.</i> (2008) Gamal <i>et al.</i> (2009) Patel <i>et al.</i> (2009) Wandhare <i>et al.</i> (2010a) Vineela (2011) Natera <i>et al.</i> (2012) Venkatesh (2012)

Table 2.4. Review of literature on heterosis over mid parent (Relative heterosis), better parent (Heterobeltiosis) and standard check (Standard heterosis) for yield and yield components in hybrids of cotton

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
1.	Plant height (cm)	Abdel <i>et al.</i> (2007) Dukre <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Saifullah <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Mohammad <i>et al.</i> (2010) Kaushik and Sastry (2011) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Abdel <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Saifullah <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Kaushik and Sastry (2011) Naqib (2011) Patil <i>et al.</i> (2011a) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Preetha and Raveendran (2008) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Patil <i>et al.</i> (2009) Rajanna (2010) Naqib (2011) Patil <i>et al.</i> (2011a) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
2.	Days to 50% flowering	Dukre <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Deosarkar <i>et al.</i> (2009a) Kaushik and Sastry (2011)	Ganapathy and Nadarajan (2008) Deosarkar <i>et al.</i> (2009a) Kaushik and Sastry (2011) Patil <i>et al.</i> (2011a)	Preetha and Raveendran (2008) Deosarkar <i>et al.</i> (2009a) Rajanna (2010) Patil <i>et al.</i> (2011a) Vineela <i>et al.</i> (2012b)
3.	Number of monopodia per plant	Maisuria <i>et al.</i> (2007) Deosarkar <i>et al.</i> (2009a) Mohammad <i>et al.</i> (2010) Kaushik and Sastry (2011) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Deosarkar <i>et al.</i> (2009a) Kaushik and Sastry (2011) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Mahantesh (2009) Deosarkar <i>et al.</i> (2009a) Rajanna (2010) Mohan (2011) Tuteja <i>et al.</i> (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)

Table 2.4 (cont.)

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
4.	Number of sympodia per plant	Dukre <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Saifullah <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Mohammad <i>et al.</i> (2010) Kaushik and Sastry (2011) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Saifullah <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Kaushik and Sastry (2011) Naqib (2011) Patil <i>et al.</i> (2011a) Nidagundi <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Preetha and Raveendran (2008) Deosarkar <i>et al.</i> (2009a) Patil <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Rajanna (2010) Naqib (2011) Tuteja <i>et al.</i> (2011) Patil <i>et al.</i> (2011a) Javendra and Amit (2012) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
5.	Number of bolls per plant	Abdel <i>et al.</i> (2007) Dukre <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Pole <i>et al.</i> (2008b) Saifullah <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Mohammad <i>et al.</i> (2010) Kaushik and Sastry (2011) Maria <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Abdel <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Pole <i>et al.</i> (2008b) Saifullah <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Kaushik and Sastry (2011) Naqib (2011) Patil <i>et al.</i> (2011a) Maria <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Ganapathy and Nadarajan (2008) Pole <i>et al.</i> (2008b) Patil <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Tuteja <i>et al.</i> (2011) Mohan (2011) Patil <i>et al.</i> (2011a) Javendra and Amit (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Amit <i>et al.</i> (2013)

Table 2.4 (cont.)

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
6.	Boll weight (g)	Abdel <i>et al.</i> (2007) Dukre <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Mohammad <i>et al.</i> (2010) Maria <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Abdel <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Naqib (2011) Patil <i>et al.</i> (2011a) Maria <i>et al.</i> (2012) Nidagundi <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Preetha and Raveendran (2008) Patil <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Mohan (2011) Naqib (2011) Tuteja <i>et al.</i> (2011) Javendra and Amit (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Amit <i>et al.</i> (2013)
7.	Seed index (g)	Dukre <i>et al.</i> (2007) Paulo <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Deshpande <i>et al.</i> (2008) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Patil <i>et al.</i> (2011a) Nidagundi <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Rajanna (2010) Mohan (2011) Patil <i>et al.</i> (2011a) Tuteja <i>et al.</i> (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
8.	Lint index (g)	Dukre <i>et al.</i> (2007) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Deshpande <i>et al.</i> (2008) Wankhade <i>et al.</i> (2009) Nidagundi <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Wankhade <i>et al.</i> (2009) Rajanna (2010) Mohan (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)

Table 2.4 (cont.)

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
9.	Ginning out-turn (%)	Dukre <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Pole <i>et al.</i> (2008b) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Patil <i>et al.</i> (2011a) Nidagundi <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Preetha and Raveendran (2008) Wankhade <i>et al.</i> (2009) Patil <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Tuteja <i>et al.</i> (2011) Mohan (2011) Sekhar <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
10.	2.5% span length (mm)	Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Deshpande <i>et al.</i> (2008) Wankhade <i>et al.</i> (2009) Rajamani <i>et al.</i> (2009) Patil <i>et al.</i> (2011a) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012)	Khosla <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Jyothiba <i>et al.</i> (2010) Mohan (2011) Tuteja <i>et al.</i> (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Amit <i>et al.</i> (2013)
11.	Micronaire value (10 ⁻⁶ g/inch)	Rajamani <i>et al.</i> (2009) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Patil <i>et al.</i> (2011a) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Preetha and Raveendran (2008) Rajamani <i>et al.</i> (2009) Rajanna (2010) Mohan (2011) Tuteja <i>et al.</i> (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)

Table 2.4 (cont.)

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
12.	Bundle strength (g/tex)	Maisuria <i>et al.</i> (2007) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Deshpande <i>et al.</i> (2008) Wankhade <i>et al.</i> (2009) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Preetha and Raveendran (2008) Wankhade <i>et al.</i> (2009) Jyothiba <i>et al.</i> (2010) Mohan (2011) Tuteja <i>et al.</i> (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
13.	Uniformity ratio	Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Sekhar <i>et al.</i> (2012)	Khosla <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Rajamani <i>et al.</i> (2009) Rajanna (2010) Mohan (2011) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)
14.	Fibre elongation (%)	Maisuria <i>et al.</i> (2007) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Sekhar <i>et al.</i> (2012)	Maisuria <i>et al.</i> (2007) Zhang <i>et al.</i> (2008) Rajanna (2010) Mohan (2011) Vineela <i>et al.</i> (2012b)
15.	Lint yield per plant (g)	Paulo <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Nidagundi <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Javendra and Amit (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b)

Table 2.4 (cont.)

S. No.	Character	Relative heterosis	Heterobeltiosis	Standard heterosis
16.	Seed cotton yield per plant (g)	Dukre <i>et al.</i> (2007) Paulo <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Ganapathy and Nadarajan (2008) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Rajamani <i>et al.</i> (2009) Saifullah <i>et al.</i> (2009) Basamma <i>et al.</i> (2010) Kaushik and Sastry (2011) Balu <i>et al.</i> (2012) Maria <i>et al.</i> (2012) Patel <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Maisuria <i>et al.</i> (2007) Pole <i>et al.</i> (2008b) Deosarkar <i>et al.</i> (2009a) Rajamani <i>et al.</i> (2009) Saifullah <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Basamma <i>et al.</i> (2010) Kaushik and Sastry (2011) Naqib (2011) Patil <i>et al.</i> (2011a) Balu <i>et al.</i> (2012) Javendra and Amit (2012) Maria <i>et al.</i> (2012) Nidagundi <i>et al.</i> (2012) Punitha <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Nassar (2013)	Bagade <i>et al.</i> (2007) Khosla <i>et al.</i> (2007) Maisuria <i>et al.</i> (2007) Reshmi <i>et al.</i> (2007) Preetha and Raveendran (2008) Zhang <i>et al.</i> (2008) Patel <i>et al.</i> (2009) Rajamani <i>et al.</i> (2009) Wankhade <i>et al.</i> (2009) Deosarkar <i>et al.</i> (2009a) Basamma <i>et al.</i> (2010) Rajanna (2010) Mohan (2011) Naqib (2011) Tuteja <i>et al.</i> (2011) Balu <i>et al.</i> (2012) Javendra and Amit (2012) Patel <i>et al.</i> (2012) Sekhar <i>et al.</i> (2012) Shinde <i>et al.</i> (2012) Vineela <i>et al.</i> (2012b) Amit <i>et al.</i> (2013)

Table 2.5. Review of literature on association of component characters with seed cotton yield in cotton.

