

INHERITANCE OF SEEDCOTTON YIELD AND LINT
TRAITS IN COTTON (Gossypium hirsutum L.)

By

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree.

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(Name and Signature of Candidate)

Date: 28/12/83.....

The above declaration is confirmed.

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Date: 19/2/84.....

CERTIFICATION

This thesis entitled 'INHERITANCE OF SEEDCOTTON YIELD AND LINT TRAITS IN COTTON (Gossypium hirsutum L.). by Candidus Aleichenu Echekwu meets the regulations governing the degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.



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ABSTRACT

Studies were carried out to investigate the mode of gene action governing the inheritance of seedcotton yield, lint yield, lint percent, mean fiber length and fiber fineness within six intervarietal crosses of Upland cotton. Polygenic inheritance for these characters was indicated by unimodality in the F_2 distribution in most of the crosses for the traits studied. There were also apparent indications of the presence of complementary effects of genes for all these traits except lint yield as shown by skewness of some of the F_2 distribution.

The fit method of comparing the average of different generations with a predicted average calculated from parental and F_1 means was used to determine gene action in the inheritance. Results showed that this method was not sufficiently discriminatory as a means of studying the mode of gene action with respect to the traits evaluated using the available data. However from visual observation of the F_2 distribution, heterosis pattern and heritability estimates, additive gene effects appear to be relatively more important than non-additive effects in the inheritance of seedcotton yield, lint yield, lint percent and mean fiber length while dominance gene effects seem to be more important than additive effects in the inheritance of fiber fineness. There is also an indication of over-dominance at the coarse level for this character in three out of the six crosses evaluated.

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CHAPTER I

INTRODUCTION

The cotton production industry in Nigeria is centred around three main production zones, the Northern, Eastern and Southern zones. The northern zone comprises Kano, Sokoto, Kaduna States and also the northern fringes of Niger and Plateau States, producing about 60 to 65 percent of the total output. The eastern zone includes Borno, Bauchi and Gongola states and accounts for about 30 to 35 percent of the total production. The southern zone comprises of Benue, Kwara and the southern portions of Niger states and produces less than 5 percent of the total output. A negligible proportion is grown in Oyo state.

The present commercial varieties derived from American Allen (Gossypium hirsutum L.) through vigorous straight selection include the high yielding Samaru 71 grown in the northern and southern zones and the Samaru 72 (with longer staple length) grown in the eastern zone. Samaru 72 is now being gradually replaced by an improved version, Samaru 77 in the eastern zone. Several other introduced varieties have been compared with Samaru Allen in replicated trials in Nigeria over the years but none has been found to be superior to it. However, as has been rightly noted by Tabrah (1970), there is no variety of cotton with a combination of all the desirable traits. Also some varieties are inherently

better than others in one or more traits. The task of the cotton breeder therefore is to strive to combine more of the acceptable traits into new varieties. The more promising introductions among which are the Acala SJ1, Stripper, Deltapine and Coker varieties used in this study have been used as parents in crossing programs to form a broader genetic base for further improvement.

The major research efforts of the Institute for Agricultural Research (I.A.R.) has been geared towards solving problems of low yields, quality and susceptibility to diseases and insect pests. With the increased and increasing demand for cotton to satisfy the expanding textile mills and the competition from synthetic fibers, the emphasis on quality aspects of cotton in addition to yield has to be stepped up. The most important of these quality aspects are fiber properties. Certain of these properties are indicative of characteristics considered important when raw cotton is processed into finished products because they affect the quality of the finished products, the efficiency of the production process or both. The degree to which fibers conform to these quality requirements forms the basis of marketing systems in upland cotton. This system places a premium value on the fiber properties of long length, fineness, maturity and overall appearances. Although the marketing system does not assign values to fiber strength and elongation, both have been shown to affect either the production efficiency or quality of the end products (El-Sourady 1969).

The major objective of this project is to investigate the nature of inheritance of seedcotton and lint yields, and some quality traits of fiber length, lint percent and fiber fineness within intraspecific crosses of upland cotton. This information is required because the breeding methods employed for maximum genetic improvement of quantitative traits are dependent upon the types and relative amounts of genetic variability of these traits in the populations of interest.

CHAPTER 2REVIEW OF LITERATURE

The inheritance of quantitative characters in cotton has not been fully established due to the rather inconsistent results that have been obtained from several experiments and also because of the insufficient available data. In crosses within species, differences between parents have not been large enough to provide sufficient differentiation among segregates. Crosses between species have provided much more contrasting parental features but in turn interpretation of the data has been hindered somewhat by sterility and shedding of bolls resulting in reduced boll production on a large percentage of plants in F_2 and later generations. In this review on the agronomic and fiber characters of seedcotton yield, lint yield, lint percentage, mean fiber length and fiber fineness, the literature on each trait is reviewed separately and unless otherwise stated all literature is based on work conducted on Gossypium hirsutum L. varieties.

2.1 Seedcotton yield

Turner(1953) tested twenty-one hand-produced hybrids developed from seven 'selected' inbred lines of upland cotton for yielding ability in comparison with adapted varieties. He reported that six hybrids in one year and one in another gave seedcotton yields significantly higher than variety checks. These increases were attributed to heterotic effects. The Estimates of

variance components obtained from these materials suggest that for seedcotton yield, specific combining ability was more important than general combining ability indicating the preponderance of non-additive gene action for this trait. Marani (1963) in a diallel cross among three inbred varieties of Gossypium hirsutum L and three of Gossypium barbadense L. found significant heterosis and partial dominance for this trait. He also recorded higher variances for general than specific combining ability.

Using the diallel analysis involving four highly inbred strains each of the tetraploid species Gossypium hirsutum L. and diploid species Gossypium arboreum L., Young Murray (1966) showed that specific combining ability was much more important than general combining ability indicating that non-additive gene action predominates for seedcotton yield. Anwar Mirza and Khan (1974) in a study of the F_1 and parents using a six-parent diallel of Gossypium hirsutum L. reported that over-dominance and non-allelic interaction were important for seedcotton yield. Verhalen et al (1971) also detected over-dominance gene action for seed cotton yield in the ten-parent diallel they evaluated. They did not however detect epistasis for this trait in their material. Significant heterosis was also obtained by Khan et al (1979) in an evaluation of eight different hybrids, their parents and F_2 for seedcotton yield. They obtained an average yield increase of 26.8% and 8.8% over mid-, and better-parent values respectively.

In an analysis of a 10 x 10 half diallel cross, Singh (1980) showed that both additive and non additive genetic variance components were important for seedcotton yield which also showed overdominance. Analysis of parentals, F_1 , F_2 , BC_2 data from a cross between the varieties A218 and A231 led Kalsy and Vithal (1980) to conclude that additive and dominance variances for seedcotton yield were of equal magnitude.

2.2. Lint yield

Miller and Marani (1963) in an eight-parent diallel indicated that the major portion of the genetic variance for lint yield was additive genetic variance as suggested by very large and highly significant general combining ability variances in the F_1 and F_2 generations. The presence of small but significant estimates of specific combining ability variance in the F_2 was however indicative that at least some of the genetic variance in the population was nonadditive (due to dominance or epistasis or both). Using five parental stocks in a combining ability study based on a diallel cross, White and Richmond (1963) obtained significant heterosis in two crosses indicating the presence of partial dominance for this trait.

In another five-parent diallel, White and Kohel (1964) obtained a degree of dominance value of 0.91 which indicated partial dominance for this character with the dominance being towards the higher parent.

They also detected appreciable amount of additive variations for this trait. White (1966) in the same diallel, but including F_2 's, parents and F_1 's detected significant dominance and additive genetic variance for Lint yield with an average degree of dominance being calculated as 1.32 indicating overdominance. He detected no epistasis nor multiple allelism in these materials. Miller and Rawlings (1967) in a recurrent selection experiment for increased lint yield concluded that additive gene effects could not be excluded.

Marani (1968) in a study involving intraspecific crosses among upland cotton indicated that heterosis for Lint yield was 15% to 24% although this was always associated with heterosis for yield of seedcotton. Epistatic effects for Lint yield were relatively small as seen from F_2 performance indicating that the heterotic effect was mainly due to additive and dominance effects. Barnes and Staten (1961) obtained estimates of general and specific combining ability for lint yield in seven closely related Acala strains, which, by their relative magnitudes, suggested that specific combining ability was more important than general combining ability in six of those parents. Al-Rawi and Kohel (1969) in a nine-parent diallel detected no epistasis for lint yield but did find multiple allelism. They estimated a low narrow sense heritability on a plot-mean basis of 0.41 for this character. Verhalen et al (1971) in a ten-parent diallel

found lint yield to be controlled by overdominance gene action. They did not detect epistasis for this trait.

Meredith and Bridge (1972) testcrossed six diverse cultivars and strains on Deltapine 16 and found that both additive and dominance effects were involved in the inheritance of lint yield. Additive by additive epistasis was very small relative to additive and dominance effects for this trait. Baker and Verhalen (1973) in a ten-parent diallel concluded that dominance genetic variance was more important for lint yield than was additive genetic variance. Their estimates for degree of dominance were in the over dominance range though in most cases were not significantly different from one. Simongulian and Tabani (1980) in a five-parent diallel noted that lint yield and its components were controlled by genes with additive and dominance effects.

2.3 Lint percent

Stith (1955) reported from investigations on heritability in a cross between two varieties of Gossypium that there was partial dominance for higher lint percent. Broadsense heritability estimates in his materials were 0.45 in the F_2 and 0.79 in the F_3 using variance component methods. White and Richmond (1963) in a diallel analysis described earlier obtained significant estimate of general combining ability for lint percent. Their estimates of specific combining ability were not significant in these materials.

White and Kohel (1964) obtained significant estimates of additive genetic variance for lint percent but non-significant estimates of dominance variance in the same materials. White (1966) again in the same materials found no significant estimates of dominance for lint percent.

No epistasis was evident for this trait but multiple allelism was present. Lee et al (1967) in a diallel obtained a significant estimate of general combining ability and a non-significant estimate of specific combining ability for lint percent. In the diallel described previously, Miller and Marani (1963) calculated significant estimates of general combining ability only in the F_1 and F_2 but of specific combining ability only in the F_2 for lint percent.

Al-Rawi and Kohel (1969) in a nine-parent diallel noted that heterosis was small but significant in all crosses for lint percent, an indication of partial dominance. They calculated no epistasis for this trait, however, multiple allelism and possibly correlated gene distribution was indicated. They also detected significance for the additive genetic variance but not for the dominance variance. In a Graphic analysis of some quantitative traits in upland cotton using a 6 x 6 diallel, Gururaja et al (1977a) observed partial dominance for lint percent. Combining ability studies

from these material by Gururaja et al (1977b) revealed that additive effects predominated for this trait. Gene action analysis in these materials by Gururaja et al (1977c) also showed that three or four groups of genes controlled lint percent. Singh (1980) in the diallel described earlier also reported that both additive and non additive genetic variance components were important for lint percent which also showed partial dominance.

