VARIABILITY AND INTERRELATIONSHIP OF AGRONOMIC AND FIBRE QUALITY TRAITS IN MULTI-ADVERSITY COTTON *(Cossypium hirsutum*L.)

By

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A thesis submitted to the Postgraduate School, Ahmadu Bello University in partial fulfillment of the requirements for the award of the degree of Master of Science (M.Sc.) in Crop Breeding.

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DECLARATION

I hereby declare that this thesis was written by me and is a record of my research work. It has not been presented in any previous thesis for a higher degree. References made to published and unpublished literature have been duly acknowledged.

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CERTIFICATION

This thesis entitled "VARIABILITY AND INTERRELATIONSHIP OF AGRONOMIC AND FIBRE QUALITY TRAITS IN MULTI-ADVERSITY COTTON (*Gossypium hirsutum* L.)" by DJABOUTOU Cossi Moussibaou meets the regulations governing the award of the degree Master of Science (M.Sc.) of Ahmadu Bello University Zaria, Nigeria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

To the memory of my late father

Tankaya Emmanuel Djaboutou

who wanted me to be an educated man.

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ABSTRACT

Twenty-five cotton lines comprising 9 multi-adversity resistant lines from USA and 16 F5 lines derived from crosses between the variety S295 and the multi-adversity lines were evaluated using a 5 x 5 lattice design with 3 replications.

The analysis of variance for the nineteen characters measured revealed highly significant (P = 0.01) differences among the entries for days to boll opening, plant height, boll weight, lint percent, seed index, seed cotton yield, fibre length and fibre fineness while significant (P = 0.05) differences were observed among the entries for days to the emergence of the first flower and first five flowers in the plot, days to first flower on the second plant, number of nodes to first fruiting branch, indicating the presence of a wide range of variability in the lines evaluated. The coefficient of variation ranged from 2.6 - 51.8% for days to opening of the bolls and number of opened bolls on the second plant, respectively. The line (S295 x TX-CDP 37-HH-1-83) 119(95) gave the highest yield of 938 kg/ha while the lines (S295 x TX-CDP 37 HH-1-83) 1175(95) and (S295 x TAMCOT SP 21S) 239(95) gave the best lint percent 43.3 and 43.00% respectively.

The estimates of genotypic variance were positive for all characters measured except for number of opened bolls on the second plant in the plot.

Broad-sense heritability estimates ranged from 1.75 - 90.74% for fibre strength and lint percent, respectively.

Positive but non-significant correlations were found between seed cotton yield and plant height (rph = 0.299), height to first fruiting branch (rph = 0.288), number of fruiting branches (rph = 0.160), number of opened bolls per plot (rph = 0.343), lint percent (rph = 0.385), and lint index (rph - 0.374).

The presence of wide range of variability in the materials studied could be exploited to improve some lines of interest. These lines could be used to make crosses which will eventually be used as a base for segregating breeding populations, from which single plant selections could be made into progenies, strains, lines and eventually varieties.

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CHAPTER 1

INTRODUCTION

Cotton belongs to the genus *Gossypium*, a member of the Malvaceae family. The important botanical species included in the genus, *Gossypium,* are: *G. barbadense* having extra-long staple fibres, exceeding 1⅛ inch (28.6mm), *G. hirsutum* L. with medium to long staple fibres ranging from ⅞ inch to 1⅛ inch (21.8mm - 28.6mm), *G. arboreum* and *G. herbaceum* which possess short staple fibres below ⅜ inch (9.4mm).

About 50 per cent of the world's cotton is grown in temperate zones above 30°N, but cotton prefers climate with higher temperature throughout the year. Today, the crop is grown in over 60 countries on a total of almost 32.4 million ha, which represents approximately 2.5 per cent of all cultivated land. In Nigeria, the commercial varieties of cotton released belong to *Gossypium hirsutum* and are cultivated in the Savanna regions. There are three main production zones: the northern zone producing 60 to 65 per cent of the national crop, the eastern zone producing 30 to 35 per cent of the crop and the southern zone which produces less than 5 per cent of the crop.

Of the four major fibres that provide man with clothing - cotton, silk, wool, and flax - cotton, by reason of its cheapness and its many excellent traits, is rapidly superseding its several rivals. The cotton plant yields, in fact, a double crop - a most beautiful fibre and a seed yielding both oil and feed which, although neglected for a long time, is now estimated to worth one-sixth as much as the fibre. In addition to this, the stems can be made to yield pulp that can be used for paper making, and the roots yield drugs. It is

entirely possible, therefore, that cotton may ultimately be grown as much for these parts as for the lint.

The multi-adversity resistance (MAR) system for genetic improvement of cotton has the major objective of developing cotton cultivars possessing the gene combinations giving resistance to all pathogens, nematodes, insects and stresses and capable of producing a high volume and quality of the desired products. The MAR system makes it easier to produce cultivars with stable resistance to two or more adversities than to develop those with resistance to only one adversity.

The ultimate aim of every breeder in any cotton improvement programme is to increase seed cotton yield and improve the fibre technological qualities. To achieve this aim, the breeder must exploit the variability of quantitative characters existing within a collection of genotypes. But the expression of quantitative characters is greatly influenced by environmental fluctuations, and the phenotypic variability among a collection of genetic stocks does not give a true indication of the potential genotype variability. Therefore it is necessary to determine the exact magnitude and nature of heritable and non-heritable components of variation for quantitative characters. This will enable the breeder to know which characters would respond to selection and how much improvement can be expected by basing selection on particular character and thus help him to plan his breeding programme accordingly.

Therefore the objectives of the present investigation are:

(i) to assess the genetic variability of some agronomic and fibre quality traits among the multi-adversity resistant cotton lines.

(ii) to investigate the nature of interrelationships between these traits.

CHAPTER 2

LITERATURE REVIEW

2.1 Variability

Jerry and Laval (1975) in their study on several agronomic and fibre properties among selected lines of upland cotton, calculated the heterosis among parents for each trait as a ratio of the highest parent (HP) to the lowest (LP). This measure of variability ranged from 1.08 for uniformity ratio to 1.91 for earliness. Miller and Marani (1963) in a diallel study of eight lines observed that the F_1's were significantly earlier than the average of the corresponding parents at the 0.01 level of probability. They reported that a major portion of the genetic variance in the base population was additive in nature. Turner *et al.* (1973) in their study on genetic and environmental variability on yield and quality of cotton (*Gossypium hirsutum* L.) concluded that genotypic differences accounted for most of the variability in fibre length and strength whilst variability in fineness and maturity was mainly affected by environment. Bhardwaj and Simlote (1968) evaluated the genotypic and phenotypic variabilities in yield and other quantitative characters in American cotton varieties and found that number of fruiting branches, yield per plant, number of bolls gave the highest estimates for genetic coefficient of variation. Karami (1972) conducted an analysis of morphological and physiological characters of nine biotypes of American upland cotton and concluded from his results that number of sympodial branches was a varietal effect which showed continuous variation. Singh *et al.* (1969) concluded from the study of genotypic and phenotypic variability for

lint yield and other quantitative characters in cotton, that a wide range of phenotypic variability was observed for number of bolls. Lint yield gave the highest estimate of genetic coefficient of variation followed by number of bolls, seed yield and average weight of boll.

In a variety x environment interaction study in the Mississippi region (USA), it was reported that substantial variety x location x year interactions was estimated for boll weight in cotton indicating that the varieties showed different responses to varying environments (Bridge *et al.* (1971). Bhatt *et al.* (1967) studied genetic variability in upland cotton (*Gossypium hirsutum* L.), analysis of yield and its components and observed significant differences between varieties for all characters except for boll weight and seed yield.

Turner (1953) reported specific combining ability (SCA) to be more important than general combining ability (GCA) for seed cotton yield. Of six quantitative characters measured in ten varieties. Naidu *et al.* (1974) estimated high genotypic and phenotypic variances for seed cotton yield. Pathak and Singh (1970) indicated that dominance variance and dominant gene effects were much higher than additive variance and additive gene effects for seed cotton yield. Bhardwaj and Simlote (1968) studied the genotypic and phenotypic variabilities in a varietal collection of American cotton varieties and found that yield per plant showed a wide range of variability. The genetic coefficient of variability was also high for yield per plant. In a genetic study of ginning and fibre characters in upland cotton, Gupta and Singh (1970) found both the additive and dominance variances to be highly significant for seed index. In the study of genetic analysis of yield components and fibre

quality characters in glandless cotton (*Gossypium hirsutum* L.) Zhu (1994) pointed out that increasing the lint index and decreasing the seed index were advantageous for increasing lint percentage and boll number/plant but detrimental to boll weight. It appeared that, when the seed index was stabilized by positive selection in early generations, and positive selection was carried out for lint index in advanced generations in a large breeding population not only might lint percent, boll weight and boll number/plant be increased simultaneously, but also fibre quality traits might be improved. Gupta and Singh (1970) found both the additive and dominance variances to be highly significant for lint index. Simpson (1948), reported high and significant indices in crosses than in the inbreds in all varieties of cotton tested. Kime and Tilley (1947) in crosses of four inbred lines, selected from three varieties of cotton, observed that the F_1 generation of three of the crosses had significant high lint indices than their highest percent. In the study of genetic variability of yield and its components over environments in deshi cotton (*Gossypium arboretum* L.), Tomar *et al.* (1992) observed moderate to high estimates of genetic variation and genetic advance for lint index. William and Norman (1976) studied yield, boll and fibre characteristics in low, intermediate, and high lint percent groups of Acala strains of upland cotton (*Gossypium hirsutum* L.) and found that the three groups did not differ significantly in yield of seed cotton or seed, but the high lint percent group produced significantly more lint yield, lint/plant, lint/boll, lint/seed (lint index), and fibre elongation than did the low lint percent group. The high lint percent group produced significantly less seed/boll, seed cotton/boll, and five-

lock bolls and smaller seed (seed index) than the low lint percent group. Meredith and Bridge (1973) reported significant increases in both lint percent and yield as a result of three cycles of selection for lint percent. William *et al.* (1973) in a study of recurrent selection for lint percent within a cultivar of cotton (*Gossypium hirsutum* L.) pointed out that the genetic variability for lint percent within the S_1 and S_2 populations was found to be 188 and 83%, respectively, as compared to that of the S_0 population.

Turner *et al.* (1973) reported that in analysis of data obtained from four cultivars over six years, genotypic differences accounted for most of the variability in fibre length. Innes (1974), found in data obtained from a half diallel analysis of five inbred varieties that most of the genetic variance for effective length was additive with a low degree of dominance. Kalsy and Garg (1978) reported that halo length which is comparatively less influenced by environmental fluctuations showed C.V. values of 4.10 and 9.80 per cent. Gupta and Singh (1970) found both the additive and dominance variances to be highly significant for fibre length. Simlote and Bhardwaj (1966) observed the range of variation for mean halo length in 441 plants of variety 320 F (*Gossypium hirsutum* L.) and observed a range between 22.7 and 28.0mm.