S. No	Character	Association	S/NS	Reference
1.	Plant height (cm)	Positive	S	Muraleedhar (2005) Kaushik and Kapoor (2006) Rao (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Thiyagu <i>et al.</i> (2010) Kishore <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012) Wang <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)
		Negative	S	Pratap <i>et al.</i> (2007) Haritha (2011)
			NS	Raju (2005) Kale <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)
2.	Days to 50% flowering	Positive	S	Tuteja <i>et al.</i> (2006a) Mahantesh (2009) Kumar and Ravikesavan (2010) Bazi (2011) Dhanalakshmi <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012a)
			NS	Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007)
		Negative	S	Neelima <i>et al.</i> (2005)
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rao (2008) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Haritha (2011)
3.	Number of monopodia per plant	Positive	S	Mahantesh (2009) Kumar and Ravikesavan (2010) Mohan (2011) Tulasi <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)
			NS	Pradeep and Sumalini (2005) Kaushik and Kapoor (2006) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011) Kishore <i>et al.</i> (2011)
		Negative	S	Rauf <i>et al.</i> (2004) Batool <i>et al.</i> (2010)

Table 2.5 (cont.)

S. No	Character	Association	S/NS	Reference
			NS	Rao (2008) Venkateswarlu <i>et al.</i> (2010b)
4.	Number of sympodia per plant	Positive	S	Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006a) Pratap <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Batool <i>et al.</i> (2010) Ekinci <i>et al.</i> (2010) Patnaik and Sial (2010) Thiyagu <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011) Mohan (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a) Wang <i>et al.</i> (2012)
			NS	Pradeep and Sumalini (2005) Kishore <i>et al.</i> (2011)
		Negative	NS	Raju (2005) Rao (2008)
5.	Number of bolls per plant	Positive	S	Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006a) Verma <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rao (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Basamma <i>et al.</i> (2010) Ekinci <i>et al.</i> (2010) Khadijah <i>et al.</i> (2010) Patnaik and Sial (2010) Thiyagu <i>et al.</i> (2010) Haritha (2011) Kishore <i>et al.</i> (2011) Mohan (2011) Bazi (2011) Saravanan and Koodalingam (2011) Dhanalakshmi <i>et al.</i> (2012) Tulasi <i>et al.</i> (2012) Venkatesh (2012) Wang <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007)

Table 2.5 (cont.)

S. No	Character	Association	S/NS	Reference
6.	Boll weight (g)	Positive	S	Neelima <i>et al.</i> (2005) Raju (2005) Murthy <i>et al.</i> (2006) Kale <i>et al.</i> (2007) Rao (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Basamma <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Ekinci <i>et al.</i> (2010) Khadijah <i>et al.</i> (2010) Batool <i>et al.</i> (2010) Mohan (2011) Kishore <i>et al.</i> (2011) Haritha (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012) Wang <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)
			NS	Vijayalaxmi <i>et al.</i> (2008)
7.	Seed index (g)	Positive	S	Muthu <i>et al.</i> (2004) Gururajan and Sundar (2004) Neelima <i>et al.</i> (2005) Murthy <i>et al.</i> (2006) Mahantesh (2009) Kumar <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Mohan (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)
			NS	Kaushik and Kapoor (2006) Vijayalaxmi (2007) Rao (2008) Naqib <i>et al.</i> (2010) Kishore <i>et al.</i> (2011)
		Negative	NS	Raju (2005) Rajanna <i>et al.</i> (2011) Haritha (2011) Venkatesh (2012)
8.	Lint index (g)	Positive	S	Murthy <i>et al.</i> (2006) Mahantesh (2009) Kumar and Ravikesavan (2010) Naqib <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Haritha (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012)

Table 2.5 (cont.)

S. No	Character	Association	S/NS	Reference
				Vineela <i>et al.</i> (2012a)
			NS	Vijayalaxmi (2007) Rao (2008) Rajanna <i>et al.</i> (2011) Mohan (2011)
		Negative	S	Venkateswarlu <i>et al.</i> (2010b)
			NS	Kaushik and Kapoor (2006) Kishore <i>et al.</i> (2011)
9.	Ginning out-turn (%)	Positive	S	Tuteja <i>et al.</i> (2005a) Annapurva <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Naqib <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Haritha (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012)
			NS	Rao (2008) Rajanna <i>et al.</i> (2011)
		Negative	S	Muthuswamy and Vivekanandan (2004) Venkateswarlu <i>et al.</i> (2010b) Mohan (2011)
			NS	Raju (2005) Kaushik and Kapoor (2006) Vijayalaxmi <i>et al.</i> (2008) Kishore <i>et al.</i> (2011)
10.	2.5% span length (mm)	Positive	S	Thiyagu <i>et al.</i> (2010)
			NS	Kumar <i>et al.</i> (2010)
		Negative	S	Gururajan and Sundar (2004) Venkateswarlu <i>et al.</i> (2010b) Mohan (2011) Kishore <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Venkatesh (2012)
			NS	Rathore <i>et al.</i> (2004a) Raju (2005) Tuteja <i>et al.</i> (2005a) Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
11.	Micronaire (10 ⁻⁶ g/in)	Positive	S	Raju (2005) Neelima <i>et al.</i> (2005) Murthy <i>et al.</i> (2006) Mahantesh (2009) Kumar and Ravikesavan (2010) Venkateswarlu <i>et al.</i> (2010b) Vineela <i>et al.</i> (2012a)

Table 2.5 (cont.)

S. No	Character	Association	S/NS	Reference
		Negative	S	Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011)
			NS	Kumar <i>et al.</i> (2010) Mohan (2011) Haritha (2011)
12.	Bundle strength (g/tex)	Positive	S	Kumar <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Bazi (2011)
			NS	Rajanna (2010) Mohan (2011) Venkatesh (2012)
		Negative	S	Haritha (2011)
13.	Uniformity ratio	Positive	S	Neelima <i>et al.</i> (2005)
			NS	Raju (2005) Srinivasulu (2009) Bazi (2011)
		Negative	S	Vijayalaxmi <i>et al.</i> (2008) Anandan (2009)
			NS	Haritha (2011) Rajanna <i>et al.</i> (2011) Mohan (2011) Kishore <i>et al.</i> (2011)
14.	Fibre elongation (%)	Positive	S	Rao (2008) Mohan (2011) Thiyagu <i>et al.</i> (2010)
			NS	Muraleedhar (2005)
		Negative	S	Saravanan and Koodalingam (2011) Venkatesh (2012)
			NS	Vijayalaxmi <i>et al.</i> (2008) Haritha (2011) Rajanna <i>et al.</i> (2011)
15.	Lint yield per plant (g)	Positive	S	Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Rajanna <i>et al.</i> (2011) Bazi (2011) Dhanalakshmi <i>et al.</i> (2012) Venkatesh (2012) Vineela <i>et al.</i> (2012a)

Note: S: Significant, NS: Non-significant

Table 2.6. Review of literature on association among the seed cotton yield components in cotton

S. No	Character	Association	S/NS	Reference
I. Days to 50% flowering with				
1.	Number of monopodia per plant	Positive	S	Raju (2005) Muraleedhar (2005) Kaushik and Kapoor (2006) Iqbal <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Mahantesh <i>et al.</i> (2010)
			NS	Pradeep and Sumalini (2005) Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Rauf <i>et al.</i> (2004) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
			NS	Kale <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007)
2.	Number of sympodia per plant	Positive	S	Rauf <i>et al.</i> (2004) Muraleedhar (2005) Tuteja (2006a) Kumar <i>et al.</i> (2010) Kumar and Ravikesavan (2010) Mahantesh <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Haritha (2011) Venkatesh (2012)
			NS	Anjaneyulu (2004) Anandan (2009)
		Negative	S	Raju (2005) Vijayalaxmi <i>et al.</i> (2008)
			NS	Kaushik and Kapoor (2006) Annapurve <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Rajanna <i>et al.</i> (2011)
3.	Number of bolls per plant	Positive	S	Muraleedhar (2005) Tuteja (2006a) Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Rao and Rajamani (2009) Shazia <i>et al.</i> (2010) Bazi (2011) Venkatesh (2012)

Table 2.6 (cont.)