2.4 Fiber length

Ware et al (1943) using the F_1 and F_2 generation and first generation backcrosses grown from a Florida Green and Rowden cross reported that length of fibre was incompletely dominant in the F_1 and showed monomodal distribution in segregating generations. Miller and Marani (1963) in a diallel cross among eight inbred lines of upland cotton, obtained sizeable magnitudes of the estimates of general combining ability for fibre length and suggested that a major portion of the genetic variance in the base population was additive in nature. Specific combining ability estimates were not significant for the trait. Lee et al (1967) obtained significant values of heterosis for Upper-Half-mean length in a diallel involving ten inbred varieties. Estimates of components of additive genetic variance were highly significant for length.

Using a ten-parent diallel cross, Verhalen and Murray (1967) found that for fibre length, average over all crosses, the mean of the F_1 generation (1967) was 0.024mm longer than the mean of the midparent values and 0.005 shorter than the mean of the higher parents in each cross. They concluded that partial dominance governs the expression of this character. Verhalen and Murray (1969) obtained similar results when all possible F_2 progenies were included in the analysis. Marani (1968) noted small dominance effects for fibre length in his study of inheritance of lint quality in intraspecific crosses among Gossypium hirsutum L. varieties. Al-Rawi and Kohel (1970) investigated the genetic systems controlling fibre properties in nine selected upland cotton varieties and their F_1 and F_2 hybrids. They noted that heterosis was manifested at a low level for 50% span length (4.0%) and 2.5% span length (2.8%).

Inbreeding depression was not significant for this character. They suggested that the low level of heterosis and absence of inbreeding depression were indicative of additive genetic effects in the crosses between the varieties studied. From the estimates of average degree of dominance 0.72 for 50% span length and 0.77 for 2.5% span length, it was inferred that partial dominance was also involved in the determination of fibre length.

In the Mississippi Delta, Meredith et al (1970) studied and compared the nature of gene action of doubled haploids and their parent varieties and obtained low but significant heterosis for 2.5% span length. This would be indicative of non-additive gene action but they pointed out that the major type of gene action involved in fiber length was additive. Testercrossing six diverse cultivars and strains on Deltapine 16, Meredith Jr., and Bridge (1972) found that additive and dominance effects were involved for fibre length. In an analysis from a ten-parent diallel cross, Baker and Verhalen (1973) estimated a mean value over two years for the degree of dominance for 2.5% span length to be 0.98. They suggested complete dominance for this trait. They also indicated overdominance for 50% span length for which they got a mean value of the estimate to be 1.41. Anwar Mirza and Khan (1974) noted from a seven-parent diallel that staple length was controlled by additive gene action with partial dominance involving gene interaction.

Data obtained from a half diallel analysis of five inbred varieties by Innes (1974) indicated that most of the genetic variance for effective length was additive with a low degree of dominance. Using Gamble's (1962) six-parameter model for analysis of generation means to evaluate gene effects in the inheritance of fibre properties in P_1 , P_2 , F_1 , F_2 , B_1 and B_2 population of five lines with PRS 72 as the common parent in each cross,

Pathak (1975) noted an increase of F_1 mean for fiber length over the midparent value in four of five crosses though it was not significant in any cross. The highest value for heterosis recorded was 5.82% while the other three crosses showed very little increase in the F_1 over the midparent value. He suggested a partial dominance of long fibers over short fibers.

In four out of six cases, Tabrah (1970) recorded estimates of additive genetic variance for fibre length that were very large relative to the phenotypic variance. This should lead to a high narrow sense heritability which is indicative of additive gene effects as the predominant portion of gene action for this trait. Quisenberry (1975) in a study with hybrid populations from crosses among Acala and High Plains cultivars, showed that fibre length contained additive and non-additive genetic variance but that the greater portion was additive. Of the phenotypic variance he estimated, he found that 41% was additive genetic variance associated with the long fibred Acala lines while only 13% was associated with the short High Plains lines. The non-additive component for length was significant but only amounted to 23% of the phenotypic variance. In a 6 x 6 diallel analysis studied for six characters, Gururaja, Hiremath and Virupakshappa (1977b) showed that fiber length was conditioned by non-additive gene effects.

2.5 Fiber Fineness

The inheritance of fiber coarseness was studied by Bilbro Jr. (1961) using the parental, F_1 , F_2 and backcross population of the cross CR-2 x 4-24 (breeding strains from Acala 5 and stormmaster respectively). He found unimodal frequency distribution of micronaire units in all populations and inferred that fibre coarseness was quantitatively inherited. He also noted a similarity in micronaire values of the parents and thus the calculated mean did not differ sufficiently to make a reliable test for type of gene action. Ware and Harrell (1963) crossed Kime's fine with both Half and Half and Florida Green seed and evaluated the parental lines, F_1 's, F_2 's and three stages of backcrosses. The frequency arrays and mean levels of the F_1 populations indicated intermediate inheritance but in several comparisons, a particular F_1 mean was closer to the coarser parent than the finer parent.

Lee et al (1967) obtained a non-significant estimate for micronaire value in a ten-parent diallel cross analysis. The estimate of general combining ability as a main effect was highly significant and so was the estimate of additive genetic variance. None of the estimates of the degree of dominance obtained by Verhalen and Murray (1967, 1969) in their ten-parent diallel cross were significantly different from one, indicating overall complete dominance of this trait.

Al-Rawi and Kohel (1970) in a diallel cross analysis involving nine selected upland cotton varieties indicated that fiber fineness was polygenically inherited and showed overdominance possibly caused by repulsion linkage. They estimated the average degree of dominance for fiber fineness to be 1.08.

Tabrah (1970) in a study to estimate some genetic parameters in cotton found the relative proportion of additive to phenotypic variance to be high for all the single and combined environment analysis for fiber coarseness. The additive variance was at least twice as large as dominance variance in every instance. The proportion of environmental variation ranged from 11% to 60%. In another study to compare the nature of gene action of doubled haploids and their parent varieties Meredith et al (1970) noted that fiber fineness was inherited in an additive fashion. Meredith and Bridge (1972) in the testcross mentioned earlier noted no deviation of F_1 means from the mid-parent values for micronaire value. They indicated that additive effects predominated for micronaire. Baker and Verhalen (1973) in a ten-parent diallel obtained a mean of 0.81 over two years for the estimated degree of dominance for fineness and suggested a partial dominance for this trait.

In a diallel analysis involving seven cultivars of Gossypium hirsutum L. Anward Mirza and Khan (1974) found that the inheritance of fibre fineness was controlled by additive gene action with partial dominance involving gene interaction. Data obtained from a half diallel cross of five inbred varieties by Innes (1974) indicated that dominance variance was more important for micronaire values than additive genetic variance. Pathak (1975) from the cross mentioned earlier noted that fineness in the F_1 decreased in four out of five crosses compared with their midparent values, significantly so in two crosses. Three crosses also showed overdominance values of 1.94% to 8.3% for this fiber property. He suggested that overdominance gene action may be involved in governing fiber fineness and that coarseness is dominant over fineness.

Quisenberry (1975) worked with hybrid population from crosses among Acala and High Plains cultivars and noted that most of the phenotypic variance of fiber fineness was due to the environmental component although he obtained a statistically significant non-additive component. In a half diallel set of crosses involving twelve AH (67) parents and in a full diallel set with nine Alber 51 lines, Innes, et al (1975) noted that genetic control of fineness as indicated by micronaire value, was largely accounted for by additive effects.

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental materials

The materials used in this study are all Upland cotton (Gossypium hirsutum L.) varieties originating from diverse backgrounds. Their origin and brief descriptions are given below.

P₁ - Allen 333. Formerly a commercial variety in Nigeria which was originally introduced from U.S.A. A high yielding variety with good ginning percentage and short staple.

P₂ - Samaru 72. A commercial variety in Nigeria derived from Samaru Allen (an adapted form of Allen 333) by selection and grown in the eastern zone. It is high yielding with a medium staple.

P₃ - RASA (76) 23. A promising variety yet to go into commercial production with high yields and good ginning percentage. It is a short staple variety and is blight resistant.

P₄ - Acala SJ1. An introduction from the U.S.A. It is a high yielding medium staple variety with good spinning quality.

P₅ - Coker 310. An introduction from the U.S.A. with a long staple length.

P₆ - Deltapine (Hales). Introduction from the U.S.A. with average yield. It is short staple and has a high ginning percentage.

P₇ - Stripper. A good yielding introduction from the U.S.A. with short staple.

3.2 Experimental methods

Several crosses were made in a crossing nursery at Samaru during the off-season of 1979/80 under irrigation among seven parent materials. In the 1981 growing season six of the hybrids resulting from these crosses were selected based on the extent of fruit set and seed maturity. These were advanced to the F₂ generation. At the same time the six selected F₁ hybrids were backcrossed to both parents resulting in 12 backcross progenies. The resulting 31 populations, including seven parents, six F₁ hybrids, six F₂ progenies and 12 backcross progenies were evaluated in this study. The materials were planted at the Institute for Agricultural Research Farm at Samaru in June 1982. Plots were single rows, 5m long and 91 cm apart. Four treated seeds were sown per hole spaced at 40cm apart. The resulting seedlings were thinned to one plant per hill at 4 weeks. In instances where there was shortage of seeds, especially in the F₁ materials, one to two seeds were planted per hole with okra seeds to help in germination. All cultural practices like weeding, cultivation, fertilizer application and spraying against insect pests and diseases were carried out promptly and as recommended by the Institute for Agricultural Research.

The total seedcotton yield of each plant in each row was weighed, then ginned on a 14 inch roller gin to estimate the seed cotton yield, lint yield, lint percent and fiber properties of the segregating generations. Lint used for measurement of fiber properties of the non-segregating generations (Parents and F_1 hybrids) was obtained by bulking the total lint yield per plot and taking 10 random samples from the bulked lint. The following five characters were observed and recorded:

- 1) Seedcotton yield (SCY) - Weight (g) of seed cotton per plant.
- 2) Lint yield (LY) - Weight (g) of Lint per plant.
- 3) Lint percent (L%) - The weight of lint ginned from seedcotton expressed as a percentage of the weight of seedcotton.
- 4) Mean Fiber Length (MFL) - The average length of all the fibers in the sample measured in mm using a manual micrograph.
- 5) Fiber fineness (FF) given as micronaire values - Measured as the resistance of a given weight of ginned cotton lint to air flow as an indication of fineness of the sample. The smaller the micronaire value, the finer the sample.