Munasov *et al.* (1990) found in intra specific hybrids from crossing American cultivars of cotton with wild forms that fibre length in the F_1 was in most cases intermediate between the parent values but closer to long fibre parent, though heterosis was seen in some crosses. In a cross between the Egyptian cotton (*Gossypium barbadense*) var. Giza 69 and Var. Giza 45, Omar *et al.* (1978) pointed out that weak fibre was partially dominant over strong.

Barnes and Staten (1961) reported that SCA effects were more important for fibre fineness among hybrids of seven closely related 'Acala' strains. Turner *et al.* (1973) observed that in analyses of data obtained for four cultivars over six years, genotypic variability in fibre fineness was mainly affected by environment. In a genetic study of ginning and fibre characters in upland cotton, Gupta and Singh (1970) found both the additive and dominance variances to be highly significant for fibre fineness. Fournier and Gutknecht (1991) in their breeding work reported that breeding for low fineness causes an increase in fibre length and tenacity but breeding for high standard decreases these characters. They also indicated that greater fibre fineness can be achieved more rapidly by breeding within a variety than by crossing. Manning (1963) observed yield increases from 12 generations of progeny selection in an African cultivar, 'BP52.' Selection was practised for three components of yield: bolls/plants, seed/boll, and lint/seed, and at the end of the 10th generation, yield had been increased from 24 to 32%.

2.2 Correlations

Carvalho *et al.* (1994), in their study of genotypic, phenotypic and environmental correlation in cotton (*Gossypium hirsutum* L.) reported that fibre fineness and fibre length were negatively correlated with each other and with lint percent. Miller *et al.* (1967a) reported genetic correlations of 0.74, 0.79, and 0.87 between lint percent and lint yield in three segregating populations, respectively. From their studies on American upland cotton, Miller *et al.* (1958) pointed out that lint index which was closely associated with lint yield gave better selection index i.e. served as a better indicator of the

genetic yield potential than mere yield. Saxena (1963) in the study on the correlation between some characters of cotton 215-F noted that vegetative characters - plant height and dry matter accumulation could account for 83.05 per cent variation in the yield of seed cotton per plant. Number of bolls collected per plant and yield of seed cotton per boll could account for 86.35 per cent variation in seed cotton yield per plant. Venkataraman and Santhanam (1962) in four crosses of Cambodia cotton (*G. hirsutum* L.) obtained consistent and positive correlation between the number of bolls per plant and seed cotton yield in the parents, F_1 and F_2 generations, thus indicating the scope for utilising boll number as a selection index. Ganga (1960) reported that boll number had a direct relation to yield. Mohammed and Chandra (1973) found in the variety MCU 1 (*Gossypium hirsutum* L.) that yield showed significant and positive correlations with plant height and number internodes or bolls per plant of locules per boll and of seeds per locule. Multiple regression analysis confirmed their importance in predicting yield. In their work on American upland cottons, Miller *et al.* (1958) recorded high negative correlations between lint yield and seed index. Kearney (1928) studied correlations among boll characters in several populations of second generation hybrids between upland *hirsutum x barbadense* (Egyptian) reported negative correlation between seed index and number of seeds per boll, seed index and ginning outturn. Venkataraman and Santhanam (1962) in four crosses of Cambodia cotton (*G. hirsutum* L.) obtained negative correlation between ginning outturn and seed index. Chandramath (1973) reported that weights of testa or seed were positively correlated with lint index, and path-

coefficient analysis showed that seed weight and lint index had the highest influence on ginning percent. The seed weight influence was negative, indicating an association between small seeds and high ginning percent. A genetic correlation of 0.84 was reported by Al-Jibouri *et al.* (1958). Meredith and Bridge (1971) reported a genetic correlation of 0.70 for both intermediate population and a segregating F_3 population. In a similar study with populations produced by intercrossing, Miller and Rawlings (1967b) reported a genetic correlation of 0.67. In recurrent selection programs, Miller and Rawlings (1967b) noted that lint percent had a positively correlated response with selection for yield. In a cross between the Egyptian cottons (*Gossypium barbadense*) var. Giza 69 and var. Giza 45, Salim *et al.* (1978) observed high correlation between fibre strength and lint percent. The r values obtained from F_2 and F_3 indicated that most of that correlation was due to genetic causes. Innes (1974) studied genetic variability for lint quality in upland cotton and found a strong negative association between fibre bundle strength and ginning percent.

Kamel (1959) studied the inheritance of fibre fineness in the interspecific hybrid, *Gossypium hirsutum* x *G. bardadense*. He analysed the parents and F_1 - F_3 of *G. hirsutum* "DPL 15 x *G. bardadense*" "Sea Island" by means of the arealometer with respect to "weight fineness" and the two major components of this property, viz: fibre-wall thickness and perimeter. High positive and significant correlations were obtained for weight fineness with its two components. Desirable expressions of weight fineness could be reached through selection of one or both components. Gursham *et al.* (1961)

carried out preliminary studies of seeds of some long linted cotton strains and they obtained a highly significant coefficient of correlation of embryo weight and halo length between plants within varieties and also between seeds of the some plants. Zhou (1991) studied the correlation between earliness and fibre properties in cotton and found that varieties with longer total growth period and duration to boll formation had longer fibre length. Amanturdiev and Ibragimov (1990) in F_2 intra specific hybrids of the cotton species *Gossypium hirsutum* obtained a negative correlation (low to moderate) between fibre outturn and fibre length. Innes (1974) reported a negative association between lint length and number of seeds per boll. Babadzhanov and Amanturdiev (1972) studied correlated relationships between staple length and other economic characters in some cotton hybrids and they observed a negative correlation in F_2 between staple length and ginning outturn but there was low positive correlation between staple length and growth period. Staple length and boll size were not correlated. In the study of genotypic, phenotypic and environmental correlation in cotton (*G. hirsutum* L.). Carvalho *et al.* (1994) indicated that seed cotton yield was correlated positively with number of bolls/plant, boll weight and height and negatively with fibre strength and earliness. Bhatt *et al.* (1967 reported a strong positive correlation between boll number, boll weight, the number of locules per boll and the number of seeds/boll. Miller and Lee (1964) reported a close relationship between the yield of cotton varieties per se and their F_1 hybrids. Dedaniya and Pethani (1994) studied genetic variability, correlation in deshi cotton (*G. arboreum*) and found that seed cotton yield/plant was

positively correlated with number of bolls/plants, plant height, boll weight, lint yield/plant and bundle strength tenacity.

2.3 Heritability

In studying the genotypic and phenotypic variabilities in a varietal collection of American cotton varieties, Bhardwaj and Simlote (1968) obtained high heritability for halo length. El Ghawas *et al.* (1975) studied the inheritance of intrinsic fineness in some Egyptian cotton crosses and found that the heritability values were sufficient for successful selection of the fineness. Khorgade and Ekbote (1981) in a study of the genetic variability in American cotton (*Gossypium hirsutum* L.) reported that lint index showed comparatively high estimates of genetic advance accompanied with high estimates of heritability. Lancon (1987) studied the behaviour of sixteen agronomic traits and fibre properties in two diallel crosses involving African and American varieties of upland cotton (*Gossypium hirsutum* L.) and reported that high heritability was calculated for fibre length. In an inheritance study, Kalsy and Garg (1978) observed highly significant differences between different progenies for halo length. The heritability estimates and genetic advance values for halo length were quite higher. Kamel (1959) studied the inheritance of fibre fineness in the interspecific hybrid *Gossypium hirsutum* x *G. bardadense*. He analysed the parents and F_1 - F_3 of *G. hirsutum* "DPL 15 x *G. bardadense*" "Sea Island" by means of the arealometer with respect to "weight fineness" and the two major components of this property, viz: fibre-wall thickness and perimeter. He found that heritability as measured from correlation and regression of F_3 lines on their respective F_2 phenotypes was

very high for weight fineness. Dedaniya and Pethani (1994) studied genetic variability, correlation and path analysis in deshi cotton (*G. arboreum* L.) and found that seed cotton yield per plant had high to moderate heritability estimates and high genetic advance. In an inheritance study, Kalsy *et al.* (1978) observed highly significant differences between different progenies for yield per/plant. Yield showed high genetic coefficient of variation value of 43.1. This indicated the heritable nature of the differences observed between plants selected during 1973-74 and pointed to the possibility of their useful exploitation through selection. The heritability estimates for yield studied during 1974-75 were quite high.

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental Site

The investigations were carried out during 1996/97 and 1997/98 raining periods at the Institute for Agricultural Research Farm Samaru (11°11' 7°38'E) in the northern Guinea savanna zone of Nigeria with annual mean rainfall of 1050 mm distributed within 5 months.

3.2 Experimental Materials

The twenty-five cotton lines composed of 9 multi-adversity resistant lines from USA and 16 F_5 lines derived from crosses between the variety S295 and the multi-adversity lines (Table 1).

3.3 Experimental Layout

The experiment was laid out in a 5 x 5 triple lattice design with three replications. Plots were single rows, 10m length and 0.90m apart with 0.40m plant spacing. Six seeds were sown per hill. The seedlings were thinned to two plants per hill at 4 weeks after sowing. NPK fertilizer was applied at thinning. Insect pests were controlled using three fortnightly sprays of Cymbush 10 EC at the rate of 2.5 litres/ha starting from nine weeks after sowing. Three hoe weedings were done in each year followed by earthening up (ridge moulding) using a tractor mounted ridger. All cultural practices carried out were as recommended by Institute for Agricultural Research (IAR).

Table 1: Origin of twenty-five (25) cotton lines.