			NS	Pradeep and Sumalini (2005) Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Rajanna <i>et al.</i> (2011)
		Negative	NS	Raju (2005) Murthy <i>et al.</i> (2006) Annapurve <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b)
4.	Boll weight (g)	Positive	S	Murthy <i>et al.</i> (2006) An <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Kumar and Ravikesavan (2010) Shazia <i>et al.</i> (2010) Bazi (2011)
			NS	Anjaneyulu (2004)
		Negative	S	Raju (2005) Muraleedhar (2005) Vijayalaxmi <i>et al.</i> (2008) Pratap <i>et al.</i> (2007) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Sakthi <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Anandan (2009) Rao <i>et al.</i> (2009a)
5.	Seed index (g)	Positive	S	Raju (2005) Murthy <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008) Rao <i>et al.</i> (2009a) Mahantesh (2009) Kumar <i>et al.</i> (2010) Haritha (2011) Bazi (2011) Venkatesh (2012)
			NS	Kale <i>et al.</i> (2007) Rao (2008)
		Negative	S	Muraleedhar (2005) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
			NS	Kaushik and Kapoor (2006) Murthy <i>et al.</i> (2006) Anandan (2009) Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
6.	Lint index (g)	Positive	S	Raju (2005) An <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Mahantesh <i>et al.</i> (2010) Bazi (2011)
			NS	Anandan (2009) Rao <i>et al.</i> (2009a)
		Negative	S	Kaushik and Kapoor (2006) Murthy <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
			NS	Srinivasulu (2009) Rajanna (2010) Venkateswarulu <i>et al.</i> (2010b)
7.	Ginning out-turn (%)	Positive	S	Raju (2005) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Kumar and Ravikesavan (2010) Kumar <i>et al.</i> (2010) Shazia <i>et al.</i> (2010)
			NS	Kaushik and Kapoor (2006) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Rajanna (2010)
		Negative	S	Muthuswamy and Vivekanandan (2004) Pratap <i>et al.</i> (2007)
			NS	Anjaneyulu (2004) Iqbal <i>et al.</i> (2006) Murthy <i>et al.</i> (2006) Annapurve <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Rao <i>et al.</i> (2009a) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
8.	2.5% span length (mm)	Positive	S	Muraleedhar (2005) An <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Venkatesh (2012)
			NS	Raju (2005) Murthy <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Rao <i>et al.</i> (2009a) Mahantesh <i>et al.</i> (2010)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
			S	Gururajan and Sundar (2004) Venkateswarulu <i>et al.</i> (2010b)
		Negative	NS	Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Anandan (2009) Rajanna <i>et al.</i> (2011)
9.	Micronaire value (10 ⁻⁶ g/in)	Positive	S	Murthy <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) Rao and Rajamani (2009) Kumar and Ravikesavan (2010) Rajanna <i>et al.</i> (2011)
			NS	Sakthi <i>et al.</i> (2007)
		Negative	S	Muraleedhar (2005) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Haritha (2011) Venkatesh (2012)
			NS	Anandan (2009) Srinivasulu (2009) Rao <i>et al.</i> (2009a) Kumar <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b)
10.	Bundle strength (g/tex)	Positive	S	Vijayalaxmi <i>et al.</i> (2008) An <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Bazi (2011) Venkatesh (2012)
			NS	Anjaneyulu (2004) Murthy <i>et al.</i> (2006) Srinivasulu (2009) Kumar and Ravikesavan (2010) Mahantesh <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Raju (2005)
			NS	Sakthi <i>et al.</i> (2007) Rao <i>et al.</i> (2009a) Rajanna <i>et al.</i> (2011)
11.	Uniformity ratio	Positive	S	Neelima <i>et al.</i> (2005)
			NS	Anjaneyulu (2004) Rao <i>et al.</i> (2009a) Rajanna <i>et al.</i> (2011)
		Negative	S	Venkateswarulu <i>et al.</i> (2010b)
			NS	Raju (2005) Tuteja <i>et al.</i> (2005a,b)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Murthy <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Mahantesh <i>et al.</i> (2010)
12.	Fibre elongation (%)	Positive	S	Muraleedhar (2005)
			NS	Rao <i>et al.</i> (2009a) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
		Negative	S	Vijayalaxmi <i>et al.</i> (2008)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008) Anandan (2009)
13.	Lint yield per plant (g)	Positive	S	Mahantesh (2009)
		Negative	S	Pratap <i>et al.</i> (2007) Rao (2008) Mahantesh <i>et al.</i> (2010) Venkatesh (2012)
			NS	Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
II. Plant height (cm) with				
1.	Days to 50% flowering	Positive	S	Murthy <i>et al.</i> (2006) Mahantesh (2009) Kumar and Ravikesavan (2010) Venkatesh (2012)
		Negative	S	An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008) Rajanna (2010)
2.	Number of monopodia per plant	Positive	S	Rauf <i>et al.</i> (2004) Kaushik and Kapoor (2006) Padmavathi (2008) Batool <i>et al.</i> (2010) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012)
		Negative	NS	Pradeep and Sumalini (2005) Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
3.	Number of sympodia per plant	Positive	S	Muthu <i>et al.</i> (2004) Kaushik and Kapoor (2006) Verma <i>et al.</i> (2006) Tuteja <i>et al.</i> (2006a) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Wang <i>et al.</i> (2012)
			NS	Pradeep and Sumalini (2005) Kale <i>et al.</i> (2007) Rao (2008)
4.	Number of bolls per plant	Positive	S	Muthu <i>et al.</i> (2004) Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006a) Padmavathi (2008) Batool <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012) Wang <i>et al.</i> (2012)
			NS	Annapurve <i>et al.</i> (2007) Anandan (2009) Srinivasulu (2009) Rao <i>et al.</i> (2009a) Khadijah <i>et al.</i> (2010)
		Negative	S	Rauf <i>et al.</i> (2004) Haritha (2011)
			NS	Pradeep and Sumalini (2005) Sakthi <i>et al.</i> (2007)
5.	Boll weight (g)	Positive	S	Rauf <i>et al.</i> (2004) Karademir <i>et al.</i> (2009) Rao <i>et al.</i> (2009a) Batool <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Kishore <i>et al.</i> (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012)
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)
		Negative	NS	Sakthi <i>et al.</i> (2007) Anandan (2009) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
6.	Seed index (g)	Positive	S	Muthu <i>et al.</i> (2004) An <i>et al.</i> (2008) Padmavathi (2008) Rao <i>et al.</i> (2009a) Batool <i>et al.</i> (2010) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012)
			NS	Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Pratap <i>et al.</i> (2007) Venkatesh (2012)
			NS	Srinivasulu (2009)
7.	Lint index (g)	Positive	S	Rao <i>et al.</i> (2009a) Kumar and Ravikesavan (2010) Batool <i>et al.</i> (2010) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012)
			NS	Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Venkatesh (2012)
			NS	Kaushik and Kapoor (2006) Sakthi <i>et al.</i> (2007) Srinivasulu (2009)
8.	Ginning out-turn (%)	Positive	S	Raju (2005) Batool <i>et al.</i> (2010) Kumar and Ravikesavan (2010)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012)
			NS	Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
		Negative	S	Pratap <i>et al.</i> (2007) Wang <i>et al.</i> (2012)
			NS	Kaushik and Kapoor (2006) Sakthi <i>et al.</i> (2007) Annapurva <i>et al.</i> (2007) Srinivasulu (2009) Rao <i>et al.</i> (2009a) Venkateswarulu <i>et al.</i> (2010b)
9.	2.5% span length (mm)	Positive	S	Muthu <i>et al.</i> (2004) Muraleedhar (2005) Verma <i>et al.</i> (2006) An <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Thiyagu <i>et al.</i> (2010) Saravanan and Koodalingam (2011) Venkatesh (2012)
			NS	Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Rajanna <i>et al.</i> (2011)
		Negative	S	Muraleedhar (2005)
			NS	Kaushik and Kapoor (2006) Srinivasulu (2009) Rao <i>et al.</i> (2009a) Mahantesh <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b)
10.	Micronaire value (10^{-6} g/in)	Positive	S	Padmavathi (2008) Vijayalaxmi (2008) Rao <i>et al.</i> (2009a) Thiyagu <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b)
			NS	Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Muraleedhar (2005) An <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
			NS	Sakthi <i>et al.</i> (2007) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
11.	Bundle strength (g/tex)	Positive	S	An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010) Venkateswarulu <i>et al.</i> (2010b) Haritha (2011) Saravanan and Koodalingam (2011) Venkatesh (2012)
			NS	Srinivasulu (2009) Rao (2008) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
		Negative	NS	Raju (2005) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)
12.	Uniformity ratio	Positive	S	Raju (2005) Rao (2008) Padmavathi (2008) Vijayalaxmi (2008) Srinivasulu <i>et al.</i> (2010b) Saravanan and Koodalingam (2011)
			NS	Rao (2008)
		Negative	S	Sakthi <i>et al.</i> (2007) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Mahantesh <i>et al.</i> (2010)
13.	Fibre elongation (%)	Positive	NS	Sakthi <i>et al.</i> (2007) Rao (2008) Mahantesh <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Haritha (2011)
			S	Muthu <i>et al.</i> (2004)
		Negative	NS	Muraleedhar (2005) Rajanna <i>et al.</i> (2011)
14.	Lint yield /plant (g)	Positive	S	Rajanna <i>et al.</i> (2011)
		Negative	S	Pratap <i>et al.</i> (2007)
			NS	Vijayalaxmi (2008) Rao (2008)
III. No. of monopodia per plant with				
1.	Number of sympodia/plant	Positive	S	Pratap <i>et al.</i> (2007) Mohan (2011) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
		Negative	S	Rauf <i>et al.</i> (2004) Verma <i>et al.</i> (2006)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Vijayalaxmi <i>et al.</i> (2008)
			NS	Pradeep and Sumalini (2005)
2.	Number of bolls per plant	Positive	S	Verma <i>et al.</i> (2006) Iqbal <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Mohan (2011) Kishore <i>et al.</i> (2011)
			NS	Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Rajanna <i>et al.</i> (2011)
		Negative	S	Rauf <i>et al.</i> (2004)
3.	Boll weight (g)	Positive	S	Rauf <i>et al.</i> (2004) Pratap <i>et al.</i> (2007) Shazia <i>et al.</i> (2010) Tulasi <i>et al.</i> (2012)
		Negative	NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
4.	Ginning out-turn (%)	Positive	S	Muthu <i>et al.</i> (2004) Pratap <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Shazia <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011) Tulasi <i>et al.</i> (2012)
			NS	Kale <i>et al.</i> (2007) Rao (2008)
		Negative	S	Mohan (2011)
5.	Seed index (g)	Positive	S	Pratap <i>et al.</i> (2007) Mahantesh (2009) Shazia <i>et al.</i> (2010) Mohan (2011) Tulasi <i>et al.</i> (2012)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	NS	Raju (2005) Kale <i>et al.</i> (2007)
6.	Lint index (g)	Positive	S	Pratap <i>et al.</i> (2007) Mahantesh (2009) Shazia <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
		Negative	NS	Raju (2005) Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)
7.	2.5% span length (mm)	Positive	S	Mohan (2011)
			NS	Kale <i>et al.</i> (2007)
		Negative	S	Rao (2008) Rao and Rajamani (2009)
			NS	Verma <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
8.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Rao and Rajamani (2009)
			NS	Rao (2008) Rajanna <i>et al.</i> (2011)
		Negative	S	Muraleedhar (2005) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009)
9.	Bundle strength (g/tex)	Positive	S	Muraleedhar (2005) Mohan (2011)
			NS	Vijayalaxmi <i>et al.</i> (2008)
		Negative	NS	Rajanna <i>et al.</i> (2011)
10.	Uniformity ratio	Positive	S	Rao and Rajamani (2009)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	S	Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Venkatesh (2012)
11.	Fibre elongation (%)	Positive	S	Muraleedhar (2005) Mohan (2011)
			NS	Rao(2008)
		Negative	S	Vijayalaxmi <i>et al.</i> (2008) Venkatesh (2012)
			NS	Rajanna <i>et al.</i> (2011)
12.	Lint yield per plant (g)	Positive	S	Rajanna <i>et al.</i> (2011)
			NS	Mahantesh (2009)
IV. Number of sympodia per plant with				
1.	Number of bolls per plant	Positive	S	Neelima <i>et al.</i> (2005) Tuteja <i>et al.</i> (2006a) Sakthi <i>et al.</i> (2007) Rao (2008) Mahantesh (2009) Rao and Rajamani (2009) Kumar and Ravikesavan (2010) Shazia <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Mohan (2011) Rajanna <i>et al.</i> (2011) Wang <i>et al.</i> (2012)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Alishah <i>et al.</i> (2008) Anandan (2009)
		Negative	NS	Raju (2005) Vijayalaxmi <i>et al.</i> (2008)
2.	Boll weight (g)	Positive	S	Neelima <i>et al.</i> (2005) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Kumar and Ravikesavan (2010) Shazia <i>et al.</i> (2010) Mohan (2011) Tulasi <i>et al.</i> (2012)
			NS	Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Mahantesh (2009) Rao and Rajamani (2009) Rajanna <i>et al.</i> (2011) Wang <i>et al.</i> (2012)
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Anandan (2009)
3.	Ginning out- turn (%)	Positive	S	Muthu <i>et al.</i> (2004) Muthuswamy and Vivekanandan (2004) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Pratap <i>et al.</i> (2007) Shazia <i>et al.</i> (2007) An <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Mohan (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012) Wang <i>et al.</i> (2012)
			NS	Neelima <i>et al.</i> (2005) Sakthi <i>et al.</i> (2007) Rao (2008) Rasheed <i>et al.</i> (2009)
		Negative	S	Mahantesh (2009)
			NS	Vijayalaxmi <i>et al.</i> (2008)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
4.	Seed index (g)	Positive	S	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008) Mahantesh (2009) Rajanna <i>et al.</i> (2011) Mohan (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012)
			NS	Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009)
		Negative	S	Muthuswamy and Vivekanandan (2004) Muraleedhar (2005) Wang <i>et al.</i> (2012)
			NS	Kale <i>et al.</i> (2007) Mahantesh (2009) Venkateswarulu <i>et al.</i> (2010b)
5.	Lint index (g)	Positive	S	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Raju (2005) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Padmavathi (2008) Mahantesh (2009) Haritha (2011) Tulasi <i>et al.</i> (2012) Venkatesh (2012)
			NS	Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Rajanna <i>et al.</i> (2011)
		Negative	S	Muraleedhar (2005) Venkateswarlu <i>et al.</i> (2010b)
			NS	Srinivasulu (2009)
6.	2.5% span length (mm)	Positive	S	Sakthi <i>et al.</i> (2007) Kumar and Ravikesavan (2010) Thiyagu <i>et al.</i> (2010) Mohan (2011)
			NS	Verma <i>et al.</i> (2006) Rasheed <i>et al.</i> (2009)
		Negative	S	Raju (2005)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Kale <i>et al.</i> (2007) Rao (2008) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Rao and Rajamani (2009)
			NS	Muraleedhar (2005) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