Measurement of the fiber characters was based on the American Society for Testing and Materials (A.S.T.M.) standards. A.S.T.M. test methods specify that tests must be made in a standard atmosphere ($70^{\circ} \pm 2^{\circ}\text{F}$ with a relative

humidity of $65 \pm 2\%$) on specimens that are in moisture equilibrium with the standard atmosphere, Mayne (1966).

Statistical Analysis

Individual plant data and their means were used in computations for each trait. Heterosis was estimated from

$$\frac{\bar{F}_1 - MP}{MP} \times 100 \text{ (Miller and Marani 1963)}$$

where \bar{F}_1 = mean of the first filial generation

derived from crossing two parents.

MP = Mid-parental value which is the average of two parents used in the cross.

Inbreeding depression was estimated from

$$\frac{\bar{F}_1 - \bar{F}_2}{\bar{F}_1} \times 100 \text{ (Miller and Marani 1963)}$$

where \bar{F} is the mean of the corresponding generation.

Frequency distributions were obtained for all traits in the six crosses evaluated. Estimates of the minimum number of genes controlling the inheritance of each trait were computed using the three estimators

$$1) \quad n = \frac{0.25(0.75 - h + h^2) D^2}{\sigma_{F_2}^2 - \sigma_{F_1}^2} \quad \text{(Wright 1921)}$$

where n = number of genes

$$h = \frac{\bar{F}_1 - \bar{P}_1}{\bar{P}_2 - \bar{P}_1} \quad D = \bar{P}_2 - \bar{P}_1$$

\bar{P}_1 = mean of the smaller parent

\bar{P}_2 = mean of the larger parent

\bar{F}_1 = mean of the F_1 population

\bar{F}_2 = mean of the F_2 population

$\sigma_{F_1}^2$ = Variance of the F_1 population mean

$\sigma_{F_2}^2$ = Variance of the F_2 population mean

Assumptions:

- a) No linkage between pertinent genes
- b) One parent supplies only plus factors and the other only minus factors among those in which they differ
- c) All genes are equally important
- d) The degree of dominance of all plus factors is the same for all
- e) No interaction exists between pertinent non-allelic genes.

$$2) \quad n = \frac{D^2}{8(\sigma_{F_2}^2 - \sigma_{F_1}^2)} \quad (\text{Castle 1921})$$

where n = number of genes

D = Mean difference between the parents

$\sigma_{F_1}^2$ = Variance of F_1 population mean

$\sigma_{F_2}^2$ = variance of F_2 population mean

Assumptions:

- a) No dominance
- b) each gene has an equal effect
- c) both parents are homozygous

$$3) K_1 = \frac{\left[\frac{1}{2} (P_1 - P_2) \right]^2}{D} \quad (\text{Mather and Jinks 1971})$$

where $D = S (d^2_{a_i})$ = the deviation of either parents from the mid-parent value.

K_1 = number of genes.

Assumptions:

- a) No interaction and Linkage
- b) Equal increments for the different alleles, that is all d's are equal.

Gene action was determined by the fit method of comparing observed means with theoretical means predicted from Parental, F_1 and Backcross means.

The formulae for computing the theoretical means are given below (Powers and Lyon 1941).

1. Arithmetic means

$$a) F_2 = \frac{\bar{P}_1 + 2 \bar{F}_1 + \bar{P}_2}{4}$$

$$b) B_1 = \frac{\bar{F}_1 + \bar{P}_1}{2}$$

$$c) B_2 = \frac{\bar{F}_1 + \bar{P}_2}{2}$$

2. Geometric means

$$a) F_2 = \text{Antilog } \frac{\log \bar{P}_1 + 2\log \bar{F}_1 + \log P_2}{4},$$

$$b) B_1 = \text{Antilog } \frac{\log \bar{F}_1 + \log \bar{P}_1}{2}$$

$$c) B_2 = \text{Antilog } \frac{\log \bar{F}_1 + \log \bar{P}_2}{2}$$

Indications of mode of gene action governing inheritance of particular traits were also shown by the comparative mean performance of the generations and estimates of Heterosis.

Broadsense and narrow-sense heritability estimates were obtained using the variance component methods. F_2 variances were used to compute the broadsense estimates by the equation

$$H = \frac{\sigma_{F_2}^2 - (\sigma_{P_1}^2 \times \sigma_{P_2}^2)}{\sigma_{F_2}^2} \times 100$$

$$\text{where } \sigma_{F_2}^2 = \sigma_G^2 + \sigma_E^2; \quad \sigma_P^2 = \sigma_E^2$$

$$\sigma_{P_1}^2 = \sigma_{E_1}^2, \quad \sigma_{P_2}^2 = \sigma_{E_2}^2$$

(Mahmood and Krammer, 1951; Weber and Moorthy, 1952)

The narrow sense estimates were computed as:

$$H = \frac{2\sigma_{F_2}^2 - (\sigma_{B_1}^2 + \sigma_{B_2}^2)}{\sigma_{F_2}^2} \quad (\text{Warner 1952})$$

$$\text{where } \sigma_{F_2}^2 = \frac{1}{2}A + \frac{1}{4}D + E$$

$$\sigma_{B_1}^2 + \sigma_{B_2}^2 = \frac{1}{2}A + \frac{1}{2}D + 2E$$

$$\begin{aligned} 2\sigma_{F_2}^2 - \sigma_{B_1}^2 - \sigma_{B_2}^2 &= A + \frac{1}{2}D + 2E - (\frac{1}{2}A + \frac{1}{2}D + 2E) \\ &= \frac{1}{2}A \end{aligned}$$

In these relationships,

A = additive variance

D = dominance variance

E = environmental variance

B₁ = Backcross to parent P₁

B₂ = Backcross to parent P₂

F₂ = Second Filial Generation

CHAPTER 4RESULTS4.1 Mean performance.

The mean values of the generations for seedcotton yield (SCY) indicate that the F_1 was intermediate between the two parents in all crosses evaluated (Table 1). In three out of the six crosses, $P_7 \times P_2$, $P_4 \times P_5$ and $P_4 \times P_1$, the F_1 value was higher than the mid-parent (MP) values. This indicates partial dominance of the higher yielding parent. The F_1 value was lower than the midparent value in the remaining three crosses $P_3 \times P_7$, $P_3 \times P_4$, and $P_1 \times P_6$, which indicates partial dominance of the lower yielding parent. F_2 mean values were lower than the corresponding F_1 means in four out of the six crosses although the difference between the F_1 and F_2 were small. In the remaining two crosses $P_3 \times P_7$ and $P_3 \times P_4$, F_2 mean was higher. The lack of inbreeding depression of the F_2 relative to the F_1 suggests that considerable additive genetic variation is available for seedcotton yield. The means of the backcrosses for this character were inter-mediate between the F_1 and the corresponding recurrent parent in all the crosses.

The same trend in mean performance is exhibited for Lint yield (LY) and lint percent (L%). In three crosses $P_7 \times P_2$, $P_4 \times P_5$ and $P_3 \times P_4$ the F_1 values were more than the midparent values for LY. In three crosses

Table 1: Mean Performance of Six generations for five traits in Six Upland Cotton Crosses

Cross	Genera- tion	Characters				
		SCY(gm)	LY(g)	L%	MFL(mm)	FF
Stripper x Samaru 72	P ₁	50.5+ ₂	19.3+ ₂	38.3+ ₃	24.3+ ₁	3.5+ ₁
	P ₂	46.5+ ₃	17.0+ ₁	36.5+ ₂	26.2+ ₁	3.8+ ₀
	F ₁	49.4+ ₂	18.5+ ₁	37.4+ ₂	23.5+ ₁	3.5+ ₀
	MP	48.5	18.3	37.4	25.2	3.7
	F ₂	48.3+ ₃	17.7+ ₂	36.3+ ₂	24.7+ ₂	3.5+ ₁
	B ₁	48.4+ ₂	18.2+ ₁	37.5+ ₂	23.6+ ₁	3.4+ ₁
	B ₂	46.3+ ₃	16.9+ ₂	36.6+ ₃	23.9+ ₁	3.6+ ₁
RASA(76)23 x Stripper	P ₁	55.5+ ₂	20.1+ ₁	36.3+ ₁	22.9+ ₁	3.5+ ₀
	P ₂	50.5+ ₂	19.3+ ₂	38.3+ ₃	24.2+ ₁	3.5+ ₁
	F ₁	52.4+ ₂	19.6+ ₁	37.4+ ₂	24.1+ ₁	3.6+ ₁
	MP	53.0	19.7	37.3	23.6	5.5
	F ₂	53.4+ ₂	19.7+ ₂	36.9+ ₃	23.7+ ₁	3.5+ ₁
	B ₁	54.2+ ₂	19.8+ ₂	36.5+ ₂	23.8+ ₁	3.4+ ₁
	B ₂	52.6+ ₃	19.7+ ₂	37.6+ ₃	23.8+ ₁	3.5+ ₁
Acala SJI x Coker 310	P ₁	60.5+ ₂	23.2+ ₁	38.3+ ₂	24.5+ ₁	4.2+ ₁
	P ₂	70.4+ ₃	24.7+ ₂	35.1+ ₂	27.7+ ₁	3.4+ ₀
	F ₁	67.3+ ₂	25.0+ ₂	37.2+ ₂	24.3+ ₁	3.9+ ₁
	MP	65.5	34.0	36.7	26.1	3.8
	F ₂	65.7+ ₇	24.3+ ₄	37.1+ ₄	25.9+ ₂	4.2+ ₁
	B ₁	63.3+ ₃	23.8+ ₂	37.6+ ₂	24.9+ ₁	3.9+ ₁
	B ₂	67.2+ ₆	24.4+ ₂	36.4+ ₃	25.7+ ₁	3.5+ ₁
RASA(76)23 x Acala SJI	P ₁	55.5+ ₂	20.1+ ₁	36.3+ ₂	22.9+ ₁	3.5+ ₀
	P ₂	60.5+ ₂	23.2+ ₁	38.3+ ₂	24.5+ ₁	4.2+ ₁
	F ₁	57.4+ ₂	21.9+ ₂	38.1+ ₂	24.2+ ₁	4.3+ ₁
	MP	58.9	21.7	37.3	23.7	3.9
	F ₂	57.2+ ₃	21.8+ ₂	37.8+ ₃	23.7+ ₁	3.6+ ₁
	B ₁	56.2+ ₃	20.8+ ₂	37.1+ ₃	24.0+ ₁	3.5+ ₁
	B ₂	58.5+ ₃	21.9+ ₁	37.4+ ₃	24.4+ ₃	3.8+ ₁
Acala SJI x Allen 333	P ₁	60.5+ ₂	23.2+ ₁	38.3+ ₂	24.5+ ₁	4.2+ ₁
	P ₂	70.4+ ₃	24.7+ ₁	35.0+ ₁	26.0+ ₁	3.7+ ₀
	F ₁	66.3+ ₂	24.0+ ₂	36.2+ ₂	25.0+ ₁	3.8+ ₀
	MP	65.5	24.0	36.7	25.3	4.0
	F ₂	66.0+ ₆	24.2+ ₃	36.7+ ₂	25.0+ ₁	3.9+ ₁
	B ₁	62.9+ ₃	23.4+ ₃	37.2+ ₃	25.4+ ₁	3.8+ ₁
	B ₂	68.1+ ₃	24.6+ ₂	36.1+ ₃	25.5+ ₁	3.7+ ₁
Allen 333 x Deltapine	P ₁	70.4+ ₂	24.7+ ₁	35.0+ ₁	26.0+ ₀	3.7+ ₀
	P ₂	40.4+ ₂	15.7+ ₂	39.2+ ₂	23.6+ ₁	3.6+ ₁
	F ₁	51.0+ ₃	18.9+ ₂	36.6+ ₃	24.0+ ₁	4.0+ ₀
	MP	55.4	20.2	37.1	24.8	3.7
	F ₂	47.4+ _{1.1}	17.4+ ₅	36.7+ ₃	24.5+ ₂	3.8+ ₁
	B ₁	64.6+ _{1.0}	23.6+ ₄	36.6+ ₃	24.4+ ₁	3.8+ ₁
	B ₂	46.5+ _{1.0}	17.6+ ₄	37.6+ ₃	23.9+ ₁	3.6+ ₁