Genetic materials			Origin
1. TAMCOT SP 37			Cotton lines from the multi-adversity resistance (MAR) programme (U.S.A.)
2. TAMCOT SP 21S			"
3. TX CDP 37 HH-1-83			"
4. TAMCOT-CAMD-E			"
5. TX-CABUCS- 2-1-83			"
6. TX-CABCHUS-1-84			"
7. TX-LEBOCAS-3-1-85			"
8. TX-CABCUS-2-84			"
9. TX-CABS-1-83			Advanced cotton lines developed from a cross between (S295) a variety that is resistant to all known isolates of bacterial blight pathogens and a multi-adversity resistant lines.
10. (S295X TX-CDP 37 HH-1-83)		119(95)	
11.	"	1191(95)	
12.	"	1212(95)	
13.	"	1244(95)	
14.	"	1175(95)	
15. (S295 X TAMCOT SP 21S)		211(95)	
16.	"	251(95)	
17.	"	239(95)	
18.	"	299(95)	
19.	"	295(95)	
20. (S295 x TAMCOT-CAMD-E)		324(95)	
21.	"	37(95)	
22.	"	32(95)	
23.	"	320(95)	
24.	"	346(95)	
25.	"	344(95)	

3.4 Data Collection

Five plants were randomly selected for each cotton line in each plot and observations were recorded on the following nineteen characters:

1. Days to first flower per plot (DFFP) - number of days from planting to the emergence of the first flower in the plot.
2. Days to first five flower (average of 5 flowers per plot)(DFFP5) - average number of days from planting to the emergence of the first five flowers in the plot.
3. Days to first flower per second plant (DFFP2) - number of days from planting to the emergence of the first flower on the second plant.
4. Days to first five flowers on second plant (D5FF2) - number of days from planting to the emergence of the first five flowers on the second plant.
5. Boll opening (BO5) - number of days from planting to the opening of the bolls (average of the first opening of 5 plants).
6. Plant height (cm) (PH) - measured before harvesting from base of plant to the base of the pedicle of the oldest unexpanded leaf in the growing plant.
7. Height of first fruiting branch (HFFB) measured from the base of plant to the base of the first fruiting branch.
8. Nodes to first fruiting branch (NFFB).
9. Number of fruiting branches (NFB).
10. Number of opened bolls (NOB2) on the second plant in the plot.
11. Number of opened bolls (NOBPA5), per plot (average of 5 plants).

12. Boll weight (BW) - average of ten bolls per plot.

13. Lint percent (LP) - ratio of lint to seed cotton expressed as a percentage.

14. Lint index (LI) - computed from the formula:

$$\text{Lint index} = \frac{\text{Seed index x Ginning \%}}{100 - \text{Ginning \%}}$$

15. Seed index (SI) - weight (g) of 100 seeds.

16. Seed cotton yield (SCY) - weight of seed cotton expressed in kg/ha.

17. Fibre length (FL) - measured in (mm) using a digital Fibrograph.

18. Fibre strength (FS) - the strength of a bundle of cotton fibres measured on the stelometer with the two jaws holding the fibre bundle separated by ⅛ inch (0.32 cm) space. Strength is expressed in grams per tex and was measured according to ASTM designation D-1445-1967.

19. Fibre fineness (micronaire)(FFm) - measured as the resistance of a given weight of ginned cotton lint to air flow as an indication of the fineness of the sample. The smaller the micronaire value the finer is the sample.

3.5 Statistical Analysis

The statistical model used for the combined analysis of variance (ANOVA) was:

$$Y_{ijk} = \mu + E_i + R_{ij} + G_k + (GE)_{ik} + e_{ijk}$$

were,

μ = overall mean

E_i = the effect of i^{th} year; i = 1,2

R_{ij} = the effect of the j^{th} replication in the i^{th} year; j = 1,2,3

G_k = effect of the k^{th} line; k = 1,2, ... 25

(GE) = the interaction effect between the k^{th} line in the ith environment (year), and assuming

$E_i \sim NID(0, \sigma_E^2)$

$G_k \sim NID(0, \sigma_G^2)$

$e_{ijk} \sim NID(0, \sigma^2)$

NID = Normally and Independently Distributed.

Analysis of variance was performed for all characters from each experiment. The analysis for each character was computed on plot means. Both entries and environments were treated as random effects. The form of analysis of variance with the expected mean squares which were used for the estimation of genetic parameters are shown in Table 2.

Table 2: Form of ANOVA with expected mean squares (EMS) in one environment for each character.

Sources of variation	d.f.	MS	EMS
Replication	(r-1)		
Entries	(g-1)	Mg	$\sigma^2 + \sigma_g^2$
Error	(r-1)(g-1)	Me	σ^2

r = number of replication

g = number of entries

σ^2 = error variance

σ_g^2 = total genetic variance among entries

M subscript = the observed mean square of the subscripted effect.

For one year experiment, components of variance were estimated from the expected mean squares for each trait by using observed mean squares, thus:

$$\sigma^2 = \text{Me and}$$

$$\sigma^2 = \frac{\text{Mg} - \text{Me}}{r}$$

A combined analysis of variance for the two experiments in the two years for each character with the expected mean is given in Table 3. The mean square values were used in estimating genetic parameters.

Table 3: Form of combined analysis of variance with expected mean squares (EMS) in two years for each character.

Sources of variance	d.f.	MS	EMS
Years	y-1		
Replication in years	y(r-1)		
Genotypes	(g-1)	Mg	$\sigma^2_e + r\sigma^2_{gy} + ry\sigma^2_g$
Genotypes x years	(g-1((y-1)	Mgy	$\sigma^2_e + r\sigma^2_{gy}$
Error	y(r-1)(g-1)	Me	σ^2_e

where,

y = number of years

r = number of replications

g = number of entries

MS = observed mean square of the subscripted effect

σ^2_{gy} = genotype x years of interaction variance

σ^2_g = total genetic variance among entries

σ^2_e = error variance

The components of variance were estimated from the expectation of mean squares by equating the observed mean squares to their expectations as follows:

$$\sigma_e^2 = \text{Me with S.E.} \sqrt{\frac{2(\text{Me})^2}{df + 2}}$$

$$\sigma_g^2 = \frac{\text{Mg} - \text{Mgy}}{ry} \text{ with S.E.} = \sqrt{\left(\frac{1}{ry}\right)^2 \left[\frac{2(Mg)^2}{df + 2} + \frac{2(\text{Mgy})^2}{df + 2}\right]}$$

$$\sigma_{gy}^e = \frac{M_{gy} - \text{Me}}{r} \text{ with S.E.} = \sqrt{\left(\frac{1}{r}\right)^2 \left[\frac{2(\text{Mgy})^2}{df + 2} + \frac{2(\text{Me})^2}{df + 2}\right]}$$

The estimate of phenotypic variance was:

$$\sigma_{ph}^2 = \frac{\text{Mg} - \text{Mgy}}{ry} + \text{Me with S.E.} = \sqrt{\left(\frac{1}{ry}\right)^2 \left[\frac{2(\text{Mg})^2}{df + 2}\right]}$$

The F-test was used to ascertain, if the variation among entries and their interaction with the environment (year) were significantly different from zero. They were used for the combined ANOVA as follows:

$$F = \frac{\text{Mg}}{\text{Me}} \text{ with } (g - 1), y(r - 1)(g.1)\, df$$

$$F = \frac{\text{Mgy}}{\text{Me}} \text{ with } (g - l)(y - 1); y(r - 1)(g - 1)\, df$$

Duncan's Multiple Range Test (DMRT) was used to test significant differences between means.

To estimate broad sense heritability (h^2), the following formula was used:

$$h^2 = \frac{\sigma_g^2}{\frac{\sigma_e^2}{ry} + \frac{\sigma_{gy}^2}{r} + \sigma_g^2} \text{ with S.E.} = \frac{\text{S.E.}(\sigma_g^2)}{\sigma_{ph}^2}$$

where,

σ_g^2 = genotypic variance

σ_e^2 = environmental variance

σ_{gy}^2 = component of variance due to interaction of genotypes with years.

The expectations of mean products in the analysis of covariance, according to Mode and Robinson (1959), have the same form as the expected mean squares of analysis of covariance and are analogous to those used for analysis of variance. The form of analysis of variance and covariance of a pair of characters (a and b) with the expected mean cross-products for two years are shown in Table 4.

Table 4: Form of combined analysis of variance and covariance with expected mean products for two characters (a and b).

Source of variation	d.f.	Trait a	Trait b	Mean product ab	Expected mean product
Genotypes	(g-1)	Mga	Mgb	Mgagb	σab + rσgyagyb + ryσgagb
Genotypes x years	(g-1)(y-1)	Mgya	Mgyb	Mgyagyb	σab + rσgyagyb
Error	(y)r-1)(g-1)	Mea	Meb	Meaeb	σab

Using mean squares and mean cross products in the formula below, the phenotypic correlations were computed.

$$rph = \frac{Mgagb}{\sqrt{Mga.Mgb}}$$

where,

Mga = entry mean square of character a

Mgb = entry mean square of character b

MgaMgb = entry mean product of characters a and b.

For pairs of traits measured, the phenotypic and genotypic correlation coefficients were computed. The genotypic correlation coefficients were calculated from components of variance and covariance using the formula according to Mode and Robinson (1959).

$$rgab = \frac{\sigma ga\ gb}{\sqrt{\sigma^2_{ga} \cdot \sigma^2_{gb}}}$$

The environmental correlation coefficients were estimated for a pair of characters using the error mean squares and error covariance values. The environmental correlation is the measure of the effect of environment (year) on the association of the characters in each pair.

$$r_{eab} = \frac{\sigma_{ab}}{\sqrt{\sigma^2_a \cdot \sigma^2_b}}$$

where,

r_{eab} = environmental correlation coefficient for characters a and b.

σ_{ab} = environmental covariance for characters a and b.

σ^2_a = environmental variance for character a.

σ^2_b = environmental variance for character b.

CHAPTER 4

RESULTS

4.1 Mean Performance

The mean performance of the lines for the nineteen characters are presented in Tables 5 - 7. There were no significant differences among the lines for number of opened bolls per plot in 1996 (Table 5), days to first five flowers in the plot, days to first flower in the second plant, days to first five flowers on the second plant in 1997 (Table 6), number of opened bolls on the second plant for the two years combined (Table 7). Significant differences were observed for the other characters. The lines TAMCOT SP 37, TAMCOT SP 21S, TX-CDP 37 HH-1-83, TX-CABCHUS-1-84, TX-LE BOCAS-3-1-85, (S295 x TX-CDP 37HH-1-83) 119(95), (S295 x TX-CDP 37 HH-1-83) 1212(95), (S295 x TX-CDP 37 HH-1-83) 1244(95), (S295 x TAMCOT SP 21S) 211(95), (S295 x TAMCOT SP 21S) 239(95), (S295 x TAMCOT SP 21S) 295(95), (S295 x TAMCOT-CAMD-E) 32(95) and (S295 x TAMCOT-CAMD-E) 320(95) performed better in the second year for seed cotton yield than in the first year. In the combined analysis, the lines TX-CABUCS-2-1-83 and (S295 x TAMCOT SP 21S) 239(95) gave the highest number of days to first five flowers in the plot while (S295 x TX-CDP 37 HH-1-83) 119(95) and (S295 x TAMCOT-CAMD-E) 37(95) were earlier with 66.67 and 69.83 days respectively. The bolls of the lines (S295 x TAMCOT-CAMD-E) 37(95), (S295 x TX-CDP 37 HH-1-83) 119(95), (S295 x TAMCOT-CAMD-E) 344(95) and (S295 x TX-CDP 37 HH-1-83) 1191(95) opened earlier in 10, 10, 9 and 9 days, respectively than the bolls of TX-CABUCS-2-1-83. The boll weight of the lines (S295 x TAMCOT SP 21S) 211(95) and (S295 x TAMCOT-CAMD-E) 346(95) were larger than the boll weight of (S295 x TAMCOT SP

Table 5: Mean performance of the twenty-five cotton lines grown in Samaru in 1996.