7.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Raju (2005) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Thiyagu <i>et al.</i> (2010) Mohan (2011)
			NS	Sakthi <i>et al.</i> (2007) Rasheed <i>et al.</i> (2009) Venkateswarlu <i>et al.</i> (2010b)
		Negative	S	Rao and Rajamani (2009) Rajanna <i>et al.</i> (2011)
			NS	Srinivasulu (2009) Mahantesh(2009)
8.	Bundle strength (g/tex)	Positive	S	Muthu <i>et al.</i> (2004) Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010) Haritha (2011) Mohan (2011) Rajanna <i>et al.</i> (2011)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008)
		Negative	S	Mahantesh (2009) Rao and Rajamani (2009) Venkateswarlu <i>et al.</i> (2010b) An <i>et al.</i> (2008)
			NS	Raju (2005) Vijayalaxmi <i>et al.</i> (2008)
9.	Uniformity ratio	Positive	S	Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Rao and Rajamani (2009) Rao <i>et al.</i> (2009a) Mohan (2011) Venkatesh (2012)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	S	Rao (2008) Venkateswarlu <i>et al.</i> (2010b)
			NS	Mahantesh (2009)
10.	Fibre elongation (%)	Positive	S	Thiyagu <i>et al.</i> (2010) Haritha (2011)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
			NS	Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Rajanna <i>et al.</i> (2011) Mohan (2011)
		Negative	S	Muthu <i>et al.</i> (2004) Sakthi <i>et al.</i> (2007) Venkatesh (2012)
			NS	Muraleedhar (2005)
11.	Lint yield per plant (g)	Positive	S	Pratap <i>et al.</i> (2007) Rao (2008) Mahantesh (2009) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Vijayalaxmi <i>et al.</i> (2008)
V. Number of bolls per plant with				
1.	Boll weight (g)	Positive	S	Neelima <i>et al.</i> (2005) Sakthi <i>et al.</i> (2007) An <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010) Basamma <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Venkatesh (2012) Wang <i>et al.</i> (2012)
			NS	Rao (2008) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Raju (2005) Iqbal <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Rao and Rajamani (2009) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Pradeep and Sumalini (2005) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Srinivasulu (2009)
2.	Seed index (g)	Positive	S	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Mahantesh (2009) Kumar and Ravikesavan (2010)
			NS	Srinivasulu (2009)
		Negative	S	Muraleedhar (2005) Vijayalaxmi <i>et al.</i> (2008) Mohan (2011)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Venkatesh (2012) Wang <i>et al.</i> (2012)
			NS	Kale <i>et al.</i> (2007) Rao (2008) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
3.	Lint index (g)	Positive	S	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Anandan (2009) Kumar and Ravikesavan (2010)
			NS	Sakthi <i>et al.</i> (2007) Mahantesh (2009) Srinivasulu (2009)
		Negative	S	Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Venkateswarlu <i>et al.</i> (2010b) Mohan (2011)
			NS	Rao (2008) Rajanna <i>et al.</i> (2011)
4.	Ginning out-turn (%)	Positive	S	Muthu <i>et al.</i> (2004) Pratap <i>et al.</i> (2007) Anandan (2009) Kumar and Ravikesavan (2010) Mahantesh <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Venkatesh (2012)
			NS	Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Srinivasulu (2009)
		Negative	S	Raju (2005) Venkateswarlu <i>et al.</i> (2010b) Haritha (2011) Mohan (2011)
			NS	Rajanna <i>et al.</i> (2011)
5.	2.5% span length (mm)	Positive	S	An <i>et al.</i> (2008) Kumar and Ravikesavan (2008) Thiyagu <i>et al.</i> (2010) Mohan (2011)
			NS	Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Rao (2008) Mahantesh (2009)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
		Negative		Kumar and Ravikesavan (2010)
			S	Muraleedhar (2005)
			NS	Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
6.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Muthu <i>et al.</i> (2004) Raju (2005) Sakthi <i>et al.</i> (2007) Rao (2008) Anandan (2009) Kumar and Ravikesavan (2010) Thiyagu <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Venkatesh (2012)
				Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Mohan (2011)
		Negative	S	
			NS	Mahantesh (2009) Rajanna <i>et al.</i> (2011)
7.	Bundle strength (g/tex)	Positive	S	Muthu <i>et al.</i> (2004) An <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Haritha (2011) Venkatesh (2012)
			NS	Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
		Negative	S	Rao and Rajamani (2009)
			NS	Raju (2005) Rao (2008) Anandan (2009) Venkateswarlu <i>et al.</i> (2010b)
8.	Uniformity ratio	Positive	S	Muthu <i>et al.</i> (2004) Haritha (2011) Venkatesh (2012)
			NS	Srinivasulu (2009) Rajanna <i>et al.</i> (2011)
		Negative	S	Vijayalaxmi <i>et al.</i> (2008) Mohan (2011)
			NS	Sakthi <i>et al.</i> (2007) Anandan (2009) Venkateswarlu <i>et al.</i> (2010b)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
9.	Fibre elongation (%)	Negative	S	Muthu <i>et al.</i> (2004) Vijayalaxmi <i>et al.</i> (2008) Thiyagu <i>et al.</i> (2010) Mohan (2011)
			NS	Muraleedhar (2005) Sakthi <i>et al.</i> (2007) Anandan (2009) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
10.	Lint yield per plant (g)	Positive	S	Pratap <i>et al.</i> (2007) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
VI. Boll weight (g) with				
1.	Seed index (g)	Positive	S	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Murthy <i>et al.</i> (2006) An <i>et al.</i> (2008) Padmavathi (2008) Kumar and Ravikesavan (2010) Venkateswarlu <i>et al.</i> (2010b) Mohan (2011) Rajanna <i>et al.</i> (2011) Wang <i>et al.</i> (2012)
			NS	Anandan (2009)
		Negative	S	Rao (2008)
			NS	Srinivasulu (2009) Mahantesh (2009)
2.	Lint index (g)	Positive	S	Raju (2005) Sakthi <i>et al.</i> (2007) An <i>et al.</i> (2008) Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Kumar and Ravikesavan (2010) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Haritha (2011) Mohan (2011)
			NS	Rao <i>et al.</i> (2009a)
		Negative	NS	Anandan (2009) Srinivasulu (2009)
3.	Ginning out-turn (%)	Positive	S	Muthuswamy and Vivekanandan (2004) Raju (2005)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010) Mohan (2011) Venkatesh (2012)
			NS	Srinivasulu (2009) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
		Negative	NS	Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Mahantesh (2009)
4.	2.5% span length (mm)	Positive	S	Verma <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) An <i>et al.</i> (2008) Rao and Rajamani (2009)
				Kumar and Ravikesavan (2010) Venkatesh (2012)
			NS	Sakthi <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Anandan (2009) Srinivasulu (2009) Rajanna <i>et al.</i> (2011)
		Negative	S	Mohan (2011)
			NS	Rao (2008) Venkateswarulu <i>et al.</i> (2010b)
5.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Rao and Rajamani (2009) Kumar and Ravikesavan (2010) Venkateswarulu <i>et al.</i> (2010b)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008)
		Negative	S	Venkatesh (2012)
			NS	Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010)
6.	Bundle strength (g/tex)	Positive	S	Muraleedhar (2005) Rao (2008) Mahantesh (2009) Rao and Rajamani (2009) Kumar and Ravikesavan (2010) Venkatesh (2012)
			NS	Muthuswamy and Vivekanandan (2004) Sakthi <i>et al.</i> (2007)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
		Negative		Vijayalaxmi <i>et al.</i> (2008) Anandan (2009)
			S	Haritha (2011) Mohan (2011)
			NS	Srinivasulu (2009) Rajanna <i>et al.</i> (2011)
7.	Uniformity ratio	Positive	S	Rao (2008) Venkateswarulu <i>et al.</i> (2010b)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	S	Muraleedhar (2005) Rao (2008) Rao and Rajamani (2009)
			NS	Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009)
8.	Fibre elongation (%)	Positive	S	Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009)
			NS	Muraleedhar (2005) Rao (2008) Srinivasulu (2009) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
9.	Lint yield per plant (g)	Positive	S	Rao (2008) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
VII. Ginning out-turn (%) with				
1.	Seed index (g)	Positive	NS	Pratap <i>et al.</i> (2007) Padmavathi (2008) Srinivasulu (2009) Sabir <i>et al.</i> (2010)
				Vijayalaxmi (2008) Rao <i>et al.</i> (2009a) Haritha (2011) Rajanna <i>et al.</i> (2011) Wang <i>et al.</i> (2012)
		Negative	NS	Kale <i>et al.</i> (2007) Mahantesh (2009) Venkateswarulu <i>et al.</i> (2010b)
2.	Lint index (g)	Positive	S	Muthu <i>et al.</i> (2004) Raju (2005) Sakthi <i>et al.</i> (2007) Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Venkateswarulu <i>et al.</i> (2010b) Haritha (2011) Rajanna <i>et al.</i> (2011)
			NS	Anandan (2009) Rao <i>et al.</i> (2009a)
		Negative	NS	Srinivasulu (2009)
3.	2.5% span length (mm)	Positive	S	Kale <i>et al.</i> (2007)
4.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Muthu <i>et al.</i> (2004) An <i>et al.</i> (2008) Padmavathi (2008) Mohan (2011)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008) Mahantesh <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			S	Vijayalaxmi <i>et al.</i> (2008)
		Negative	NS	Raju (2005) Anandan (2009) Srinivasulu (2009)
5.	Bundle strength (g/tex)	Positive	S	Murthy <i>et al.</i> (2006) Rao (2008) Kumar and Ravikesavan (2010)
			NS	Vijayalaxmi <i>et al.</i> (2008) Srinivasulu (2009)
		Negative	S	Padmavathi (2008) Mahantesh (2009) Mohan (2011)
			NS	Sakthi <i>et al.</i> (2007) Anandan (2009) Rajanna <i>et al.</i> (2011)
6.	Uniformity ratio	Positive	S	Muthu <i>et al.</i> (2004) Raju (2005) Sakthi <i>et al.</i> (2007) Padmavathi (2008) Kumar and Ravikesavan (2010) Mohan (2011)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	S	Altaher and Singh (2003)
			NS	Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
7.	Fibre elongation (%)	Positive	S	Mahantesh (2009) Kumar and Ravikesavan (2010) Rajanna <i>et al.</i> (2011)
			NS	Muraleedhar (2005) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009)
		Negative	S	Padmavathi (2008) Mahantesh (2009)
			NS	Sakthi <i>et al.</i> (2007) Rao (2008) Vijayalaxmi <i>et al.</i> (2008)
8.	Lint yield per plant (g)	Positive	S	Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rao (2008) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
			NS	Mandloi <i>et al.</i> (2003)
VIII. Seed index (g) with				
1.	Lint index (g)	Positive	S	Muthu <i>et al.</i> (2004) Raju (2005) Neelima <i>et al.</i> (2005) An <i>et al.</i> (2008) Mahantesh (2009) Kumar and Ravikesavan (2010) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Mohan (2011) Venkatesh (2012)
			NS	Anandan (2009) Haritha (2011)
2.	Ginning out-turn (%)	Positive	NS	Kale <i>et al.</i> (2007)
		Negative	S	Rajanna <i>et al.</i> (2011) Mohan (2011)
3.	2.5% span length (mm)	Positive	S	Raju (2005) An <i>et al.</i> (2008) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Haritha (2011) Mohan (2011) Rajanna <i>et al.</i> (2011)
			NS	Anandan (2009) Srinivasulu (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Kale <i>et al.</i> (2007)
			NS	Mandloi <i>et al.</i> (2003)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
4.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	An <i>et al.</i> (2008) Rao (2008) Vijayalaxmi <i>et al.</i> (2008)
			NS	Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Mahantesh (2009) Rajanna <i>et al.</i> (2011) Mohan (2011)
			NS	Anandan (2009) Venkateswarulu <i>et al.</i> (2010b)
5.	Bundle strength (g/tex)	Positive	S	Muthu <i>et al.</i> (2004) Padmavathi (2008) Srinivasulu <i>et al.</i> (2010b) Mohan (2011)
			NS	Anandan (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Rajanna <i>et al.</i> (2011) Venkatesh (2012)
			NS	Rao (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009)
6.	Uniformity ratio	Positive	S	Venkateswarulu <i>et al.</i> (2010b) Venkatesh (2012)
			NS	Vijayalaxmi (2008)
		Negative	S	Muraleedhar (2005) Rajanna <i>et al.</i> (2011)
			NS	Rao (2008) Anandan (2009) Mahantesh (2009) Srinivasulu (2009)
7.	Fibre elongation (%)	Positive	S	Vijayalaxmi <i>et al.</i> (2008) Haritha (2011)
			NS	Rao <i>et al.</i> (2009a) Rajanna <i>et al.</i> (2011)
		Negative	NS	Muthu <i>et al.</i> (2004) Muraleedhar (2005) Anandan (2009) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010)
8.	Lint yield per plant (g)	Positive	S	Mahantesh (2009)
			NS	Rao (2008)
		Negative	S	Venkatesh (2012)
			NS	Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
IX. Lint index (g) with				
1.	Ginning out-turn (%)	Positive	S	Raju (2005) Sakthi <i>et al.</i> (2007) Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Haritha (2011) Mohan (2011) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
2.	2.5% span length (mm)	Positive	S	Muthu <i>et al.</i> (2004) Murthy <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Kumar and Ravikesavan (2010)
			NS	Rao <i>et al.</i> (2009a) Rajanna <i>et al.</i> (2011)
		Negative	S	Mohan (2011)
			NS	Anandan (2009) Mahantesh (2009) Srinivasulu (2009) Venakteswarulu <i>et al.</i> (2010b)
3.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Neelima <i>et al.</i> (2005) An <i>et al.</i> (2008) Rao (2008) Kumar and Ravikesavan (2010)
			NS	Raju (2005) Sakthi <i>et al.</i> (2007) Vijayalaxmi (2008) Anandan (2009) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
		Negative	S	Mahantesh (2009)
			NS	Srinivasulu (2009)
4.	Bundle strength (g/tex)	Positive	S	Muthu <i>et al.</i> (2004) Murthy <i>et al.</i> (2006) Kumar and Ravikesavan (2010)
			NS	Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Venkateswarulu <i>et al.</i> (2010b)
		Negative	S	Venkatesh (2012)
			NS	Raju (2005) Srinivasulu (2009) Rao <i>et al.</i> (2009a)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
5.	Uniformity ratio	Positive	S	Venkateswarulu <i>et al.</i> (2010b) Mohan (2011)
			NS	Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Srinivasulu (2009)
		Negative	S	Muthu <i>et al.</i> (2004) Sakthi <i>et al.</i> (2007) Rajanna <i>et al.</i> (2011)
			NS	Rao (2008) Mahantesh <i>et al.</i> (2010)
6.	Fibre elongation (%)	Positive	S	Vijayalaxmi <i>et al.</i> (2008)
			NS	Muraleedhar (2005) Rao (2008) Srinivasulu (2009)
		Negative	S	Muthu <i>et al.</i> (2004)
			NS	Anandan (2009) Mahantesh <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)
7.	Lint yield per plant (g)	Positive	S	Pratap <i>et al.</i> (2007) Mahantesh (2009) Rajanna <i>et al.</i> (2011)
			NS	Vijayalaxmi <i>et al.</i> (2008) Rao (2008)
		Negative	S	Mandloi <i>et al.</i> (2003) Muthu <i>et al.</i> (2004)
X. 2.5% span length with				
1.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Mandloi <i>et al.</i> (2003) Muthuswamy and Vivekanandan (2004)
			NS	Tuteja <i>et al.</i> (2005b) Anandan (2009) Srinivasulu (2009)
		Negative	S	Raju (2005) Pratap <i>et al.</i> (2007) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Venkateswarlu <i>et al.</i> (2010b) Haritha (2011) Mohan (2011) Rajanna <i>et al.</i> (2011)
NS	Sakthi <i>et al.</i> (2007) Rao (2008) Mahantesh <i>et al.</i> (2010)			