*SCY - Seedcotton yield; LY - Lint yield; L% Lint percentage;
MFL - Mean fiber length; FF - Fiber fineness; MP-Mid-Parent value.

$P_3 \times P_7$, $P_4 \times P_5$, $P_3 \times P_4$, the F_1 values were also more than the mid-parent values for lint percent. This suggests partial dominance for higher lint yield and lint percent over lower levels. A slight indication of overdominance is shown for high lint yield in the cross $P_4 \times P_5$ where the F_1 was higher than the high parent.

The trend exhibited by Mean Fiber Length (MFL) and Fiber fineness are similar. In two crosses $P_3 \times P_7$ and $P_3 \times P_4$, F_1 means were as high as the high parental mean, F_1 means were observed to be lower than the midparent in the other crosses for Mean Fiber Length (MFL). The mean values in the F_2 show that a greater proportion of the increments or decrements in the F_1 over the parental means was lost in the F_2 . Since the differences between the mean values of the parents and the F_1 's were small, the magnitudes of these decrements or increments were small. The mean values for the backcross generation generally fell between the F_1 values and recurrent parents in all cases.

The mean performance of the various generations for Fiber fineness show that the F_1 was higher than the mid-parent value in four crosses $P_3 \times P_7$, $P_4 \times P_5$, $P_3 \times P_4$ and $P_1 \times P_6$. All these crosses except $P_4 \times P_5$ have values higher than the high parent, an indication of overdominance (at the coarse level). In one cross however ($P_7 \times P_2$) the mean of the F_1 was equal to the

the mean of the finer parent. The means of the F_2 generally decreased when compared to the corresponding F_1 in all crosses evaluated except in cross $P_4 \times P_1$ where it increased. The mean of the backcross fell between the means of the F_1 and the recurrent parents in all the crosses evaluated.

4.2 Heterosis and Inbreeding depression

Heterosis expressed as percent increase of the F_1 hybrid above the average of the parents was observed for all characters measured (Table 2). The magnitudes of the heterotic effects were generally low for seedcotton yield, ranging from 1.0% to 2.8% for positive heterosis and -1.1% to -7.9% for negative heterosis. In five out of the six crosses evaluated, the values were less than 2.0%. The manifestation of heterosis, however small the effect is, is an indication of the presence of dominance gene effects. The negative values obtained here indicate dominance of the lower yielding parent.

The values for Inbreeding depression ranged from 0.45% to 7.1%. The magnitudes of inbreeding depression followed the same pattern with the heterotic effects, that is characters which evidenced the greatest amount of heterosis likewise showed the most inbreeding depression. The low inbreeding depression values is a pointer to the presence of a little amount of non-additive gene effects.

Table 2: Percent Heterosis and Inbreeding Depression(%) of agronomic and Fiber characters in Six upland cotton crosses.

Cross		Character				
		SCV	LY	L%	MFL	FF
Stripper x Samaru 72	Heterosis	11.85	1.90	-0.03	-6.94	-4.00
	Inbreeding depression	1.50	4.30	1.50	-5.29	-
RASA(76)23 x Stripper	Heterosis	-1.10	-0.50	0.27	2.29	3.00
	Inbreeding depression	-1.90	-0.50	1.30	1.49	0.27
Acala SJI x Coker 310	Heterosis	2.80	4.40	1.40	-6.71	2.60
	Inbreeding depression	2.40	2.80	0.27	-6.49	2.50
RASA(76)23 x Acala SJI	Heterosis	1.00	1.20	2.20	2.06	1.20
	Inbreeding depression	-0.35	0.50	0.79	1.94	1.60
Acala SJI x Allen 333	Heterosis	1.30	0.21	-1.40	1.03	-4.00
	Inbreeding depression	0.45	-0.80	-1.40	0.80	-3.00
Allen 333 x Deltapine	Heterosis	-7.9	-6.40	-1.40	-3.34	10.00
	Inbreeding depression	-7.10	7.90	-0.30	-2.20	5.00

Heterotic values for lint yield range from 0.21% to 6.4% with four out of the six crosses having values of less than 2.0%. Negative heterosis was obtained in $P_1 \times P_6$ (-6.4%). The heterotic effects indicate the presence of some dominance gene action in the inheritance of this character. Inbreeding depression ranged in values from 0.5% to 7.9%. Values of the inbreeding depression were also relatively low. These results suggest the presence of an appreciable amount of additive effects in these materials.

Lint percent showed the lowest amount of heterosis of all the characters evaluated in this study. Inbreeding depressions are also quite low.

The values of heterotic effects recorded for mean fiber length were relatively high, ranging from positive heterosis of 1.03% to 2.29% in the three crosses $P_4 \times P_1$, $P_3 \times P_4$ and $P_3 \times P_7$ to negative heterosis of -3.34% to -6.94% in the remaining three crosses. This observation is indicative of the dominance of the short-fibered parent. Values for inbreeding depression ranged in the same pattern of negative and positive values for the three respective crosses. For Mean Fiber length there is also an indication of the presence of additive gene effects since the values for inbreeding depression were low in four out of the six crosses evaluated.

Fiber fineness exhibited the highest heterotic effects with values ranging from 1.2% to 10%. Negative heterosis was obtained in two crosses $P_7 \times P_2$ (-4.0%) and $P_4 \times P_1$ (-4.0%). This indicates dominance of the finer parent. Values for inbreeding depression for this character ranged from 0.2% to 5.0%. No inbreeding depression was recorded for fiber fineness in cross $P_7 \times P_2$ where the F_2 mean equalled the F_1 mean. A negative value (-3.0) was recorded for cross $P_4 \times P_1$ where there was partial dominance of the finer parent. The low values obtained for inbreeding depression pinpoints the presence of an appreciable amount of additive gene effects for this trait.

The presence of negative inbreeding depression in these materials in some crosses for all the traits studied can be attributed to one of two reasons. Where the heterotic effects show a dominance of the low parent, inbreeding depression could be negative since the mean value of the F_2 is not likely going to be higher than the F_1 mean value. Instances where negative inbreeding depression is still obtained when the heterotic effects show dominance of the higher parent could be due to environmental or sampling effects.

4.3 Frequency distributions

The results for seedcotton yield indicate that the F_1 was intermediate between the parentals in all the crosses evaluated (Table 3). The F_2 distribution is unimodal in five out of the six crosses and

Table 3: Frequency distribution of seedcotton yield in six cotton crosses (Cont'd)

		Class value in grams											Mean	SD													
(Cross)		39.8	41.3	42.8	44.3	45.8	47.3	48.8	50.3	51.8	53.3	54.8	56.3	57.8	59.3	60.8	62.3	63.8	65.3	66.8	68.3	69.8	71.3				
cala	SJ1														3	7											
	X															2	4		3	3	4	4	2	5	10	60.5	.77
Allen	333															5		8	3	7	8	7	10	20			
	X															3		1	3	4	3	3	2	10			
	B1															4		1	3	3	3	7	20				
	B2															1		1	1	3	3	3	20				
Allen	333															5							5	10			
	X															3							5	10			
	B1															4							10	20			
	B2															2							10	20			
Deltapine																1							10	20			
	X															3							10	20			
	B1															3							10	20			
	B2															2							10	20			
	P1															5							10	20			
	P2															5							10	20			
	F1															3							10	20			
	F2															3							10	20			
	B1															2							10	20			
	B2															3							10	20			
	P1															5							10	20			
	P2															5							10	20			
	F1															3							10	20			
	F2															3							10	20			
	B1															2							10	20			
	B2															3							10	20			
	Mean															60.4							70.4				
	SD															.78							.85				
																.91							4.78				
																3.91							4.65				
																4.2							4.2				

Table 4: Frequency distribution of Lint yield in six cotton crosses (Cont'3)

Cross	Class values in grams															N	Mean	SD							
	14.4	15.1	15.8	16.5	17.2	17.9	18.6	19.3	20.0	20.7	21.4	22.1	22.8	23.5	24.2				24.9	25.6	26.3	27.0	27.7		
Acala SJ1 X Allen 333	P1																					10	23.2	.42	
	P2																						10	24.7	.40
	F1																						10	24.0	.48
	F2																						20	24.2	.98
	B1																						20	23.4	.93
	B2																						20	24.6	.76
Allen 333 X Leltapine	P1																					10	24.7	.40	
	P2																						10	15.7	.69
	F1																						10	18.9	.63
	F2																						20	17.4	2.14
	B1																						20	23.6	1.93
	B2																						20	17.6	1.84

exhibited negative skewness (towards the higher yielding parent) in two crosses $P_7 \times P_2$ and $P_3 \times P_7$. The F_2 distribution in the $P_3 \times P_4$ cross is very narrow. The frequency array for the backcross generation tends to shift towards the recurrent parent in all crosses evaluated for seed cotton yield.