	1	2	3	4	5	6	7	8	9	10
TAMCOT SP 37	64.33 b	71.33 abcd	79.00 abc	83.33 abcd	119.33 ab	87.00 bcde	21.00 abcde	4.44 bcd	10.00 abc	13.33 ab
TAMCOT SP 21S	66.00 ab	73.67 abcd	68.33 bc	72.00 cd	121.33 ab	92.33 abcde	17.67 e	4.67 abc	10.33 abc	27.00 a
TXCDP 37HH-1-83	68.00 ab	72.33 abcd	71.67 bc	76.00 bcd	118.67 b	90.00 abcd	21.00 abc	5.00 cd	10.00 abc	14.33 ab
TAMCOT-CAMD-E	67.67 ab	72.67 abcd	75.00 abc	81.00 abcd	118.33 b	97.00 abcd	21.00 abcde	4.00 cd	11.00 ab	13.67 ab
TX-CABUCS-2-183	70.33 ab	78.33 ab	88.67 a	3.67 a	126.33 a	106.67 a	21.33 abcd	4.00 cd	10.67 abc	8.33 b
TX-CABCHUS-1-84	67.67 ab	70.33 bcd	72.67 bc	78.00 bcd	117.33 b	94.00 abcde	18.67 cde	4.33 bcd	10.33 abc	18.00 ab
TX-LEBOCAS-3-1.85	70.67 ab	77.33 abc	75.33 abc	73.00 bcd	123.33 ab	84.67 cde	20.00 bcde	4.33 bcd	10.00 abc	21.00 ab
TX-CABCUS-2-84	67.67 ab	73.00 abcd	71.00 bc	73.33 bcd	118.67 ab	84.33 cde	21.33 abcd	4.00 cd	10.33 abc	21.33 ab
TX-CABS-1-83	65.67 b	73.67 abcd	77.33 abc	80.33 abcd	119.33 ab	90.67 bcde	20.67 abcde	4.33 bcd	10.00 abc	12.33 ab
(S295 x TX-CDP 37 HH-183) 119(95)	65.00 b	67.67 d	65.33 c	70.67 d	115.67 b	80.33 e	23.00 ab	3.67 d	9.33 bc	16.00 ab
" 1191(95)	64.33 b	69.00 cd	70.00 bc	74.00 bcd	116.00 b	93.00abcde	18.00 de	4.00 cd	11.67 a	19.33 ab
" 1212(95)	70.00 ab	76.67 abcd	73.00 bc	76.33 bcd	121.67 ab	79.67 e	20.67 abcde	4.67 abc	10.00 abc	22.00 ab
" 1244(95)	67.67 ab	73.00 abcd	73.00 bc	77.33 bcd	118.67 ab	92.00 abcde	22.00 abc	4.67 abc	9.67 abc	9.33 b
" 1175(95)	66.33 ab	71.33 abcd	68.67 bc	73.00 bcd	117.33 b	98.67 abc	20.67 abcde	4.67 abc	10.33 abc	18.33 ab
(S295 x TAMCOT SP 21S) 211(95)	68.67 ab	72.33 abcd	71.00 bc	75.33 bcd	117.33 b	89.33 bcde	23.67 a	4.67 abc	9.00 bc	15.33 ab
" 251(95)	68.67 ab	75.33 abcd	76.67 abc	81.00 abcd	121.33 ab	79.33 e	19.67 bcde	4.67 abc	9.33 bc	11.67 ab
" 239(95)	72.67 a	80.00 a	83.00 ab	86.67 ab	122.33 ab	100.33 ab	21.33 abcd	5.00 ab	10.33 abc	11.67 ab
" 299(95)	67.00 ab	73.67 abcd	82.67 ab	85.33 abc	120.00 ab	87.00 bcde	20.33 abcde	4.67 abc	11.00 ab	14.00 ab
" 295(95)	67.67 ab	71.33 abcd	75.00 abc	79.33 bcd	122.33 ab	90.33 bcde	22.67 ab	5.33 a	10.33 abc	21.67 ab
(S295 x TAMCOT-CAMD-E 324(95)	69.00 ab	76.00 abcd	73.67 bc	76.00 bcd	119.67 ab	83.00 de	22.00 ab	4.00 cd	10.00 abc	19.33 ab
" 37(95)	65.33 b	68.67 cd	68.67 bc	74.00 bcd	116.00 b	91.33 bcde	22.67 ab	4.00 cd	10.33 abc	14.00 ab
" 32(95)	70.33 ab	76.67 abcd	75.00 abc	78.67 bcd	119.00 ab	86.33 bcde	19.33 bcde	4.00 cd	10.00 abc	13.33 ab
" 320(95)	72.67 a	76.33 abcd	74.00 bc	78.33 bcd	122.67 ab	79.67 e	20.67 abcde	4.00 cd	8.67 c	14.00 ab
" 346(95)	64.33 b	70.00 bcd	73.67 bc	78.33 bcd	117.00 b	89.67 bcde	20.67 abcde	4.67 abc	9.67 abc	14.67 ab
" 344(95)	65.33 b	70.67 bcd	72.33 bc	76.33 bcd	117.00 b	93.67 abcde	21.67 abc	4.33 bcd	10.00 abc	12.67 ab
CV%	5.00	6.24	9.90	9.01	3.25	8.51	8.74	9.37	11.16	53.12
GM	67.72	73.25	74.19	78.09	119.47	89.61	20.89	4.40	10.11	15.87

Table 5 cont'd.

	11	12	13	14	15	16	17	18	19
TAMCOT SP 37	16.33 a	4.27 defg	37.30 s	5.24 cde	8.81 efghi	691.7 abcd	23.00 abcde	16.25 ab	2.70 bcd
TAMCOT SP 21S	17.00 a	4.20 defg	39.00 m	5.54 abcde	8.66 ghijk	549.0 bcd	22.46 cdefg	15.40 ab	2.64 bcd
TXCDP 37HH-1-83	15.67 a	4.33 cdef	41.67 e	6.21 ab	8.69 fghijk	669.7 abcd	22.59 cdefg	16.17 ab	2.87 abc
TAMCOT-CAMD-E	15.33 a	4.20 defg	38.17 q	5.66 abcde	9.18 de	676.3 abcd	22.36 defg	15.66 ab	2.69 bcd
TX-CABVCS-2-183	16.00 a	4.27 defg	35.70 w	5.69 abcde	10.25 a	407.0 d	23.01 abcde	16.43 ab	2.53 cd
TX-CABCHUS-1-84	15.33 a	4.17 defg	39.47 l	5.45 bcde	8.33 jklmn	488.0 cd	22.36 defg	14.60 b	2.69 bcd
TX-LEBOCAS-3-1.85	14.33 a	4.17 defg	36.77 u	5.60 abcde	9.61 b	417.7 d	22.28 efg	16.23 ab	2.79 abcd
TX-CABCUS-2-84	15.00 a	4.40 cde	37.37 r	5.59 abcde	9.33 cd	624.7 abcd	24.06 a	15.65 ab	2.67 bcd
TX-CABS-1-83	18.00 a	3.93 gh	35.67 x	5.04 e	9.07 def	540.3 bcd	21.87 fg	16.37 ab	2.66 bcd
(S295 x TX-CDP 37 HH-1-83) 119(95)	17.00 a	3.77 h	41.13 f	6.27 ab	8.96 defg	851.0 ab	22.50 cdefg	16.52 ab	3.00 a
" 1191(95)	22.33 a	4.13 efg	38.90 n	5.41 bcde	8.49 hijklm	634.3 abcd	22.33 defg	16.61 ab	2.78 abcd
" 1212(95)	16.33 a	4.50 cde	41.70 d	6.14 abc	8.59 ghijk	625.0 abcd	22.94 bcdef	15.35 ab	2.55 cd
" 1244(95)	15.00 a	4.57 cd	40.10 j	5.68 abcde	8.48 ijklm	730.3 abcd	22.45 cdefg	16.36 ab	2.73 abcd
" 1175(95)	18.33 a	4.30 edefg	42.83 b	6.11 abc	8.15 mno	804.3 abc	22.38 defg	14.94 b	2.77 abcd
(S295 x TAMCOT SP 21S) 211(95)	13.67 a	5.27 a	38.43 o	5.60 abcde	8.97 defg	652.0 abcd	23.76 ab	17.19 a	2.61 bcd
" 251(95)	15.00 a	4.20 defg	36.93 t	5.16 de	8.81 efghi	548.0 bcd	23.45 abcd	17.33 a	2.66 bcd
" 239(95)	15.33 a	4.50 cde	44.60 a	6.41 a	7.97 no	422.7 d	21.43 g	16.38 ab	3.09 a
" 299(95)	19.00 a	4.00 fgh	36.47 v	5.00 e	8.70 fghij	618.3 abcd	23.54 abc	16.26 ab	2.46 d
" 295(95)	17.33 a	4.30 edefg	39.50 k	5.37 bede	8.20 lmno	536.0 bcd	21.97 efg	15.39 ab	2.66 bcd
(S295 x TAMCOT-CAMD-E) 324(95)	16.00 a	4.17 defg	41.93 c	5.70 abcde	7.89 o	729.7 abcd	21.82 fg	15.83 ab	2.69 bcd
" 37(95)	17.00 a	4.67 bc	40.20 i	5.76 abcde	8.56 hijkl	899.3 a	22.34 defg	15.88 ab	2.73 abcd
" 32(95)	17.33 a	4.57 cd	40.40 h	6.00 abcd	8.88 efgh	628.7 abcd	21.63 g	15.96 ab	2.58 cd
" 320(95)	13.33 a	4.20 defg	39.50 k	5.72 abcde	8.77 fghi	470.7 d	21.94 efg	16.40 ab	2.63 bcd
" 346(95)	17.33 a	4.93 ab	38.27 p	6.04 abcd	9.76 b	713.3 abcd	22.55 cdefg	15.00 b	2.48 cd
" 344(95)	17.33 a	4.17 defg	40.73 g	5.70 abcde	8.30 klmn	680.3 abcd	22.80 bcdef	16.65 ab	2.61 bcd
CV%	30.08	4.62	0.0	8.28	2.26	26.14	2.57	6.47	7.00
GM	16.42	4.33	39.31	5.68	8.78	624.33	22.55	16.03	2.69

Key

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. BOS: Days to the opening of the bolls
6. PH: Plant height (cm)
7. PHFFB: Plant height to first fruiting branch (cm)
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight (g)
13. LP: Lint percent (%)
14. LI: Lint index (%)
15. SI: Seed index (g)
16. SCY: Seed cotton yield (kg/ha)
17. FL: Fibre length (mm)
18. FS: Fibre strength
19. FF: Fibre fineness

Table 6: Mean performance of the twenty-five cotton lines grown in Samaru in 1997.