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
2.	Bundle strength (g/tex)	Positive	S	Muthu <i>et al.</i> (2004) Rathore <i>et al.</i> (2004a) Raju (2005) Tuteja <i>et al.</i> (2005b) Pratap <i>et al.</i> (2007) An <i>et al.</i> (2008)
				Rao (2008) Kumar and Ravikesavan (2010) Mahantesh <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Mohan (2011) Venkatesh (2012)
			NS	Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009)
		Negative	NS	Srinivasulu (2009)
			S	Venkatesh (2012)
3.	Uniformity ratio	Positive		Raju (2005) Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rao (2008) Rajanna (2010)
			NS	Muthu <i>et al.</i> (2004) Tuteja <i>et al.</i> (2005b)
		Negative	S	Kumar and Ravikesavan (2010) Rao and Rajamani (2010) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011) Mohan (2011)
			NS	Muthu <i>et al.</i> (2004) Tuteja <i>et al.</i> (2005b) Anandan (2009) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010)
4.	Fibre elongation (%)	Positive	S	Muraleedhar (2005) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Venkateswarulu (2010b) Haritha (2011) Mohan (2011) Rajanna <i>et al.</i> (2011) Venkatesh (2012)
		Negative	S	Muthuswamy and Vivekanandan (2004)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
				Kumar (2004) Kumar and Ravikesavan (2010)
5.	Lint yield per plant (g)	Positive	NS	Vijayalaxmi <i>et al.</i> (2008) Venkatesh (2012)
		Negative	NS	Rao (2008)
			S	Rajanna <i>et al.</i> (2011)
XI. Micronaire value with				
1.	Bundle strength (g/tex)	Positive	NS	Srinivasulu (2009)
		Negative	S	Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Rao (2008) An <i>et al.</i> (2009) Mahantesh (2009) Rao and Rajamani (2009) Srinivasulu (2009) Hussain <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Mohan (2011) Venkatesh (2012)
			NS	Tuteja <i>et al.</i> (2005b) Anandan (2009) Rajanna <i>et al.</i> (2011)
2.	Uniformity ratio	Positive	S	Rathore <i>et al.</i> (2004a) Raju (2005) Murthy <i>et al.</i> (2006) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Rao and Rajamani (2009) Mahantesh <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b) Venkateswarlu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Muthu <i>et al.</i> (2004) Srinivasulu (2009) Rao <i>et al.</i> (2009a)
		Negative	S	Tuteja <i>et al.</i> (2005a)
			NS	Anandan (2009)
3.	Fibre elongation (%)	Positive	S	Kumar (2004) Muthuswamy and Vivekanandan (2004) Rao (2008)
		Negative	S	Muraleedhar (2005) Mahantesh (2009) Rajanna <i>et al.</i> (2011) Mohan (2011) Venkatesh (2012)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
4.	Lint yield per plant (g)	Positive	S	Rao (2008) Venkateswarulu <i>et al.</i> (2010b)
			NS	Mandloi <i>et al.</i> (2003)
		Negative	S	Rajanna <i>et al.</i> (2011)
			NS	Haritha (2011)
XII. Bundle strength (g/tex) with				
1.	Uniformity ratio	Positive	S	Venkatesh (2012)
		Negative	S	Tuteja <i>et al.</i> (2005a) Pratap <i>et al.</i> (2007) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Rao and Rajamani (2009) Srinivasulu (2009) Mahantesh <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)
			NS	Rao <i>et al.</i> (2009a)
2.	Fibre elongation (%)	Positive	S	Muthuswamy and Vivekanandan (2004) Kumar (2004) Muraleedhar (2005) Padmavathi (2008) Vijayalaxmi <i>et al.</i> (2008) Mahantesh (2009) Rajanna <i>et al.</i> (2011) Mohan (2011) Venkatesh (2012)
				Negative
			NS	
			3.	Lint yield per plant (g)
Negative	S	Mandloi <i>et al.</i> (2003)		
	NS	Rao (2008) Rajanna <i>et al.</i> (2011)		
		XIII. Uniformity ratio with		
1.	Micronaire value (10 ⁻⁶ g/inch)	Positive	S	Rathore <i>et al.</i> (2004a) Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Mohan (2011)
			NS	Muthu <i>et al.</i> (2004)
		Negative	S	Tuteja <i>et al.</i> (2005a)