Table 4 shows the segregating pattern for lint yield. The F_1 was intermediate between the parentals in all crosses except $P_4 \times P_5$ where it was similar to that of the higher yielding parent. The frequency distribution of the F_2 was unimodal in four out of the six crosses studied and did not produce any significant skewness. Transgressive segregation was manifested in two crosses $P_4 \times P_5$ and $P_4 \times P_1$. The distribution in the backcross appears to shift towards the recurrent parent in five of the six crosses. In one cross $P_3 \times P_7$ (B_2) the recurrent parent appears not to have any influence on the segregation pattern. Transgressive segregation was manifested in three crosses $P_7 \times P_2$, $P_4 \times P_5$ and $P_4 \times P_1$.

Table 5 shows that for lint percent, the F_1 was again intermediate between the distributions of the parents in all crosses except $P_3 \times P_4$ where it was similar to the distribution of the better parents. The distribution of the F_2 was positively skewed in three crosses $P_7 \times P_2$, $P_3 \times P_7$ and $P_1 \times P_6$ and showed unimodality in five out of the six crosses evaluated. Transgressive segregation was manifested in only two

crosses $P_4 \times P_5$ and $P_3 \times P_4$. In all the crosses evaluated the distribution of the backcrosses appears to shift towards the recurrent parent.

Results for mean fiber length are presented in Table 6 and indicate that the distribution of the F_1 was similar to the short fibered parent in three crosses $P_7 \times P_2$, $P_4 \times P_5$, $P_1 \times P_6$; intermediate between the parent in only one cross $P_4 \times P_1$; and similar to the long-fibered parent in two crosses $P_3 \times P_7$ and $P_3 \times P_4$. The spread of the F_2 distribution fell within the parental extremes in all crosses and showed unimodality in the six crosses also. It is positively skewed in four out of the six crosses. The distribution of the backcross generation tends to be similar to that of the F_1 irrespective of the recurrent parents in the five crosses where the F_1 distributions were similar to particular parents.

Table 7 shows the frequency distribution of fiber fineness in micronaire units. The F_1 distribution was intermediate between the parentals in two crosses $P_7 \times P_2$ and $P_4 \times P_5$; closer to the coarser parent in three crosses $P_3 \times P_7$, $P_3 \times P_4$, $P_1 \times P_6$, and closer to the finer parent in only one cross $P_4 \times P_1$. The F_2 distribution transgressed those of the parents in three crosses $P_7 \times P_2$, $P_3 \times P_7$ and $P_3 \times P_4$ and showed unimodality in three crosses $P_3 \times P_7$, $P_4 \times P_5$ and $P_1 \times P_6$. It is positively skewed (towards the finer parent) in

Table 5: Frequency distribution of Lint Percent in Six cotton crosses

		33.3	33.8	34.3	34.8	35.3	35.8	36.3	36.8	37.3	37.8	38.3	38.8	39.3	39.8	40.3	40.8	N	Mean	SD
Stripper x Samaru 72	P ₁					1	1			2	3	1	1	3				10	38.3	.78
	P ₂							4	1	3								10	36.5	.62
	F ₁					1	3	3	3	4	1	2						10	37.4	.56
	F ₂					1	5	3	3	4		3	1					20	36.8	1.10
	B ₁	1	1			1	2	3	3	5	6	1	1		1			20	37.5	.85
B ₂							2	2	5	6	1	1					20	36.6	1.1	
RASA(76)23 x Stripper	P ₁					2	1	3	2	2								10	36.3	.68
	P ₂									2	3	1	1	3				10	38.3	.78
	F ₁							1	2	4	1	2						10	37.4	.70
	F ₂					3	1	7	1	2	2	1	1	2				20	36.9	1.28
	B ₁		2			2	4	2	3	3	2	2						20	36.5	1.1
B ₂					1		3	4	1	2	5		4				20	37.6	1.21	
Acala SJI x Coker 310	P ₁							1	1	2	5	1						10	38.3	.72
	P ₂	1	3			4	2											10	35.1	.51
	F ₁							3	1	2	3	1						10	37.2	.77
	F ₂	1	1			1	2	4	2	3	1	1		2	2			20	37.1	1.63
	B ₁					3	5	2	2	4	1	2	1					20	37.6	1.51
B ₂					2	1	3	2	2								20	36.4	1.12	
RASA(76)23 x Acala SJI	P ₁					2	1	3	2	2								10	36.3	.68
	P ₂							1	1	1	3	1	3	1				10	38.3	.72
	F ₁							1	2	4	4	1	3	1	1			10	38.1	.72
	F ₂	1				1	2	2	4	1	4	1	3	1	1			20	37.8	1.49
	B ₁		1			2	3	3	3	1	2	3		2				20	37.1	1.37
B ₂					1	2	2	3	3	3	1	6		2			20	37.4	1.13	
Acala SJI x Allen 333	P ₁							1	1		2	5	1					10	38.3	.72
	P ₂																	10	35.0	.42
	F ₁		2	4		3	1											10	36.2	.77
	F ₂					1	1	3	3	1	2	1	4					20	37.2	.93
	B ₁					1	2	1	3	5	3		4	1				20	37.2	.93
B ₂		1			5	3	4	5	2								20	36.1	.78	
Allen 333 x Deltapine	P ₁	2	4			3	1											10	35.0	.42
	P ₂																	10	39.2	.61
	F ₁						3	3	1	1	1	1		2	1	6	1	10	36.4	.90
	F ₂					7	2	1	1	5	1	2	2					20	36.7	1.47
	B ₁			4		3	1		4	3		5						20	36.6	1.37
B ₂		1			1		3		2	1	5	2	5				20	37.8	1.35	

Table 6. Frequency distribution of Fiber Length (mean length) in six cotton crosses

		Class values in mm													N	Mean	SD										
		22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.9	25.1	25.4	25.7	26.0	26.2	26.5	26.8	27.1	27.4	27.7	28.0	28.2				
Cross		22	22	22	23	23	23	24	24	24	25	25	25	26	26	26	26	27	27	27	28	28					
		2	2	2	3	3	3	4	4	4	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Stripper x Semaru 72	P ₁			1	2	3	4						1	3	2	4									10	24.23	.31
	P ₂					2	3	1	2	3	5	2	1	2	1	4									10	26.18	.25
RASA(76)23 x Strilper	F ₁			2	10	5	6	4	2	1	2	1	2	1	4									20	23.45	.27	
	F ₂			1	3	3	3	2	1	2	1	1	2	1	4									20	24.69	.67	
Acala SJ1 x Coker 310	B ₁			1	5	6	4	2	1	2	2	1	1	2	4									20	23.92	.58	
	B ₂				1	1	1	2	1	2	1	1	2	4										20	23.92	.58	
RASA(76)23 x Acala SJ1	P ₁			1	4	4	1																	10	22.88	.29	
	P ₂					4	4	1																10	24.47	.35	
Acala SJ1 x Coker 310	F ₁				3	3	2	2	4	7	6	7	3	5	4	1								10	27.69	.35	
	F ₂				1	3	4	2	3	3	3	3	4	4	1	1								10	24.33	.30	
RASA(76)23 x Acala SJ1	B ₁				1	3	4	2	3	4	4	3	4	1	1									20	25.91	.55	
	B ₂				1	3	4	2	3	4	4	3	4	1	1									20	24.87	.48	
RASA(76)23 x Acala SJ1	P ₁				1	4	4	1																10	24.47	.35	
	P ₂				1	4	4	1																10	27.69	.35	
Acala SJ1 x Coker 310	F ₁				3	3	2	2	4	7	6	7	3	5	4	1								10	24.33	.30	
	F ₂				1	3	4	2	3	3	3	3	4	4	1	1								10	25.91	.55	
RASA(76)23 x Acala SJ1	B ₁				1	3	4	2	3	4	4	3	4	1	1									20	24.87	.48	
	B ₂				1	3	4	2	3	4	4	3	4	1	1									20	24.96	.50	

a

Table 7: Frequency distribution of Fibre Fineness in six cotton crosses

Cross	Class value in micronaire units																	N	Mean	SD	
	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5				4.6
Stripper x Samaru 72	P1			1	3	2	1	1	1	1	3	1	1						10	3.5	.20
	F1	1	2	3	1	2	4	2	4	1	2	4	1	1					10	3.5	.12
	B2		1	1	2	5	2	3	4	2	4	1	1	1	1				20	3.4	.16
RASA(76)23 x Stripper	P1				1	2	2	3	2	1	1	3	1	1					10	3.5	.13
	F1				3	4	1	2	1	3	1	1	1	1	1				10	3.5	.196
	B2	1	2	3	4	4	2	2	5	3	1	1	1	1	1				20	3.4	.24
Acala SJI x Coker 310	P1				1	4	1	3	1	1	1	1	1	1					10	4.2	.28
	F1				1	1	4	1	3	2	2	2	1	1	1				10	3.4	.14
	B2	1	3	1	1	2	1	3	4	2	3	2	1	1	2	2	2	2	20	3.5	.28
RASA(76)25 x Acala SJI	P1				1	2	2	3	2	1	1	1	1	1					10	3.5	.13
	F1				1	1	2	2	3	2	2	2	1	1	1				10	4.2	.28
	B2				1	2	1	3	2	1	1	1	1	1	2	2	2	2	20	3.5	.24
Acala SJI x Acala SJI	P1				1	2	2	3	2	1	1	1	1	1					10	3.5	.27
	F1				1	1	2	2	3	2	2	2	1	1	1				10	4.3	.27
	B2				1	2	1	3	2	1	1	1	1	1	2	2	2	2	20	3.5	.26
																			20	3.5	.21

three crosses $P_3 \times P_7$, $P_4 \times P_1$ and $P_1 \times P_6$ and negatively skewed (towards the coarse parent in two crosses $P_7 \times P_2$ and $P_4 \times P_5$).

The backcross distributions appear to shift towards the recurrent parent in four out of the six crosses. The segregation of backcrosses as shown by the distributions of two crosses $P_3 \times P_7$ and $P_4 \times P_1$ does not show any influence of the recurrent parent. In all the crosses for all five traits studied the parents showed a range of values, though mainly within two and five close class values. This observed situation is mainly due to intra-plot (environmental) variation and the incidence of disease.

4.4. Gene number

The values for seedcotton yield indicate that a minimum of 1 to 5 genes control the inheritance of this trait in the six crosses using the three estimators. A comparatively high value of 15 was however obtained in one cross $P_1 \times P_6$, using the Mather and Jinks (1971) method. The array of all the estimates for this trait from all the crosses show that more than 65% of the values were below 3.

Values for lint yield seem to be lower ranging from 0.2 to 4.5 and with more than 75% of all the estimates for the six crosses falling below a minimum of 3 genes. The highest value obtained was 4.5 using the Mather and Jinks (1971) method as recorded in cross $P_1 \times P_6$.