	1	2	3	4	5	6	7	8	9	10
TAMCOT SP 37	66.00 abcd	69.33 a	66.67 a	77.33 a	114.33 abcde	83.00 abcde	20.67 abc	4.00 a	11.00 a	21.67 abcde
TAMCOT SP 21S	66.00 abcd	67.67 a	73.33 a	83.33 a	116.33 abcde	71.67 abcde	21.00 abc	4.44 a	9.67 ab	14.67 bcde
TX-CDP 37HH-1-83	67.33 abc	71.00 a	71.67 a	82.33 a	114.33 abcde	82.67 abcde	24.00 ab	4.67 a	9.33 ab	23.00 abcd
TAMCOT-CAMD-E	66.00 abcd	69.33 a	72.67 a	81.33 a	112.67 bcde	72.33 abcde	23.33 abc	4.00 a	9.33 ab	16.67 bcde
TX-CABUCS-2-183	66.00 abcd	69.67 a	71.00 a	80.33 a	120.33 a	75.67 abcde	24.33 a	4.00 a	9.33 ab	21.00 abcde
TX-CABCHUS-1-84	64.00 d	68.67 a	66.67 a	76.00 a	112.33 bcde	65.67 de	18.00 c	4.33 a	8.67 ab	17.67 abcde
TX-LEBOCAS-3-1.85	66.33 abcd	69.67 a	70.00 a	79.67 a	119.00 ab	71.33 abcde	22.67 abc	3.67 a	2.00 ab	14.00 cde
TX-CABCUS-2-84	68.33 ab	70.33 a	67.67 a	82.00 a	113.67 abcde	67.67 cde	20.67 abc	4.33 a	8.33 ab	14.00 cde
TX-CABS-1-83	65.00 cd	67.67 a	67.00 a	81.67 a	115.00 abcde	85.67 abc	18.67 bc	3.67 a	11.00 a	21.67 abcde
(S295 x TX-CDP 37 HH-1-83) 119(95)	65.33 bcd	67.67 a	67.00 a	78.00 a	110.67 de	76.33 abcde	22.67 abc	4.00 a	9.33 a	28.67 a
" 1191 (95)	66.67 abcd	70.00 a	72.00 a	78.67 a	112.67 bcde	69.00 bcde	22.00 abc	4.00 a	9.00 ab	13.67 cde
" 1212 (95)	65.00 cd	67.33 a	67.67 a	73.33 a	116.67 abcde	68.67 bcde	23.67 ab	4.33 a	9.33 ab	13.00 cde
" 1244 (95)	67.33 abc	70.67 a	70.67 a	77.00 a	113.67 abcde	77.67 abcde	23.33 abc	4.33 a	9.67 ab	21.33
" 1175 (95)	65.00 cd	68.00 a	66.33 a	77.67 a	113.33 abcde	85.00 abcd	24.00 ab	4.33 a	10.33 ab	17.00 abcde
(S295 x TAMCOT SP 21S) 211(95)	65.33 bcd	68.00 a	69.00 a	81.33 a	111.67 cde	66.67 cde	20.67 abc	3.67 a	7.33 b	11.33 de
" 251(95)	66.00 abcd	71.00 a	69.67 a	78.00 a	116.00 abcde	64.00 e	21.67 abc	4.00 a	8.67 ab	19.67 abcde
" 239(95)	66.33 abcd	69.67 a	70.00 a	80.67 a	117.67 abcd	88.67 a	22.67 abc	4.00 a	9.67 ab	10.33 e
" 299(95)	68.67 a	70.67 a	72.33 a	80.67 a	115.00 abcde	72.33 abcde	21.67 abc	4.00 a	9.67 ab	24.33 abc
" 295(95)	64.67 cd	67.67 a	69.33 a	79.33 a	117.00 abcde	71.67 abcde	24.00 ab	4.67 a	8.00 ab	14.33 cde
(S295 x TAMCOT-CAMD-E) 324(95)	65.67 abcd	71.33 a	66.67 a	82.33 a	115.33 abcde	68.00 cde	20.33 abc	4.33 a	9.33 ab	19.67 abcde
" 37(95)	64.67 cd	67.00 a	66.67 a	77.33 a	110.33 e	69.33 bcde	21.33 abc	4.33 a	9.00 ab	21.33 abcde
" 32(95)	65.00 cd	68.33 a	67.00 a	76.67 a	114.33 abcde	87.67 ab	23.67 ab	4.33 a	10.33 ab	26.67 ab
" 320(95)	65.00 cd	70.67 a	66.67 a	76.33 a	118.00 abc	67.00 cde	21.33 abc	4.00 a	8.67 ab	14.00 cde
" 346(95)	64.33 cd	68.67 a	71.00 a	81.00 a	112.00 bcde	67.33 cde	22.00 abc	4.33 a	7.67 ab	13.00 cde
" 344(95)	65.00 cd	68.00 a	67.00 a	78.33 a	111.67 cde	75.00 abcde	20.67 abc	4.67 a	9.33 ab	19.00 abcde
CV%	2.42	3.19	6.43	8.27	3.07	13.06	12.36	13.62	18.63	32.68
GM	65.80	69.12	69.02	79.23	114.56	74.00	21.96	4.17	9.28	18.06

Table 6 cont'd.

	11	12	13	14	15	16	17	18	19
TAMCOT SP 37	21.67 abcdef	4.36 abc	37.97 q	5.43 defgh	8.83 ab	804 f	25.85 abcd	17.86 abcde	4.06 e
TAMCOT SP 21S	18.67 abcdefg	4.37 abc	40.70 h	5.67 bcdef	8.17 bcd	654 l	23.99 hi	17.89 abcde	4.04 f
TX-CDP 37HH-1-83	25.00 ab	4.41 abc	42.50 b	6.40 a	8.67 abc	847 d	25.37 abcdefg	18.34 abcde	4.34 e
TAMCOT-CAMD-E	16.67 bcde	4.13 bc	39.63 k	5.67 bcdef	8.17 bc	651 m	24.98 bcdefghi	20.58 g	3.91 g
TX-CABUCS-2-183	19.67 abcdefg	3.74 c	35.23 w	4.80 ij	8.67 abc	323 w	25.71 abcde	19.67 abc	3.47 v
TX-CABCHUS-1-84	15.33 fg	4.52 abc	38.40 o	5.17 efghi	8.17 bcd	546 v	24.73 cdefghi	16.49 de	3.32 y
TX-LEBOCAS-3-1.85	17.00 cdefg	4.96 ab	37.90 r	5.27 efghi	8.67 abc	692 k	24.52 efghi	17.42 bede	3.73 q
TX-CABCUS-2-84	13.67 g	3.99 bc	35.60 v	4.90 hij	8.83 ab	284 x	26.20 ab	20.13 ab	3.81 m
TX-CABS-1-83	24.33 abc	4.48 abc	36.60 u	4.53 j	7.83 bcd	526 t	26.01 abc	19.64 abc	3.55 u
(S295 x TX-CDP 37 HH-1-83) 119(95)	22.00 abcdef	4.14 bc	40.77 g	5.40 defgh	7.83 bcd	1026 b	24.66 defghi	19.60 abcd	3.84 l
" 1191(95)	15.00 fg	4.28 abc	38.63 m	4.93 ghi	7.67 cd	496 v	25.44 abcdefg	16.84 cde	3.82 m
" 1212(95)	17.00 cdefg	4.21 bc	41.30 d	5.53 cdefg	7.83 bcd	760 g	24.74 cdefghi	17.89 abcde	3.41 x
" 1244(95)	17.00 cdefg	4.38 abc	39.77 j	5.73 bcde	8.67 abc	734 i	25.55 abcdef	18.99 abcd	3.88 k
" 1175(95)	26.33 a	4.55 abc	43.80 a	6.23 ab	8.00 bcd	747 h	25.11 bcdefgh	17.71 abcde	4.67 a
(S295 x TAMCOT SP 21S) 211(95)	13.67 g	5.32 a	38.73 m	5.90 abcd	9.33 a	718 j	25.69 abcde	19.80 abcd	3.99 h
" 251(95)	18.33 bcdefg	4.26 abc	37.17 t	4.93 ghi	8.33 bcd	540 s	25.87 abcd	17.98 abcde	3.97 i
" 239(95)	18.33 bcdefg	4.67 abc	41.40 c	5.43 defgh	7.67 cd	839 e	25.73 abcde	17.32 bcde	4.53 b
" 299(95)	23.67 abcde	3.79 c	37.53 s	4.80 ij	8.00 bcd	576 q	26.62 a	20.61 a	3.60 t
" 295(95)	15.33 fg	4.53 abc	41.23 e	5.67 bcdef	8.17 bcd	897 c	25.84 abcdefg	18.68 abcde	4.24 d
(S295 x TAMCOT-CAMD-E) 324 (95)	16.00 efg	4.11 bc	38.20 p	4.97 ghij	8.00 bcd	261 y	24.23 fghi	18.30 abcde	3.80 o
" 37(95)	17.00 cdefg	3.86 c	40.97 f	5.43 defgh	7.83 bcd	473 v	23.71 i	17.73 abcde	3.67 s
" 32(95)	24.00 abcd	4.49 abc	41.30 d	6.03 abc	8.33 bcd	1110 a	24.17 ghi	16.51 de	3.70 r
" 320(95)	18.00 bcdefg	4.14 bc	40.47 i	5.27 efghi	7.83 bcd	603 p	25.31 abcdefg	15.86 e	3.46 w
" 346(95)	13.00 g	4.94 ab	38.87 l	5.60 cdef	8.83 ab	648 m	25.50 abcdef	20.71 a	4.00 g
" 344(95)	18.33 bcdefg	3.70 c	40.77 g	5.13 fghi	7.50 d	640 o	25.05 bcdefgh	18.20 abcde	3.77
CV%	26.36	12.22	0.0	5.58	6.10	0.0	2.64	8.16	0.0
GM	18.59	4.34	39.41	5.39	8.23	655.84	25.21	18.39	3.86

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height (cm)
7. PHFFB: Plant height to first fruiting branch (cm)
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight (g)
13. LP: Lint percent (%)
14. LI: Lint index (%)
15. SI: Seed index (g)
16. SCY: Seed cotton yield (kg/ha)
17. FL: Fibre length (mm)
18. FS: Fibre strength
19. FF: Fibre fineness

Table 7: Mean performance of the twenty-five cotton lines grown in Samaru for 1996 and 1997 combined..