Table 2.6 (cont.)

S. No	Character	Association	S/NS	Reference
2.	Bundle strength(g/tex)	Positive	NS	Tuteja <i>et al.</i> (2005a) Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008)
		Negative	NS	Rajanna <i>et al.</i> (2011)
3.	Fibre elongation (%)	Positive	S	Sakthi <i>et al.</i> (2007) Mohan (2011)
				Venkatesh (2012)
			NS	Srinivasulu (2009) Rajanna <i>et al.</i> (2011)
		Negative	S	Muraleedhar (2005) Mahantesh <i>et al.</i> (2010)
			NS	Vijayalaxmi (2008) Anandan (2009) Rao <i>et al.</i> (2009a)
4.	Lint yield per plant (g)	Positive	S	Venkatesh (2012)
			NS	Rajanna <i>et al.</i> (2011)
		Negative	NS	Vijayalaxmi <i>et al.</i> (2008)
XIV. Fibre elongation (%) with				
1.	Lint yield per plant (g)	Positive	S	Rao (2008) Venkatesh (2012)
		Negative	NS	Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011)
2.	Seed cotton yield per plant (g)	Positive	S	Rao (2008) Mohan (2011) Venkatesh (2012)
		Negative	NS	Haritha (2011) Rajanna <i>et al.</i> (2011)
XV. Lint yield per plant with				
1.	Seed cotton yield per plant (g)	Positive	S	Pratap (2007) Rao (2008) Mahantesh (2009) Rajanna <i>et al.</i> (2011) Venkatesh (2012)