Table 8: Estimates of Gene Number Controlling Inheritance of some Agronomic and Fiber Quality Traits in Cotton

Cross	Estimates	Characters				
		SCY	LY	L%	MFL	FF
Stripper x Samaru 72	a	1.6	2.0	0.5	3.3	0.3
	b	1.4	2.0	0.5	1.2	1.7
	c	2.0	1.1	1.0	1.0	0.2
RASA(76)23 x Stripper	a	2.4	0.2	0.4	1.7	-
	b	2.3	0.2	0.4	1.3	-
	c	2.5	0.4	1.0	-	-
Acala SJ1 x Coker 310	a	1.6	0.2	0.6	9.5	1.8
	b	1.5	0.1	0.6	6.0	1.8
	c	5.0	0.8	1.6	1.0	0.4
RASA(76)23 x Acala SJI	a	2.9	0.2	0.4	2.3	8.6
	b	2.8	1.7	0.3	2.0	4.7
	c	2.5	1.6	1.0	1.0	0.4
Acala SJI x Allen 333	a	2.1	0.4	2.7	1.0	0.4
	b	2.1	0.5	2.6	1.8	0.3
	c	5.0	0.8	1.8	1.0	0.3
Allen 333 x Deltapine	a	5.3	2.5	1.7	2.7	1.0
	b	5.1	2.4	1.6	2.2	0.04
	c	15.0	4.5	2.1	1.0	0.1

*a - Using Wright's formula

b - Using Wright's improved formula;

c - Using Mather and Jinks method.

The highest estimate for the minimum number of genes segregating for lint percent was found to be approximately 3 with a range of 0.3 to 2.7 and with more than 75% of all the estimates from all crosses using the three methods falling below 2.

Estimates for Mean fiber length using the three methods for estimation show less than 3 genes controlling the inheritance of this trait in nearly all crosses. In cross $P_4 \times P_5$, however, estimates of 6 and 9.5 were obtained using Wrights and Castle-Wright's formulae of estimation respectively. A range of 1.0 to 9.5 was recorded for the six crosses.

The same trend is exhibited for Fiber fineness. The highest estimate was about 9 using Wrights (1921) formula. Most of the estimates had values below 2. No estimate could be made for one cross $P_3 \times P_7$ because the parental means were the same for fiber fineness.

4.5 Gene action

The fit between observed and theoretical means was used to determine whether the data could be explained more logically on the assumption that the effects of the genes are arithmetically cumulative (additive effects) or on the assumption that they are geometrically cumulative (non-additive effects). These results are presented in Appendix Tables 1 and 2.

An examination of these Tables reveals that there is a very good agreement between the observed and theoretical means assuming both arithmetic and geometric means. The Chi-square values for the goodness of fit between the observed and theoretical means were all very low, actually less than 0.4 for all traits in almost all the crosses evaluated.

The probability values for seedcotton yield for F_2 , B_1 and B_2 generations range from 80% to 99% in five out of the six crosses studied - assuming both arithmetic and geometric relationship. In one cross, $P_1 \times P_6$ however, probability values of 30% to 50% (F_2 generation) and 50% to 70% (B_1 generation) were obtained. These observations seem to suggest that additive and non-additive gene effects are important in the inheritance of this character.

The data for the lint yield follows the same pattern as that of the seedcotton yield. Except for one cross $P_1 \times P_6$ where probability values of 50% to 70% were obtained in F_2 and B_1 generations, probability values were above 80% in all crosses assuming both arithmetic and geometric relationship. In two cases of F_2 in the crosses $P_3 \times P_7$ and $P_3 \times P_4$, perfect fits were obtained with p-value being 100%. The equal importance both arithmetic and geometric relationship is indicated by these results.

Probability values of over 80% were obtained in all crosses for lint percent assuming both arithmetic and geometric relationship. This also pinpoints equal influence of both gene effects in the inheritance of lint percent in the materials studied.

Estimates of χ^2 values for the fits between theoretical and observed means showed probability values of over 80% in all crosses for Fiber Length. Perfect fits were obtained in three instances, F_2 in the cross $P_2 \times P_7$ and B_2 in the crosses $P_4 \times P_1$ and $P_1 \times P_6$ assuming arithmetic gene action and also B_2 in the cross $P_4 \times P_1$ assuming geometric gene action. This observation shows the influence of additive effects in the inheritance of Fiber Length.

Five individual cases of perfect fits were obtained between observed and theoretical means for fiber fineness, four assuming geometric gene action and one assuming arithmetic gene action. All the crosses show good fits in all cases with χ^2 probability values in excess of 80%. The data here indicate that additive gene action is important in the inheritance of this trait.

4.6 Heritability

Estimates of heritability expressed as a percentage for seedcotton yield, lint yield, lint percent, mean fiber length and fiber fineness obtained from the F_2 variance method (Broad sense) were generally larger

than those obtained from the F_2 and reciprocal backcross variance method (narrow sense), (Table 9).

Seedcotton yield exhibited the highest estimates of broad sense heritability considering the six crosses studied with the highest value (96.9%) obtained in cross $P_1 \times P_6$. The estimates in crosses $P_4 \times P_5$ (93.3%) and $P_4 \times P_1$ (90.6%) were about the same and higher than those in crosses $P_7 \times P_2$ (70.7%) and $P_3 \times P_7$ (71.8%). The lowest broad sense heritability estimate (64.2%) was obtained in cross $P_3 \times P_4$. The highest narrow sense heritability estimates for seedcotton yield (86.4%) was obtained in cross $P_3 \times P_7$. Incidentally the 76.3% obtained in this cross was unexpectedly higher than the corresponding broad sense estimate. This unexpected result might be due to environmental effects or scaling of variance of F_2 and those of backcrosses, B_1 and B_2 . The average narrow sense estimates in crosses $P_7 \times P_2$ (52.3%) and $P_1 \times P_6$ (55.9%) were about the same and higher than the low estimates in crosses $P_3 \times P_4$ (20.1%) and $P_4 \times P_1$ (12.2%). These results indicate that a sizeable proportion of the total variability present in these materials is due to additive gene effects.

The disparity between narrow sense and broad sense heritability for lint yield are generally lower than those for seedcotton yield.

Table 9: Heritability (%) Estimates for some
Agronomic and Fiber Traits in Upland Cotton

Cross	Heritability Type*	Characters				
		SCY	LY	L%	MFL	FF
Stripper x Samaru 72	BSH	70.7	60.4	56.2	82.0	66.2
	NSH	52.3	21.2	24.0	59.3	41.3
RASA(76)23 x Stripper	BSH	71.8	64.7	67.4	57.6	57.7
	NSH	76.3	51.2	39.4	43.8	26.7
Acala SJ1 x Coker 310	BSH	93.3	93.5	86.1	59.8	51.3
	NSH	86.4	88.7	67.0	42.8	25.0
RASA(76)23 x Acala SJ1	BSH	64.2	82.7	77.9	58.5	50.1
	NSH	20.1	84.6	57.9	46.3	48.6
Acala SJ1 x Allen 333	BSH	90.6	82.8	72.5	62.4	77.1
	NSH	12.2	50.0	67.6	32.1	68.9
Allen 333 x Deltapine	BSH	69.9	94.1	90.0	72.2	79.9
	NSH	55.9	44.9	32.9	57.6	63.4

*BSH - Broad Sense Heritability
NSH - Narrow Sense Heritability

The highest broadsense estimates were recorded in crosses $P_1 \times P_6$ (94.1%) and $P_4 \times P_5$ (93.5%) with results in crosses $P_3 \times P_4$ (82.7%) and $P_4 \times P_1$ (82.8%) being similar. Crosses $P_7 \times P_2$ (60.4%) and $P_3 \times P_7$ (64.7%) had the lowest broad sense estimates. The lowest narrow sense heritability estimates (21.2%) was recorded in cross $P_7 \times P_2$ and the highest estimate (88.7%) in cross $P_4 \times P_5$. The 64.6% obtained in cross $P_3 \times P_4$ was again higher than the corresponding broad sense estimate and is again ascribable to sampling error in measuring variance of F_2 and backcrosses B_1 and B_2 . The remaining narrow sense estimates range from 44.9% - 51.2%. These findings indicate that additive gene effects are more important in the inheritance of this trait than non-additive gene effects.

The broadsense heritability estimates for lint percent and mean fiber length were still quite high but were generally lower than those for lint yield. The values obtained ranged from 56% to 90% for lint percent and 58% to 82% for mean fiber length. The highest narrow sense heritabilities for lint percent were exhibited in crosses $P_4 \times P_5$ (67.0%) and $P_4 \times P_1$ (67.6%) and the lowest estimates were obtained in crosses $P_7 \times P_2$ (24.0%), $P_1 \times P_6$ (32.9%) and $P_3 \times P_7$ (39.4%). Cross $P_3 \times P_4$ had an intermediate value of 57.9%. For mean fiber length the highest narrow sense estimates were recorded in crosses $P_7 \times P_2$ (59.3%) and $P_1 \times P_6$ (57.6%) while the lowest estimate was recorded in cross $P_4 \times P_1$ (32.1%).

The remaining three crosses had the values 42%, 43% and 46%. Averaged over all crosses the disparity between the broad sense and narrow sense heritability estimates were higher for lint percent than mean fiber length. The observations from these two traits pinpoints the possible suggestion that the magnitudes of additive gene effects, though lower than those for seedcotton yield and lint yield are reduced. Infact the values for lint percent indicate almost an equal importance of non-additive and additive effects. The additive effects were more important than non-additive effects for mean fiber length.

Of all the traits studied, fiber fineness seems to have the lowest heritability estimates. The value for the broad sense estimates ranged from 50.1% to 79.9%. Narrow sense estimates were lowest in the crosses $P_4 \times P_5$ (25.0%) and $P_3 \times P_7$ (26.7%) while the highest estimates were recorded in the cross $P_1 \times P_6$ (63.4%) and $P_4 \times P_1$ (68.9%). The preponderance of additive effects is again shown by these results although the presence of non-additive effects is reaffirmed.

CHAPTER 5DISCUSSION

The phenotype is the total sum of assemblage of genes and of the interaction of those genes with the environment. The characters in this study are controlled by several genes. The genetic component of an individual quantitative trait may be made up of additive and non-additive (dominance and epistatic) effects. The additive effect for a given trait is the sum of the average effects of the genes conditioning that trait, the sum being made of the allelic pair at each locus and over all loci (Falconer 1960). The non-additive effects result from interaction between alleles at the same locus (dominance) or interaction between alleles at different loci (epistasis). The results presented in this study were obtained from an experiment designed to provide some insight into the nature of gene action associated with several quantitative traits in upland cotton.