	1	2	3	4	5	6	7	8	9	10
TAMCOT SP 37	65.17 bc	70.33 abc	72.83 abcd	80.33 abc	116.83 cdefghi	85.00 abcdefg	20.83 abcd	4.17 bc	10.50 a	17.50 a
TAMCOT SP 21S	66.00 abc	70.67 abc	70.83 bcd	77.67 bc	118.88 bcdef	82.00 abcdefg	19.33 cd	4.50 abc	10.00 ab	20.83 a
TX-CDP 37HH-1-83	67.67 abc	71.67 abc	71.67 bcd	79.17 abc	116.50 cdefghi	83.33 abcdef	22.33 ab	4.83 ab	9.83 ab	18.67 a
TAMCOT-CAMD-E	66.83 abc	71.00 abc	73.83 abcd	81.17 abc	115.50 defghi	84.67 abcdefg	22.17 abc	4.00 c	10.17 ab	15.17 a
TX-CABUCS-2-183	68.17 abc	74.00 a	79.83a	87.00 a	123.33 a	91.17 abc	22.83 ab	4.00 c	10.00 ab	14.67 a
TX-CABCHUS-1-84	65.83 abc	69.50 bc	69.67 bcd	77.00 bc	114.83 fghi	79.83 bcdefg	18.33 d	4.33 abc	9.50 ab	17.83 a
TX-LEBOCAS-3-1.85	68.50 ab	73.50 ab	72.67 abcd	76.33 bc	121.17 ab	78.00 cdefg	21.33 abcd	4.00 c	9.50 ab	17.50 a
TX-CABCUS-2-84	68.00 abc	71.67 abc	69.33 cd	78.17 bc	116.17 cdefghi	76.00 defg	21.00 abcd	4.17 bc	9.33 ab	17.67 a
TX-CABS-1-83	65.33 bc	70.67 abc	72.17 bcd	81.00 abc	117.17 bcdefghi	88.17 abcd	19.67 bcd	4.00 c	10.50 a	17.00 a
(S295 x TX-CDP 37 HH-1-83) 119(95)	65.17 bc	67.67 c	66.67 d	74.33 c	113.67 i	78.33 cdefg	22.83 ab	3.83 c	9.33 ab	22.33 a
" 1191(95)	65.50 bc	69.50 bc	71.00 bcd	76.33 bc	114.33 hi	81.00 bcdefg	20.00 abcd	4.00 c	10.33 a	16.50 a
" 1212(95)	67.50 abc	72.00 abc	71.33 bcd	74.83 bc	119.17 bcde	74.67 efg	22.17 abc	4.50 abc	9.67 ab	17.50 a
" 1244(95)	67.50 abc	71.83 abc	71.83 bcd	77.17 bc	116.17 cdefghi	84.83 abcdefg	22.67 abc	4.50 abc	9.67 ab	15.33 a
" 1175(95)	65.67 abc	69.67 bc	67.50 d	75.33 bc	115.33 efghi	91.83 ab	22.33 abc	4.50 abc	10.33 a	17.67 a
(S295 x TAMCOT SP 21S) 211(95)	67.00 abc	70.17 abc	70.00 bcd	78.33 bc	114.50 ghi	78.00 cdefg	22.17 abc	4.17 bc	8.17b	13.33 a
" 251(95)	67.33 abc	73.17 ab	73.17 abcd	79.50 abc	118.67 bcdefg	71.67 g	20.67 abc	4.33 abc	9.00 ab	15.67 a
" 239(95)	69.50 a	74.83 a	76.50 abc	83.67 ab	120.00 abc	94.50 a	22.00 abc	4.50 abc	10.00 ab	11.00 a
" 299(95)	67.83 abc	72.17 abc	77.50 ab	83.00 abc	117.50 bcdefgh	79.67 bedefg	21.00 abcd	4.33 abc	10.33 a	19.17 a
" 295(95)	66.17 abc	69.50 bc	72.17 bcd	79.33 abc	119.67 abcd	81.00 bcdefg	23.33 a	5.00 a	9.17 ab	18.00 a
(S295 x TAMCOT-CAMD-E) 324(95)	67.33 abc	73.67 ab	70.17 bcd	79.17 abc	117.50 bedefgh	75.50 defg	21.17 abcd	4.17 bc	9.67 ab	19.50 a
" 37(95)	65.00 bc	69.83 c	67.67 d	75.67 bc	113.17 i	80.33 bedefg	22.00 abc	4.17 bc	9.67 ab	17.67 a
" 32(95)	67.67 abc	72.50 abc	71.00 bcd	77.67 bc	116.67 cdefghi	87.00 abcde	21.00 abcd	4.17 bc	10.17 ab	20.00 a
" 320(95)	68.83 ab	73.50 ab	70.33 bcd	77.33 bc	120.33 abc	73.33 fg	21.00 abcd	4.00 c	8.67 ab	14.00 a
" 346(95)	64.33 c	69.33 bc	72.33 bcd	79.67 abc	114.50 ghi	78.50 bcdefg	21.33 abcd	4.50 abc	9.17 ab	13.33 a
" 344(95)	65.17 bc	69.33 bc	69.67 bcd	77.33 bc	114.33 hi	84.33 abcdefg	21.17 abcde	4.50 abc	9.67 ab	15.83 a
CV%	4.18	4.97	7.80	7.94	2.60	11.72	11.44	11.45	14.95	51.81
GM	66.76	71.19	71.61	78.66	117.01	81.80	21.43	4.29	9.69	16.97

Table 7 cont'd.

	11	12	13	14	15	16	17	18	19
TAMCOT SP 37	19.00 abcd	4.31 cde	37.63 ghi	5.34 defghi	8.82 bcd	747.80 abcd	24.42 abcd	17.06 ab	3.38 bcdef
TAMCOT SP 21S	17.83 abcd	4.29 cde	39.85 def	5.60 bcdef	8.41 defgh	601.70 bcdef	23.23 e	16.65 ab	3.34 cdef
TX-CDP 37HH-1-83	20.33 abc	4.37 bcde	42.08 abc	6.35 a	8.67 cde	758.30 abcd	23.98 bcde	17.26 ab	3.61 abc
TAMCOT-CAMD-E	15.83 abc	4.17 cde	38.90 efg	5.67 abcdefg	8.68 cde	663.70 bcde	23.67 bcde	18.12 ab	3.30 cdef
TX-CABUCS-2-183	17.83 abcd	4.00 cde	35.47 j	5.25 efghi	9.46 a	365.2 f	24.36 abcd	18.05 ab	3.09 def
TX-CABCHUS-1-84	15.33 bcd	4.34 bcde	38.93 efg	5.31 defghi	8.25 defgh	516.80 cdef	23.54 cde	15.55 b	3.06 ef
TX-LEBOCAS-3-1.8S	15.67 abcd	4.57 bcd	37.33 ghi	5.44 cdefgh	9.14 abc	555.00 cdef	23.40 de	17.85 ab	3.35 cdef
TX-CABCUS-2-84	14.33 cd	4.19 cde	36.48 ij	5.25 efghi	9.08 abc	454.20 ef	25.13 a	17.88 ab	3.24 cdef
TX-CABS-s1-83	21.17 ab	4.21 cde	36.13 ij	4.79 i	9.45 defg	533.30 cdef	23.94 bcde	18.08 ab	3.20 def
(S295 x TX=CDP 37 HH-1-83)119(95)	19.50 abc	3.95 cde	40.95 cd	5.84 abcde	8.40 defgh	938.30 a	23.58 cde	17.74 ab	3.42 bcde
" 1191(95)	18.67 abcd	4.21 cde	38.77 efg	5.70 ghi	8.08 efgh	565.30 cdef	23.89 bcde	16.73 ab	3.29 cdef
" 1212(95)	17.67 abcd	4.35 bcde	41.50 bcd	5.84 abcde	8.21 defgh	692.70 abcde	23.84 bcde	16.62 ab	3.07 def
" 1244(95)	16.00 abcd	4.48 bcde	39.93 def	5.75 abcdef	8.58 cdef	732.00 abcd	23.99 bcde	17.67 ab	3.31 cdef
" 1175(95)	22.33 a	4.43 bcde	43.32 a	6.17 ab	8.08 efgh	775.80 abc	23.75 bcde	16.23 ab	3.72 ab
(S295 x TAMCOT SP 21S) 211(95)	13.67 a	5.29 a	38.58 fgh	5.75 abcdef	9.15 abc	685.00 abcde	24.73 ab	18.34 a	3.29 cdef
" 251(95)	16.67 abcd	4.23 cde	37.05 hij	5.05 ghi	8.57 cdef	543.8 cdef	24.66 abc	17.66 ab	3.31 cdef
" 239(95)	16.83 abcd	4.59 be	43.00 ab	5.92 abcd	7.82 h	631.00 bcdef	23.58 cde	16.84 ab	3.81 a
" 299(95)	21.33 ab	3.89 e	37.00 hij	4.89 hi	8.35 defgh	597.2 bcdef	25.08 a	18.44 a	3.03 f
" 295(95)	16.33 abcd	4.47 bcde	40.37 de	5.52 cdefgh	8.19 efgh	716.70 abcde	23.68 bcde	17.04 ab	3.45 bcd
(S295 x TAMCOT-CAMD-E) 324(95)	16.00 abcd	4.37 cde	40.07 def	5.32 defghi	7.94 fgh	495.30 def	23.02 e	17.07 ab	3.24 cdef
" 37(95)	17.00 abcd	4.26 cde	40.58 cd	5.98 bcdefg	8.20 defgh	686.30 abcde	23.07 e	16.80 ab	3.20 def
" 32(95)	20.67 ab	4.53 bcde	40.85 cd	6.02 abc	8.61 cde	869.20 ab	22.90 e	16.24 ab	3.25 cdef
" 320(95)	15.67 abcd	4.17 cde	39.83 def	5.49 cdefgh	8.30 defgh	536.70 cdef	23.62 bcde	16.13 ab	3.05 ef
" 346(95)	15.17 bcd	4.94 ab	38.57 fgh	5.82 abcdef	9.30 ab	680.80 abcde	24.03 bcde	17.86 ab	3.25 cdef
" 344(95)	17.83 abc	3.93 de	40.75 cd	5.42 cdefghi	7.90 gh	660.00 bcde	23.93 bcde	17.38 ab	3.19 def
CV%	26.92	10.33	3.17	8.51	5.35	30.67	3.33	10.82	8.09
GM	17.51	4.33	39.36	5.54	8.50	640.09	23.88	17.21	3.30

Key

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height (cm)
7. PHFFB: Plant height to first fruiting branch (cm)
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPAS: Number of opened bolls per plot
12. BW: Boll weight (g)
13. LP: Lint percent (%)
14. LI Lint index (%)
15. SI: Seed index (g)
16. SCY: Seed cotton yield (kg/ha)
17. FL: Fibre length (mm)
18. FS: Fibre strength
19. FF: Fibre fineness

21S) 299(95) and (S295 x TAMCOT SP 21S) 344(95). The lines (S295 x TX-CDP 37 HH-1-83) 1175(95) and (S295 x TAMCOT SP 21S) 239(95) recorded the highest lint percent while the lines TX-CABUCS-2-1-83 and TAMCOT SP 37 showed the lowest lint percent. The seed cotton yields of the lines (S295 x TX-CDP 37 HH-1-83) 119(95) and (S295 x TAMCOT-CAMD-E) 32(95) were higher than that of the lines TX-CABUCS-2-1-83 and (S295 x TAMCOT-CAMD-E) 324(95). The lines (S295 x TAMCOT SP 21S) 299(95), TX-CABCUS-2-84 recorded the highest fibre length while TAMCOT SP 21S, (S295 x TAMCOT-CAMD-E) 324(95), (S295 x TAMCOT-CAMD-E) 37(95) and (S295 x TAMCOT-CAMD-E) 32(95) presented the lowest.