Note: S: Significant, NS: Non-significant

Table 2.7. Review of literature on direct effects of component characters on seed cotton yield in cotton

S. No	Character	Positive Direct effect	Negative Direct effect
1.	Plant height (cm)	Muthu <i>et al.</i> (2004) Kaushik and Kapoor (2006) Sakthi <i>et al.</i> (2007) Venkateswarulu <i>et al.</i> (2010b) Haritha (2011) Rajanna <i>et al.</i> (2011) Saravanan and Koodalingam (2011) Venkatesh (2012) Wang <i>et al.</i> (2012)	Raju (2005) Verma <i>et al.</i> (2006) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rasheed <i>et al.</i> (2009) Kumar <i>et al.</i> (2010)
2.	Days to 50% flowering	Tuteja <i>et al.</i> (2006b) Padmavathi (2008) Vijayalaxmi (2008) Rao <i>et al.</i> (2009a) Kumar <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010b) Rajanna <i>et al.</i> (2011)	Muthu <i>et al.</i> (2004) Kaushik and Kapoor (2006) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Anandan (2009) Haritha (2011)
3.	Number of monopodia per plant	Muthu <i>et al.</i> (2004) Iqbal <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Ekinci <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b) Mohan (2011) Rajanna <i>et al.</i> (2011) Venkatesh (2012) Vineela <i>et al.</i> (2012a)	Raju (2005) Verma <i>et al.</i> (2006) Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006b) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Padmavathi (2008) Vijayalaxmi (2008) Sarada <i>et al.</i> (2010) Tulasi <i>et al.</i> (2012)
4.	Number of sympodia per plant	Neelima <i>et al.</i> (2005) Verma <i>et al.</i> (2006) Kaushik and Kapoor (2006) Pratap <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Ekinci <i>et al.</i> (2010) Kumar <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b) Haritha (2011) Saravanan and Koodalingam (2011) Venkatesh (2012) Wang <i>et al.</i> (2012)	Muthu <i>et al.</i> (2004) Raju (2005) Tuteja <i>et al.</i> (2006b) Alishah <i>et al.</i> (2008) Karademir <i>et al.</i> (2009) Rasheed <i>et al.</i> (2009) Rao <i>et al.</i> (2009a) Venkateswarlu <i>et al.</i> (2010b) Bazi (2011)

Table 2.7 (cont.)

S. No	Character	Positive Direct effect	Negative Direct effect
5.	Number of bolls per plant	Verma <i>et al.</i> (2006) Iqbal <i>et al.</i> (2006) Kaushik and Kapoor (2006) Kale <i>et al.</i> (2007) Pratap <i>et al.</i> (2007) Annapurve <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Ekinci <i>et al.</i> (2010) Kumar <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b) Haritha (2011) Mohan (2011) Saravanan and Koodalingam (2011) Dhanalakshmi <i>et al.</i> (2012) Tulasi <i>et al.</i> (2012) Venkatesh (2012) Wang <i>et al.</i> (2012)	Tuteja <i>et al.</i> (2006b) Alishah <i>et al.</i> (2008) Karademir <i>et al.</i> (2009)
6.	Boll weight (g)	Raju (2005) Iqbal <i>et al.</i> (2006) Annapurve <i>et al.</i> (2007) Kale <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Ekinci <i>et al.</i> (2010) Kumar <i>et al.</i> (2010) Sarada <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Thiyagu <i>et al.</i> (2010) Srinivasulu <i>et al.</i> (2010b) Haritha (2011) Mohan (2011) Venkatesh (2012) Wang <i>et al.</i> (2012) Vineela <i>et al.</i> (2012a)	Verma <i>et al.</i> (2006) Alishah <i>et al.</i> (2008) Vijayalaxmi (2008) Karademir <i>et al.</i> (2009) Rasheed <i>et al.</i> (2009) Rao <i>et al.</i> (2009a) Patnaik and Sial (2010) Tulasi <i>et al.</i> (2012)
7.	Seed index (g)	Kaushik and Kapoor (2006) Murthy <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Sarada <i>et al.</i> (2010) Mohan (2011) Rajanna <i>et al.</i> (2011) Dhanalakshmi <i>et al.</i> (2012) Tulasi <i>et al.</i> (2012) Venkatesh (2012)	Gururajan and Sundar (2004) Raju (2005) Kale <i>et al.</i> (2007) Rasheed <i>et al.</i> (2009) Haritha (2011)

Table 2.7 (cont.)

S. No	Character	Positive Direct effect	Negative Direct effect
8.	Lint index (g)	Gururajan and Sundar (2004) Neelima <i>et al.</i> (2005) Raju (2005) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Haritha (2011) Saravanan and Koodalingam (2011)	Muthu <i>et al.</i> (2004) Kaushik and Kapoor (2006) Pratap <i>et al.</i> (2007) Padmavathi (2008) Sarada <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Tulasi <i>et al.</i> (2012) Venkatesh (2012)
9.	Ginning out-turn (%)	Muthu <i>et al.</i> (2004) Verma <i>et al.</i> (2006) Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006b) Kale <i>et al.</i> (2007) Pratap <i>et al.</i> (2007) Sarada <i>et al.</i> (2010) Mohan (2011) Saravanan and Koodalingam (2011) Tulasi <i>et al.</i> (2012) Wang <i>et al.</i> (2012)	Gururajan and Sundar (2004) Raju (2005) Iqbal <i>et al.</i> (2006) Annapurve <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Shazia <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Haritha (2011) Venkatesh (2012)
10.	2.5% span length (mm)	Muthu <i>et al.</i> (2004) Raju (2005) Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006b) Kale <i>et al.</i> (2007) Kumar <i>et al.</i> (2010) Sarada <i>et al.</i> (2010) Mohan (2011) Rajanna <i>et al.</i> (2011)	Gururajan and Sundar (2004) Verma <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Padmavathi (2008) Rao <i>et al.</i> (2009a) Venkateswarlu <i>et al.</i> (2010b) Haritha (2011) Venkatesh (2012)
11.	Micronaire value (10 ⁻⁶ g/inch)	Muthu <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Murthy <i>et al.</i> (2006) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Sarada <i>et al.</i> (2010) Mohan (2011) Rajanna <i>et al.</i> (2011)	Gururajan and Sundar (2004) Verma <i>et al.</i> (2006) Raju (2005) Anandan (2009) Rao <i>et al.</i> (2009a) Venkateswarlu <i>et al.</i> (2010b) Bazi (2011) Haritha (2011) Venkatesh (2012)
12.	Bundle strength (g/tex)	Murthy <i>et al.</i> (2006) Sakthi <i>et al.</i> (2007) Padmavathi (2008) Sarada <i>et al.</i> (2010) Rajanna <i>et al.</i> (2011)	Muthu <i>et al.</i> (2004) Gururajan and Sundar (2004) Raju (2005) Vijayalaxmi <i>et al.</i> (2008) Kumar <i>et al.</i> (2010) Venkateswarlu <i>et al.</i> (2010b) Haritha (2011) Venkatesh (2012)

Table 2.7 (cont.)