5.1 Heterosis and Inbreeding depression

Heterosis and inbreeding depression often occur in the cultivated tetraploid cottons Gossypium hirsutum and Gossypium barbadense. However such phenomena are less pronounced and less consistent in these cottons than in certain other species such as corn and tomatoes. Previous studies of Kearney (1923), Jones and Loden (1951), Turner (1953), Kime and Tilley (1947) as cited by Young and Murray (1966) showed that heterotic effects in cotton

are inconsistent. In this study the manifestation of heterosis was generally low for all the traits studied. The magnitudes of heterotic effects obtained for seed-cotton and lint yields were similar to those obtained by Al-Rawi and Kohel (1969) but were in contrast to the results of Jones and Loden (1951), Miller and Marani (1963), White and Richmond (1963), Meredith et al (1970) and Meredith and Bridge (1972). For lint percent the results of Miller and Marani (1963), Al-Rawi and Kohel (1969) and Meredith et al (1970) were also similar to the present study. The magnitudes of the heterotic effects obtained in this study for fiber length were in general agreement with those of White and Richmond (1963) Miller and Marani (1963), Young and Murray (1966) Al-Rawi and Kohel (1970) and Meredith and Bridge (1972). Fiber fineness exhibited the highest amount of heterosis in the materials used in this study and the values and pattern of heterotic effects obtained were similar to the results of Young and Murray (1966), Meredith et al (1970), Al-Rawi and Kohel (1970) Meredith and Bridge (1972).

Two possible reasons have been advanced by Young and Murray (1966) for the somewhat lesser expression of heterosis and inbreeding depression in tetraploid cottons as compared to diploid cross pollinated crops such as corn and tomato. First the tetraploid cottons may have been sufficiently self-pollinated before domestication to develop genomes typical for self-pollinated plants. Plants which are predominantly

self-pollinated normally do not express the striking inbreeding depression and heterosis typical of the cross pollinated plants. Dohzhansky (1946) has hypothesized that self-pollinated plants are expected to show little heterosis because the deleterious recessive and unfavourable recombinations are quickly eliminated from the population. Similarly, Mather (1943) has suggested that inbreeding organisms achieve an internal, chromosome balance and as a result are not upset by inbreeding.

The second possible explanation involves the polyploid condition of these cottons. Since the diploid parents each carry many genes with identical functions, new amphidiploids would be expected to carry duplicate genes at many loci. Since duplication has been found for several genes with qualitative effects in the tetraploid cottons, Murray (1965) Rhyne (1957), duplication of many favourable dominant polygenes would also likely be present. If we accept the theory for heterosis proposed by Jones (1917), inbreeding effects would be expected to be less pronounced in the tetraploids, because segregants lacking a dominant favourable allele at a particular duplicated locus would be less frequent than in the diploids. Hertzsch (1959) as cited by Young and Murray (1966) has demonstrated that new polyploids are less sensitive to inbreeding than their diploid parents.

I would like to subscribe to both explanations.

Thus the smallness and inconsistencies of the heterotic

effects found in the six Gossypium hirsutum L. crosses, here, could be partially attributed to genetic duplication and partially to the possible fact that the genomes of the diploid species carry genomes somewhat characteristic of self-pollinated species. Consequently hybrids here will not have the potential that they could have had in such species as corn.

5.2 Frequency distributions

Smoothness, apparent normality or unimodality of F_2 distribution can be used as evidence of polygenic inheritance provided that the major portion of the variance in F_2 is genetic.

For seedcotton yield, the unimodality exhibited in the F_2 distribution in five out of the six crosses evaluated is evidence that this trait is polygenically inherited. The skewness shown in the F_2 is probably due to the complementary effects of genes. This assertion is however not reinforced by the backcross distributions which still showed the influence of the gene dosage supplied by the recurrent parent.

The F_2 distribution for lint yield also suggests polygenic inheritance as evidenced by unimodality in four crosses out of six. This assertion is further reinforced by the presence of transgressive segregates in two crosses.

For lint percent the distribution of the F_2 was unimodal in five crosses out of six. This indicates polygenic inheritance for this trait. The presence of skewness in three crosses for this character suggests the possible influence of complementary factors.

Polygenic inheritance is also indicated for mean fiber length as is indicated by unimodal distribution of F_2 in all the crosses evaluated. The skewness shown by the F_2 distribution is again suggestive of the effect of complementary factors in the inheritance of this trait. This suggestion is strengthened by the behaviour of the backcross generations where in five out of the six crosses evaluated the effect of the gene dosage supplied by the recurrent parent is not exhibited in the segregation pattern of the backcross generation.

The presence of transgressive segregates and unimodality shown in the F_2 distribution for fiber fineness in three crosses infers the operation of polygenic inheritance for this trait. The presence of skewness in five crosses in the distribution of F_2 also indicates the operation of some complementary factors in the inheritance of this trait. This assertion is reinforced by the segregation pattern of the backcross generations in two crosses where the influence of the recurrent parent is apparently negligible.

Similar observations (unimodality of F_2 distributions) were made by Ware, et al (1943), Burton (1951), Bilbro (1961) and Ware and Harrell (1963) who also made similar conclusions of polygenic inheritance for these traits.

5.3 Gene number

The distribution of the F_2 segregants indicate that the traits evaluated behave as quantitative ones and since no conventional ratios are expected in such traits, it is not possible to make an exact determination of the number of genes by which the parents differed. Some commonly used statistical estimators were used to estimate the minimum number of genes segregating for the traits studied. Estimates were computed using Wright's (1921), Castle and Wright's (1921) and Mather and Jinks (1971), formulae on the assumptions inherent in the equations. An under-estimation of the estimated gene number results if there is failure of any of the underlying assumptions using any of these three methods.

In this study, except for two traits, Mean Fiber Length and Fiber fineness, in Crosses $P_3 \times P_7$ and $P_3 \times P_4$, respectively, the estimates obtained for the minimum number of genes conditioning all the traits studied did not exceed a value of 3. Although not much literature is available to me in this regard on cotton, this estimate seems to be a gross under-estimate of the true situation. This is in consideration of the inconsistencies observed in segregation patterns in the crosses

for the traits. Panse (1957) working with Gossypium arboreum species obtained estimates of 4 or less as the minimum number of effective factors segregating for fiber length and also indicated that this value was very small. He explained his low values as being due to the fact that all the methods used in these estimations calculate only closely linked groups of genes rather than individual genes. Such groups will obviously segregate in blocks except for occasional crossovers.

I would like to suggest the need to carry out much further, theoretical and experimental investigations for determining the actual number of genes responsible for quantitative characters by taking into account the phenomena of linkage, the difference in the magnitude of individual genes and the extent of their mutual interaction.

5.4 Gene action

The reliability of information obtained from the fit method, that is, comparing the averages of different generations with a predicted average calculated from parental and F_1 means depends on the efficiency of the method as applied to the available data. Also since the formulae for obtaining theoretical means take dominance and heterosis into account, this assumption has to be satisfied to obtain a reliable test (Powers and Lyon, 1941). The efficiency of the method can be ascertained by testing the statistical significance of

the difference between the comparable means among generations. The method is efficient when the contrasted formulae are discriminatory (Powers and Lyon, 1941).

In the present study, in no case was there a statistically significant difference between the obtained mean and the corresponding theoretical mean and even between the two theoretical means for all the traits in the crosses evaluated. It is thus apparent as regards this study that this method is not sufficiently sensitive to be of any particular value as a means of studying gene action. The agreement between the observed and theoretical means was very good in all the crosses for the traits studied assuming both arithmetic (additive) and geometric (non additive) gene action. This should apparently indicate equal importance of both additive and non-additive gene effects controlling the inheritance of the traits studied. I would however hold the results of this study inconclusive and advise that any information obtained from the application of the method as in this study be used with caution. Powers and Lyon (1941) obtained similar results and held their results about gene action inconclusive.

5.5. Heritability

Heritability refers to the ratio of the genotypic variation to total phenotypic variation. Estimates of heritability are of primary importance to the plant breeder because this parameter determines progress

from selection. Two types of estimates are recognized, broad and narrow-sense. Broad-sense heritability is the ratio of the total genetic variance to the phenotypic variance while narrow-sense heritability is the ratio of the additive genetic variance to the phenotypic variance.

Broad-sense heritabilities were estimated using the F_2 variance method described by Mahmud and Kramer (1951), Weber and Moorthy, (1952) while the narrow-sense heritabilities were estimated by the F_2 and reciprocal backcross variance method described by Warner (1952).

The results presented here-in indicate that there are differences in heritability obtained among crosses for all the traits studied. These differences can be explained by varying gene content among parents involved in the crosses with respect to these traits. However, as was stated by Liang and Walter (1968, it is not totally unexpected since the performance of a parent's progeny would vary depending on the other parent variety in combination. The broad and narrow sense estimates obtained in this study agree with those obtained by Al-Rawi and Kohel (1969) and Niu (1981) for seedcotton and lint yield. The narrow sense estimates obtained by Tabrah (1970) and Al-Rawi and Kohel (1970) for fiber length and fineness were however similar to those obtained in this study. The narrow sense estimate of

Tabrah (1970) for lint percent was as high as those obtained in the present study but the estimates obtained by Simongulian and Tabani (1980) for this trait were much lower.

CHAPTER 6SUMMARY AND CONCLUSIONS

Studies were carried out at the Institute for Agricultural Research (I.A.R), Samaru in the 1982 growing season to investigate the mode of gene action governing the inheritance of five agronomic and fiber characters in Upland Cotton. Six F_1 hybrids, their corresponding F_2 's and first generation backcrosses (to both parents) involving seven varieties were evaluated.

The magnitudes of heterotic effects were relatively low for all traits studied except in one or two crosses of a particular trait where higher values were obtained. Considering all the crosses evaluated, heterotic effects ranged from 0.21% to 10% for positive heterosis and -0.03% to -7.9% for negative heterosis. The manifestation of heterosis however small the effect is, is an indication of the presence of dominance gene effects. The negative values obtained in these crosses for these traits indicate dominance of the lower parent.

The segregation pattern of the 24 populations presented as frequency distributions indicated unimodality in the F_2 distribution in most of the crosses for the five characters studied. This is an indication of polygenic inheritance for these traits. There is also an apparent indication of the presence of complementary effects of genes as shown by skewness of some of the F_2 distributions.

The estimates for the minimum number of genes segregating for the traits in this study indicate that except for two traits, Mean fiber length (9.5) and Fiber fineness (8.6) in crosses $P_4 \times P_5$ and $P_3 \times P_4$ respectively, the values did not exceed 3. This estimate seems to be a gross underestimate of the true situation. This is in consideration of the inconsistencies observed in segregation patterns in the crosses for these traits and previous data from literature.