4.2 Estimates of Variation

The means, standard deviations of means (S.E.$\bar{x}$), ranges and the coefficient of variation (C.V. %) for different characters are presented in Table 8. For each character means, the coefficient of variation ranged from 2.60 per cent for number of days to boll opening to 51.81 per cent for seed cotton yield (kg/ha). The number of opened bolls on the second plant in the plot, seed cotton yield (kg/ha), number of opened bolls per plot (average of 5 plants) also showed a high level of variation. A low level of variation was recorded for number of days to boll opening, lint per cent and fibre length. A wide range of variation was obtained for seed cotton yield (365.20 - 938.30 kg/ha) followed by plant height (71.67 - 94.50 cm) and number of days to the first five flowers on the second plant (74.33 – 87.00).

The results of the analysis of variance for the different characters for 1996, 1997 and the combined data are shown in Tables 9-11. The results from 1996 showed significant (P=0.05) differences among the entries for plant

Table 8: Mean (x̄), standard error of the mean (S.E. x̄), range and coefficient of variation (C.V.) for the nineteen characters.

	Characters	Means	S.E.(x̄)	Range	C.V.%
1.	DFFP	66.76	± 0.56	64.33 - 68.83	4.18
2.	DFFP5	71.19	± 0.71	67.67 - 74.83	4.97
3.	DFFP2	71.61	± 1.12	66.67 - 76.50	7.80
4.	D5FF2	78.66	± 1.25	74.33 - 87.00	7.94
5.	BO5	117.01	± 0.61	113.17 - 123.33	2.60
6.	PH (cm)	81.80	± 1.92	71.67 - 94.50	11.72
7.	PHFFB (cm)	21.43	± 0.49	18.33 - 23.33	11.44
8.	NNFFB	4.29	± 0.10	3.83 - 5.00	11.45
9.	NFB	9.69	± 0.29	8.17 - 10.50	14.95
10.	NOB2	16.97	± 1.76	11.00 - 20.83	51.81
11.	NOBPA5	17.51	± 4.44	13.67 - 22.33	26.92
12.	BW (g)	4.33	± 0.09	3.89 - 5.29	10.33
13.	LP (%)	39.36	± 0.25	35.47 - 43.32	3.17
14.	LI (%)	5.54	± 0.09	4.79 - 6.35	8.51
15.	SI (g)	8.50	± 0.09	7.82 - 9.46	5.35
16.	SCY (kg/ha)	640.09	±39.27	365.20 - 938.30	30.67
17.	FL (mm)	23.88	± 0.16	22.90 - 25.13	3.35
18.	FS (mgm/inch	17.21	± 0.69	15.55 - 18.44	10.82
19.	FF (gram/ten)	3.30	± 0.37	3.03 - 3.81	8.09

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI: Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

Table 9: Mean squares from the analysis of variance for different characters of 25 cotton lines in 1996.

Sources	D.f.	1	2	3	4	5	6	7	8	9
Replication	2	50.68*	66.01	117.29	81.01	24.17	77.45	6.97	0.04	1.21
Entries	24	17.85	30.31	78.58	79.34	21.08	159.68*	6.46	0.50**	1.31
Error	24	11.46	20.80	53.93	49.53	15.05	58.17	3.33	0.17	1.27

Table 9 cont'd.

Sources	D.f.	10	11	12	13	14	15	16	17	18	19
Replication	2	57.31	2.89	0.52**	3.76**	0.06	1.07**	259466.45**	3.58**	4.52*	0.06
Entries	24	59.47	10.51	0.29**	15.54**	0.43	0.21**	50272.57	1.28**	1.33	0.05
Error	24	71.04	24.41	0.03	0.00	0.22	0.03	26630.52	0.33	1.07	0.02

* = significant difference at 5% level of probability.
** = significant difference at 1% level of probability.

Key

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height (cm)
7. PHFFB: Plant height to first fruiting branch (cm)
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight (g)
13. LP: Lint percent (%)
14. LI Lint index (%)
15. SI: Seed index (g)
16. SCY: Seed cotton yield (kg/ha)
17. FL: Fibre length (mm)
18. FS: Fibre strength
19. FF: Fibre fineness

Table 10: Mean squares for the analysis of variance for different characters of 25 cotton lines in 1997.

Sources	D.f.	1	2	3	4	5	6	7	8	9
Replication	2	25.48**	23.56*	28.37	129.77	13.48	1133.92*	2.93	1.29*	0.84
Entries	24	4.13	5.41	15.83	18.27	20.35	166.16	8.37	0.25	2.10
Error	24	2.53	4.85	19.70	42.93	12.40	93.44	7.37	0.32	2.98

Table 10 cont'd.

Sources	D.f.	10	11	12	13	14	15	16	17	18	19
Replication	2	15.57	29.61	0.43	6.26**	0.21	0.09	526294.24**	0.45	32.64**	0.06**
Entries	24	70.75*	43.44*	0.45	13.54**	0.65	0.65**	129928.80**	1.57*	5.40*	0.33**
Error	24	34.87	15.75	0.28	0.00	0.09	0.25	0.00	0.44	2.24	0.00

* = significant difference at 5% level of probability.
** = significant difference at 1% level of probability.

Key

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height (cm)
7. PHFFB: Plant height to first fruiting branch (cm)
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight (g)
13. LP: Lint percent (%)
14. LI Lint index (%)
15. SI: Seed index (g)
16. SCY: Seed cotton yield (kg/ha)
17. FL: Fibre length (mm)
18. FS: Fibre strength
19. FF: Fibre fineness

Table 11: Means squares for combined analysis of variance for different characters of 25 cotton lines grown in Samaru.

Sources	D.f.	1	2	3	4	5	6	7	8	9
Replication in years	2	25.620	9.927	59.660	42.247	0.847	810.927**	2.987	0.606	1.727
Year	1	138.240**	640.667**	998.460**	48.167	902.827**	9141.607**	42.667**	1.927**	25.637**
Entries	24	11.543*	22.477*	55.373*	51.437	0.847**	210.384**	8.737	0.479*	2.009
Entries x years	24	10.448	13.250	39.043	46.181	0.521	95.468	6.097	0.274	1.307
Error	72	7.781	12.541	31.234	38.969	9.278	91.930	6.011	0.241	2.101

Table 11 cont□d.

Sources	D.f.	10	11	12	13	14	15	16	17	18	19
Replication in years	2	31.460	9.780	0.441	7.608**	0.059	0.899*	106510.747	0.780	8.482	0.038
Year	1	181.500	174.960**	0.004	0.346	3.174**	11.064**	37225.127	263.954**	208.412**	49.135**
Entries	24	38.263	32.451	0.564**	26.300**	0.853**	1.204**	100792.738**	2.116**	3.405	0.222**
Entries x years	24	91.958	21.516	0.184	2.791*	0.229	0.365*	79408.543**	0.750	3.334	0.173**
Error	72	77.269	22.203	0.201	1.558	0.222	0.207	38545.234	0.638	3.469	0.071

* = Significant at 0.05 level.
** = Significant at 0.01 level.

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI: Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

height and highly significant (P=0.01) differences for nodes of first fruiting branch, boll weight, lint percent, seed index and fibre length. There were no significant differences among the entries for the other characters. In 1997, significant differences were observed for number of opened bolls on the second plant in the plot, number of opened bolls per plot, fibre length, fibre strength while highly significant differences were noted for lint per cent, seed index, seed cotton yield (kg/ha) and fibre fineness. There were no significant differences for the other characters.

The mean squares from the combined analysis of variance are presented in Table 11. Differences between years were highly significant (P=0.01) for number of days to first flower in the plot, average number of days of the first five flowers in the plot, number of days of the first five flowers on the second plant, number of days to boll opening, plant height, height of first fruiting branch, number of nodes to first fruiting branches, number of fruiting branch, number of opened bolls per plant and per plot, lint index, seed index, fibre length, fibre strength and fibre fineness. There were no significant year effects for number of days of the first five flowers on the second plant, number of opened bolls on the second plant in the plot, boll weight, lint per cent and seed cotton yield (kg/ha). The genotype x year interaction mean squares were significant for lint per cent, seed index and highly significant for seed cotton yield (kg/ha), and fibre fineness. The genotype x year interaction effect was not significant for the other characters.

4.3 Estimates of Variance Components

Estimates of genetic variance components calculated for each year are presented in the Tables 12-13. Negative genotypic variances(σ_g^2) were found in 1996 for the characters, number of opened bolls on second plant and number of opened bolls per plot and for the characters days to first flower on the second plant, days to first five flowers on the second plant, nodes to first fruiting branch and number of fruiting branches in 1997. Phenotypic variances (σ_{ph}^2), genotypic variances (σ_g^2) and error variances (σ_e^2) were positive for other characters for the two years. Estimates of the components of genetic variance were also computed for the combined years from the results of the analysis of variance. Table 14 shows the estimates of phenotypic, genotypic, genotype x year interaction and environmental variances with their respective standard errors. A negative phenotypic variance was observed for number of days to boll opening but it was positive for the other characters. The standard error was higher than the estimates for number of nodes to first fruiting branch and seed cotton yield (kg/ha).

The estimates of genotypic variances were positive for all characters except for number of opened bolls on the second plant in the plot and the standard errors were smaller than the estimates for average number of days of the first five flowers in the plot, boll weight and lint per cent.

The genotype x year interaction variance estimates were negative for number of days to boll opening, number of fruiting branches, number of opened bolls per plant and per plot and boll weight. The standard errors were

Table 12: Genetic components of variance for different characters of 25 cotton lines grown in Samaru in 1996.