S. No	Character	Positive Direct effect	Negative Direct effect
13.	Uniformity ratio	Raju (2005) Murthy <i>et al.</i> (2006) Vijayalaxmi <i>et al.</i> (2008) Srinivasulu <i>et al.</i> (2010b) Mohan (2011) Rajanna <i>et al.</i> (2011)	Muthu <i>et al.</i> (2004) Pratap <i>et al.</i> (2007) Sakthi <i>et al.</i> (2007) Anandan (2009) Sarada <i>et al.</i> (2010) Haritha (2011) Venkatesh (2012)
14.	Fibre elongation (%)	Muthu <i>et al.</i> (2004) Sakthi <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Srinivasulu <i>et al.</i> (2010b) Mohan (2011) Venkatesh (2012)	Muraleedhar (2005) Padmavathi (2008) Anandan (2009) Rao <i>et al.</i> (2009a) Sarada <i>et al.</i> (2010) Haritha (2011) Rajanna <i>et al.</i> (2011)
15.	Lint yield/plant (g)	Pratap <i>et al.</i> (2007) Vijayalaxmi <i>et al.</i> (2008) Rajanna <i>et al.</i> (2011) Venkatesh (2012) Vineela <i>et al.</i> (2012a)	

Table 2.1. Review of literature on genetic variability in cotton

S.No.	Character	Wider genetic variability	Narrow genetic variability
1.	Plant height (cm)	Patnaik <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Tuteja <i>et al.</i> (2006a) Kalpande <i>et al.</i> (2008) Rao <i>et al.</i> (2009b) Sarada <i>et al.</i> (2010) Vineela (2011) Venkatesh (2012) Ranganatha <i>et al.</i> (2013)	Kale <i>et al.</i> (2007) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Rao (2008) Rajanna (2010) Kulkarni <i>et al.</i> (2011) Tulasi (2011) Haritha <i>et al.</i> (2012)
2.	Days to 50% flowering	Laxman and Ganesh (2003) Neelima <i>et al.</i> (2005)	Pratap (2006) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Sarada <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Kulkarni <i>et al.</i> (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Venkatesh (2012)
3.	No. of monopodia per plant	Raju (2005) Kaushik and Kapoor (2006) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Rao (2008) Rajanna (2010) Kishore <i>et al.</i> (2011) Kulkarni <i>et al.</i> (2011) Mohan (2011) Tulasi (2011) Vineela (2011) Dhanalakshmi <i>et al.</i> (2012) Venkatesh (2012)	Haritha <i>et al.</i> (2012)
4.	No. of sympodia per plant	Kaushik and Kapoor (2006) Tuteja <i>et al.</i> (2006a) Gitte <i>et al.</i> (2007) Neelima <i>et al.</i> (2008) Dhanalakshmi (2011) Kulkarni <i>et al.</i> (2011) Vineela (2011) Santoshkumar <i>et al.</i> (2012) Venkatesh (2012)	Vijayalaxmi <i>et al.</i> (2008) Rajmani <i>et al.</i> (2009) Rao <i>et al.</i> (2009b) Bazi (2011) Tulasi (2011) Haritha <i>et al.</i> (2012)
5.	No. of bolls per plant	Neelima <i>et al.</i> (2005) Kaushik and Kapoor (2006) Pratap (2006)	Pratap (2006) Vijayalaxmi (2007) Vijayalaxmi <i>et al.</i> (2008)

Table 2.1 (cont.)

S.No.	Character	Wider genetic variability	Narrow genetic variability
		Tuteja <i>et al.</i> (2006a) Neelima <i>et al.</i> (2008) Bazi (2011) Dhanalakshmi (2011) Kishore <i>et al.</i> (2011) Mohan (2011) Vineela (2011) Natera <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012) Venkatesh (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Rajmani <i>et al.</i> (2009) Srinivasulu <i>et al.</i> (2010a) Venkateswarulu <i>et al.</i> (2010a) Haritha (2011)
6.	Boll weight (g)	Tuteja <i>et al.</i> (2006a) Kale <i>et al.</i> (2007) Gitte <i>et al.</i> (2007) Kalpande <i>et al.</i> (2008) Rajmani <i>et al.</i> (2009) Srinivasulu <i>et al.</i> (2010a) Kulkarni <i>et al.</i> (2011) Mohan (2011) Haritha (2011) Vineela (2011) Venkatesh (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Vijayalaxmi <i>et al.</i> (2008) Rajanna (2010) Bazi (2011)
7.	Seed index (g)	Kumar (2004) Patnaik <i>et al.</i> (2004) Sivaprasad <i>et al.</i> (2004b) Kaushik and Kapoor (2006) Venkateswarulu <i>et al.</i> (2010a) Kishore <i>et al.</i> (2011) Vineela (2011) Choudki <i>et al.</i> (2012)	Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Srinivasulu (2009) Mahantesh (2009) Rajanna (2010) Bazi (2011) Dhanalakshmi (2011) Haritha <i>et al.</i> (2012) Venkatesh (2012)
8.	Lint index (g)	Patnaik <i>et al.</i> (2004) Gururajan and Sundar (2004) Sivaprasad <i>et al.</i> (2004b) Neelima <i>et al.</i> (2005) Kaushik and Kapoor (2006) Kishore <i>et al.</i> (2011) Kulkarni <i>et al.</i> (2011) Vineela (2011) Choudki <i>et al.</i> (2012)	Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Rao <i>et al.</i> (2009b)
9.	Ginning out- turn (%)	Patnaik <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Tuteja <i>et al.</i> (2006a)	Kaushik and Kapoor (2006) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008)

Table 2.1 (cont.)

S.No.	Character	Wider genetic variability	Narrow genetic variability
		Srinivasulu (2009) Rao <i>et al.</i> (2009b) Naqib <i>et al.</i> (2010) Venkateswarulu <i>et al.</i> (2010a)	Mahantesh (2009) Sarada <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Mohan (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)
10.	2.5% span length (mm)	Patnaik <i>et al.</i> (2004) Naphade <i>et al.</i> (2004) Gururajan and Sundar (2004) Kale <i>et al.</i> (2007) Rajmani <i>et al.</i> (2009) Rao <i>et al.</i> (2009b) Venkateswarulu <i>et al.</i> (2010a)	Neelima <i>et al.</i> (2005) Tuteja <i>et al.</i> (2006a) Neelima <i>et al.</i> (2008) Rao (2008) Srinivasulu (2009) Sarada <i>et al.</i> (2010) Rajanna (2010) Dhanalakshmi (2011) Kishore <i>et al.</i> (2011) Mohan (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Venkatesh (2012) Choudki <i>et al.</i> (2012) Rao and Gopinath (2013)
11.	Micronaire value (10 ⁻⁶ g/inch)	Patnaik <i>et al.</i> (2004) Naphade <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Rao <i>et al.</i> (2009b) Kulkarni <i>et al.</i> (2011) Choudki <i>et al.</i> (2012)	Kaushik and Kapoor (2006) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Srinivasulu (2009) Sarada <i>et al.</i> (2010) Rajanna (2010) Bazi (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Venkatesh (2012)
12.	Bundle strength (g/tex)	Naphade <i>et al.</i> (2004) Gururajan and Sundar (2004) Neelima <i>et al.</i> (2005) Rajmani <i>et al.</i> (2009) Rao <i>et al.</i> (2009b) Kulkarni <i>et al.</i> (2011)	Pratap (2006) Neelima <i>et al.</i> (2008) Rao (2008) Srinivasulu (2009) Rajanna (2010) Srinivasulu <i>et al.</i> (2010a) Bazi (2011)

Table 2.1 (cont.)

S.No.	Character	Wider genetic variability	Narrow genetic variability
			Dhanalakshmi (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)
13.	Uniformity ratio	Patnaik <i>et al.</i> (2004) Neelima <i>et al.</i> (2005) Rajamani <i>et al.</i> (2009) Choudki <i>et al.</i> (2012)	Muraleedhar (2005) Vijayalaxmi (2007) Neelima <i>et al.</i> (2008) Srinivasulu (2009) Rajanna (2010) Bazi (2011) Dhanalakshmi (2011) Kishore <i>et al.</i> (2011) Mohan (2011) Tulasi (2011) Vineela (2011) Haritha <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)
14.	Fibre elongation (%)	Srinivasulu <i>et al.</i> (2010a) Choudki <i>et al.</i> (2012)	Muraleedhar (2005) Vijayalaxmi (2007) Rao (2008) Srinivasulu (2009) Rajanna (2010) Sarada <i>et al.</i> (2010) Bazi (2011) Kulkarni <i>et al.</i> (2011) Mohan (2011) Vineela (2011) Haritha <i>et al.</i> (2012)
15.	Lint yield per plant (g)	Pratap (2006) Vijayalaxmi (2007) Rajanna (2010) Patil (2010) Vineela (2011) Natera <i>et al.</i> (2012) Venkatesh (2012) Rao and Gopinath (2013)	Mahantesh (2009) Rajanna (2010) Dhanalakshmi (2011)
16.	Seed cotton yield per plant (g)	Raju (2005) Pratap (2006) Kaushik and Kapoor (2006) Vijayalaxmi (2007) Srinivasulu (2009) Rajmani <i>et al.</i> (2009)	Mahantesh (2009) Rao <i>et al.</i> (2009b) Rajanna (2010) Srinivasulu <i>et al.</i> (2010a) Venkateswarulu <i>et al.</i> (2010a) Bazi (2011)

Table 2.1(cont.)

S.No.	Character	Wider genetic variability	Narrow genetic variability
		Naqib <i>et al.</i> (2010) Sarada <i>et al.</i> (2010) Kishore <i>et al.</i> (2011) Kulkarni <i>et al.</i> (2011) Mohan (2011) Haritha (2011) Choudki <i>et al.</i> (2012) Natera <i>et al.</i> (2012) Santoshkumar <i>et al.</i> (2012) Venkatesh (2012) Ranganatha <i>et al.</i> (2013) Rao and Gopinath (2013)	Vineela (2011)