The fit method of comparing the averages of different generations with a predicted average calculated from parental and F_1 means as a means of determining gene action in the inheritance of the five characters evaluated in this study was found to be inefficient. This was based on tests of differences between calculated means assuming arithmetic and geometric relationships, using t-tests. The results of this study with respect to gene action are thus inconclusive with the application of this method. However from visual observation of F_2 Distribution and Heterosis pattern, a general trend of gene action controlling the five traits is discernable. Additive gene effects appear to be relatively more important than non additive effects in the inheritance of seedcotton yield, lint yield, lint percent and mean fiber length, Non-additive (Dominance) gene effects however seem to be more important than additive effects in the inheritance

of fiber fineness. There is also an indication of overdominance (at the coarse level) for this character in three out of the six crosses evaluated.

Broadsense heritability estimates were quite high for all traits studied with values ranging from 50.1% to 96.9%. The narrow sense estimates were however generally lower but were still quite high for most of the characters studied. The values ranged from 12.2% to 88.7%. The high narrow sense heritability estimates point to the fact that additive gene effects were more important than non-additive effects in the inheritance of these traits.

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Appendix Table 1: Comparison of observed and calculated means assuming arithmetic (Additive) gene action

Cross	Trait	F ₂ Population				B ₁ Population				B ₂ Population			
		Observed	Calculated	X ²	P Values	Observed	Calculated	X ²	P Values	Observed	Calculated	X ²	F Values
Stripper x Samaru 72	SCY	48.3	48.9	.007	90-95	48.4	50.0	.051	80-90	46.3	48.0	0.60	80-90
RASA(76)23 x Stripper		53.4	52.7	.009	90-95	54.2	54.0	.001	95-98	52.6	51.5	.23	80-90
Acala SJ1 x Coker 310		65.7	66.4	.007	90-95	63.3	63.9	.006	90-95	67.2	68.9	.042	80-90
RASA(76)23 x Acala SJ1	LY	57.6	57.7	.000	98-99	56.2	56.5	.002	95-98	58.5	59.0	.004	90-95
Acala SJ1 x Allen 333		66.0	65.9	.000	98-99	62.9	63.4	.004	90-95	68.1	68.4	.001	95-98
Allen 333 x Deltapine		47.4	53.2	.063	30-50	64.6	60.7	.25	50-70	46.5	45.7	.014	90-95
Stripper x Samaru 72	L%	17.7	18.3	.020	80-90	18.2	18.9	.026	80-90	16.9	17.8	.046	80-90
RASA(76)23 x Stripper		19.7	19.7	.000	100	19.8	19.9	.001	98-99	19.7	19.5	.003	95-98
Acala SJ1 x Coker 310		24.3	24.5	.002	95-98	23.8	24.1	.004	90-95	24.4	24.9	.010	90-95
RASA(76)23 x Acala SJ1	MFL	21.8	21.8	.000	100	20.8	21.0	.002	95-98	21.9	22.6	.022	80-90
Acala SJ1 x Allen 333		24.2	21.0	.002	95-98	23.4	23.6	.002	95-98	24.6	24.4	.002	95-98
Allen 333 x Deltapine		17.4	19.6	.247	50-70	23.6	21.8	.149	50-70	17.6	17.3	.005	90-95
Stripper x Samaru 72	L%	36.8	37.4	.010	90-95	37.5	37.9	.004	90-95	36.6	37.0	.004	90-95
RASA(76)23 x Stripper		36.9	37.4	.007	90-95	36.5	36.9	.004	90-95	37.6	37.6	.002	95-98
Acala SJ1 x Coker 310		37.1	37.0	.000	95-98	37.6	37.8	.001	95-98	36.4	36.2	.001	95-98
RASA(76)23 x Acala SJ1	MFL	37.8	37.7	.003	95-98	37.1	37.2	.000	98-99	37.4	38.2	.017	80-90
Acala SJ1 x Allen 333		36.7	35.4	.002	95-98	37.2	37.3	.000	98-99	36.1	35.6	.007	90-95
Allen 333 x Deltapine		36.7	36.9	.001	95-98	36.6	35.8	.018	80-90	37.8	37.9	.000	98-99
Stripper x Samaru 72	MFL	24.7	24.3	.005	90-95	23.6	23.8	.002	95-98	23.9	24.8	.033	80-90
RASA(76)23 x Stripper		23.7	23.8	.000	99-100	23.8	23.5	.003	95-98	23.8	24.2	.005	90-95
Acala SJ1 x Coker 310		26.0	25.2	.020	80-90	24.9	24.4	.009	90-95	25.0	26.1	.042	80-90
RASA(76)23 x Acala SJ1	MFL	23.7	23.9	.002	95-98	24.0	23.5	.009	90-95	24.1	24.3	.003	95-98
Acala SJ1 x Allen 333		25.0	25.1	.001	95-98	25.4	24.7	.018	80-90	25.5	25.5	.000	100
Allen 333 x Deltapine		24.5	24.4	.0005	98-99	24.4	25.0	.016	80-90	23.9	23.8	.000	100

Appendix Table 1: Comparison of observed and calculated means assuming Arithmetic (Additive) gene action. (Cont'd)

Cross	F ₂ Population			B ₁ Population			B ₂ Population		
	Trait	Observed	Calculated	X ²	P Values	Observed	Calculated	X ²	P Values
Stripper x Samaru 72		3.5	3.5	.003	95-98	3.4	3.5	.003	95-98
RASA(76)23 x Stripper		3.5	3.6	.003	95-98	3.4	3.6	.011	90-95
Acala SJ1 x Coker 310	FP	3.8	3.9	.003	95-98	3.9	4.1	.010	90-95
RASA(76)23 x Acala SJ1		3.6	4.1	.061	80-90	3.5	3.9	.041	80-90
Acala SJ1 x Allen 333		3.8	3.9	.003	95-98	3.8	4.0	.010	90-95
Allen 333 x Deltapine		3.8	3.8	.000	100	3.8	3.9	.003	95-98

Appendix Table 2: Comparison of observed and calculated means assuming Geometric (Non-additive) gene action

Cross	Trait	F ₂ Population			B ₁ Population			B ₂ Population				
		Observed	Calculated	P Value	Observed	Calculated	P Value	Observed	Calculated	P Value		
Stripper x Samarū 72 RASA(76)23 x Stripper Acala Sjt1 x Coker 310	SCY	48.3	48.9	0.007	90-95	48.4	50.0	0.51	80-90	46.3	47.9	0.053
		53.4	52.7	0.009	90-95	54.2	53.9	0.002	95-98	52.6	51.4	0.028
		65.7	66.3	0.005	90-95	63.3	63.8	0.004	90-95	67.2	68.8	0.037
RASA(76)23 x Acala Sjt1 Acala Sjt1 x Allen 333 Allen 333 x Deltapine	LY	57.6	57.7	0.0002	98-99	56.2	56.4	0.0007	95-98	58.5	58.9	0.003
		66.0	65.8	0.0006	98-99	62.9	63.3	0.003	95-98	58.1	68.3	0.006
		47.4	52.2	0.444	50-70	64.6	59.9	0.369	50-70	46.5	45.4	0.27
Stripper x Samarū 72 RASA(76)23 x Stripper Acala Sjt1 x Coker 310	LY	17.7	18.3	0.02	80-90	18.2	18.9	0.26	80-90	16.9	17.7	0.036
		19.7	19.6	0.0005	98-99	19.8	19.9	0.0004	98-99	19.7	19.5	0.002
		24.3	24.5	0.002	95-98	23.8	24.1	0.004	95-98	24.4	24.9	0.010
RASA(76)23 x Acala Sjt1 Acala Sjt1 x Allen 333 Allen 333 x Deltapine	LY	21.8	21.8	0.000	100	20.8	21.0	0.002	95-98	21.9	22.5	0.016
		24.2	24.0	0.002	95-98	23.4	23.4	0.002	95-98	24.6	24.3	0.004
		17.4	19.3	0.187	50-70	23.6	21.6	0.185	50-70	17.6	17.2	0.009
Stripper x Samarū 72 RASA(76)23 x Stripper Acala Sjt1 x Coker 310	LY	36.8	37.4	0.096	70-80	37.5	37.8	0.002	95-98	36.6	36.9	0.002
		36.9	37.3	0.004	90-95	36.5	36.9	0.004	95-98	37.6	37.8	0.001
		37.1	36.9	0.001	95-98	37.6	37.8	0.001	95-98	36.4	36.1	0.002
RASA(76)23 x Acala Sjt1 Acala Sjt1 x Allen 333 Allen 333 x Deltapine	LY	37.8	37.8	0.0003	98-99	37.1	37.2	0.003	98-99	37.4	38.2	0.017
		36.7	36.4	0.002	95-98	37.2	37.2	0.000	100	36.1	35.6	0.007
		36.7	36.8	0.0003	98-99	36.6	35.8	0.018	80-90	37.8	37.9	0.0003
Stripper x Samarū 72 RASA(76)23 x Stripper Acala Sjt1 x Coker 310	MFL	24.7	24.3	0.06	90-95	23.6	23.81	0.003	95-98	24.0	24.8	0.030
		23.7	23.8	0.0003	98-99	23.8	23.5	0.004	90-95	23.8	24.2	0.005
		25.9	25.2	0.02	80-99	24.9	24.4	0.009	90-95	25.0	26.0	0.039
RASA(76)23 x Acala Sjt1 Acala Sjt1 x Allen 333 Allen 333 x Deltapine	MFL	23.70	23.9	0.002	95-98	24.0	23.5	0.009	90-95	24.1	24.3	0.003
		25.0	25.1	0.008	95-98	25.4	24.7	0.018	80-90	25.5	25.5	0.009
		24.5	24.4	0.0007	95-98	21.4	25.0	0.016	80-90	23.9	23.8	0.003
Stripper x Samarū 72 RASA(76)23 x Stripper Acala Sjt1 x Coker 310	FP	3.5	3.5	0.000	100	3.4	3.5	0.003	95-98	3.6	3.7	0.003
		3.5	3.5	0.000	100	3.4	3.5	0.003	95-98	3.5	3.7	0.000
		3.8	3.90	0.003	95.98	3.9	4.1	0.010	90-95	3.5	3.6	0.003
RASA(76)23 x Acala Sjt1 Acala Sjt1 x Allen 333 Allen 333 x Deltapine	FP	3.6	4.1	0.060	80-90	3.5	3.9	0.04	80-90	3.8	4.2	0.038
		3.8	3.9	0.003	95-98	3.8	4.0	0.01	90-95	3.7	3.9	0.000
		3.8	3.8	0.000	100	3.8	3.8	0.00	100	3.6	3.9	0.010

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