	1	2	3	4	5	6	7	8	9
σ^2_{ph}	5.95±2.48	10.10±4.20	26.20±10.20	26.45±11.00	7.03±2.92	53.23±22.14	2.15±0.90	0.17±0.07	0.43±0.18
σ^2_{g}	2.13 ±1.81	3.17±3.11	8.22± 8.07	9.94±8.00	2.01±2.18	33.84±15.19	1.04±0.63	0.11±0.14	0.01±0.64
σ^2_{e}	11.46±2.29	20.80±4.16	53.93± 10.79	49.53±9.91	15.05±3.01	58.17±11.63	3.33±0.67	0.17±0.03	1.27±0.25

Table 12 cont'd.

	10	11	12	13	14	15	16	17	18	19
σ^2_{ph}	19.82±8.25	3.51±1.46	0.10±0.04	5.18±8.16	0.14±0.06	0.07±0.03	26268.83±6971.54	0.43±0.18	0.45±0.37	0.02±0.00
σ^2_{g}	-3.86±7.22	-4.63±1.89	0.09±0.03	5.18±1.43	0.07±0.04	0.06±0.02	78806.5±23932.72	0.32±0.12	0.09±0.42	0.01±0.00
σ^2_{e}	71.04±14.21	24.41±4.88	0.03±0.01	0.00±0.00	0.22±0.04	0.03±0.01	26630.52±5326.10	0.33±0.07	1.07±0.21	0.02±0.00

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. BO5: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI: Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

Table 13: Genetic components of variance for different characters of 25 cotton lines grown in Samaru in 1997.

	1	2	3	4	5	6	7	8	9
σ^2_{ph}	1.37±1.15	1.81±0.75	5.28±2.19	6.09±2.53	6.78±2.82	55.39v23.04	2.79±1.16	0.09±0.03	0.70±0.29
σ^2_g	0.53±0.39	0.19±0.59	-1.29±1.96	-8.22±3.31	2.65±2.04	24.24±16.49	0.33±0.91	-0.02±0.03	-0.29±0.28
σ^2_e	2.53±0.26	4.85±0.97	19.70±4.94	42.93±8.59	12.40±2.48	93.44±18.69	7.37±1.47	0.32±0.06	2.98±0.60

Table 13 cont'd.

	10	11	12	13	14	15	16	17	18	19
σ^2_{ph}	23.58±9.81	14.48±46	0.15±0.06	4.51±1.88	0.22±0.09	0.21±0.09	43309.6±18017.88	0.53±0.22	1.80±0.75	0.11±0.05
σ^2_g	11.96±6.91	9.23±4.13	0.06±0.04	4.51±1.25	0.19±0.06	0.13±0.06	43309.5±11951.71	0.38±0.44	1.05±0.52	0.11±0.03
σ^2_e	34.87±6.97	15.75±3.15	0.28±0.06	0.00±0.00	0.09±0.02	0.25±0.05	0.00±0.00	0.44±0.09	2.24±0.45	0.00±0.00

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI: Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

Table 14: Genetic components of variance for different characters of 25 cotton lines grown in Samaru, 1996 and 1997.

	1	2	3	4	5	6	7	8	9
σ^2_{ph}	1.77 ± 1.32	3.87 ± 2.57	8.79 ± 6.33	8.18 ± 5.88	-7.16 ± 0.23	34.85 ± 24.06	1.45 ± 0.99	0.07 ± 0.55	0.38 ± 0.23
σ^2_g	0.18 ± 1.78	1.54 ± 0.28	2.72 ± 7.27	0.88 ± 7.90	0.05 ± 0.11	19.15 ± 26.42	0.44 ± 1.22	0.03 ± 0.06	0.12 ± 0.27
σ^2_{gv}	0.89 ± 2.08	0.71 ± 0.13	2.60 ± 6.87	2.40 ± 8.21	-8.76 ± 0.87	1.18 ± 17.46	0.03 ± 1.12	0.01 ± 0.05	-0.26 ± 0.29
σ^2_e	7.781 ± 1.26	12.54 ± 2.03	31.23 ± 5.07	39.00 ± 6.33	9.28 ± 1.51	91.83 ± 14.91	6.01 ± 0.97	0.24 ± 0.04	2.10 ± 0.34

Table 14 cont'd.

	10	11	12	13	14	15	16	17	18	19
σ^2_{ph}	5.59 ± 4.38	23.94 ± 3.71	0.09 ± 0.06	4.32 ± 3.01	0.14 ± 0.10	0.19 ± 0.14	9988.10 ± 11526.09	0.35 ± 0.24	0.57 ± 0.39	0.03 ± 0.03
σ^2_g	-8.92 ± 11.40	1.82 ± 4.45	0.06 ± 0.00	3.92 ± 3.02	0.10 ± 0.10	0.14 ± 0.14	3563.93 ± 12340.16	0.23 ± 0.26	0.01 ± 0.54	0.01 ± 0.00
σ^2_{gv}	4.90 ± 16.33	-0.23 ± 4.00	-0.01 ± 0.00	0.41 ± 0.47	0.01 ± 0.05	0.05 ± 0.06	13621.10 ± 14063.53	0.04 ± 0.13	-0.05 ± 0.62	0.03 ± 0.01
σ^2_e	77.27 ± 13.00	22.20 ± 3.60	0.20 ± 0.03	1.56 ± 0.25	0.22 ± 0.04	0.21 ± 0.03	38545.23 ± 6252.86	0.64 ± 0.10	3.47 ± 0.56	0.07 ± 0.01

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI: Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

less than the actual estimates only for three characters; number of days to first five flowers in the plot, number of days to boll opening, boll weight and fibre fineness.

In general the environmental variances for all the characters were higher than the phenotypic, genotypic and genotype x year interaction variances except for number of opened bolls per plant, per plot and lint per cent.

4.4 Estimates of Heritability

In Table 15 are presented the estimates of broad-sense heritability, for all 19 characters studied. Heritability was estimated on plot basis and was not computed for the traits with negative estimates of genotypic variance.

Heritability estimates ranged from 1.75% for fibre strength to 90.74% for lint percent. The high heritabilities were recorded for lint percent, seed index, lint index, fibre length. Seed cotton yield showed moderate heritability.

4.5 Correlation

Table 16 shows the phenotypic, genotypic and environmental correlation coefficients for the nineteen characters measured. Generally the genotypic and environmental correlations were very low compared to the phenotypic correlations. Also in all instances the genotypic and phenotypic correlations are in the same direction. Thus to avoid unnecessary repetitions the more important correlations have been emphasized. From the result the seed cotton yield was positively, phenotypically correlated with yield

Table 15: Estimates of broadsense heritability (h^2).

	Characters	h^2 (%)
1.	Days to first flower in the plot	10.17
2.	Days to first five flower in the plot	39.79
3.	Days to first flower in the second plant	30.94
4.	Days to first five flowers on the second plant	10.76
5.	Days to the opening of the bolls	-
6.	Plant height	54.95
7.	Plant height to first fruiting branch	30.34
8.	Number of nodes to first fruiting branch	42.86
9.	Number of fruiting branches	31.58
10.	Number of opened bolls on the second plant	-
11.	Number of opened bolls per plot	7.60
12.	Boll weight	66.67
13.	Lint percent	90.74
14.	Lint index	71.43
15.	Seed index	73.68
16.	Seed cotton yield	35.68
17.	Fibre length	65.71
18.	Fibre strength	1.75
19.	Fibre fineness	33.33

*Characters with no value have negative σ^2_g.

Table 16: Phenotypic, genotypic and environmental correlations between different characters for 1996/1997.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. DFFP	-	0.752**	0.539**	0.357	0.506**	0.020	0.015	0.065	-0.063	-0.127	-0.324	-0.139	0.045	0.078	0.047	-0.350	-0.203	-0.100	-0.191
		0.033	0.028	0.041	0.004	0.000	0.001	0.006	-0.004	-	-0.030	-0.022	0.010	0.010	0.047	-0.045	-0.004	-0.003	-0.003
		0.020	0.018	0.030	0.010	0.000	0.001	0.003	-0.003	-0.010	-0.020	-0.011	0.002	0.003	0.001	-0.023	-0.002	-0.002	-0.001
2. DFFP5		-	0.680*	0.415	0.642**	0.126	-0.170	0.170	-0.023	-0.116	-0.336	-0.173	-0.056	0.058	0.175	-0.426*	-0.344	-0.183	-0.412*
			0.026	0.035	0.004	0.003	-0.011	0.011	-0.001	-	-0.021	-0.020	-0.008	0.005	0.010	-0.225	-0.005	-0.004	-0.005
			0.015	0.023	0.009	0.002	-0.007	0.006	-0.001	-0.007	-0.013	-0.009	-0.002	0.012	0.003	-0.020	-0.002	-0.003	-0.002
3. DFFP2			-	0.756**	0.478*	0.158	-0.085	0.201	-0.026	-0.336	-0.275	-0.173	-0.110	0.015	0.190	-0.358	-0.298	-0.078	-0.340
				0.078	0.003	0.029	-0.029	0.016	0.001	-	-0.021	-0.024	-0.020	0.001	0.012	-0.041	-0.006	-0.002	-0.005
				0.051	0.008	0.004	-0.004	0.008	0.001	-0.023	-0.013	-0.011	-0.004	0.000	0.004	-0.019	-0.002	-0.002	-0.002
4. D5FF2				-	0.197	-0.139	-0.021	0.159	-0.140	-0.314	-0.193	-0.150	-0.145	-0.134	0.020	-0.387	0.118	0.174	0.061
					0.003	-0.009	-0.004	0.028	-0.016	-	-0.032	-0.045	-0.057	-0.028	0.003	-0.097	0.005	0.010	0.002
					0.008	-0.057	-0.002	0.017	-0.014	-0.056	-0.023	-0.027	-0.014	-0.013	0.001	-0.052	0.002	0.009	0.000
5. BO5					-	0.263	-0.028	0.143	0.084	-0.033	-0.168	-0.031	-0.087	0.130	0.312	-0.217	-0.368	-0.304	-0.421*
						0.002	-0.000	0.002	0.001	-	-0.002	-0.001	-0.002	0.002	0.003	-0.003	-0.001	-0.001	-0.001
						0.002	-0.001	0.004	0.002	-0.001	-0.005	-0.001	-0.014	0.003	0.031	-0.007	-0.002	-0.003	-0.002
6. PH						-	-0.003	0.033	0.634**	0.107	0.337	0.197	0.135	0.300	0.228	0.299	-0.475*	-0.312	-0.373
							0.000	0.002	0.022	(a)	0.044	0.018	0.016	0.019	0.010	0.022	-0.001	-0.005	-0.004
							0.000	0.001	0.015	0.004	0.010	0.007	0.003	0.006	0.003	0.009	-0.002	-0.004	-0.001
7. PHFFB							-	-0.038	-0.188	-0.050	0.044	0.170	0.200	0.211	-0.026	0.288	0.214	0.158	0.297
								-0.005	-0.017	-	0.006	0.039	0.059	0.033	-0.003	0.055	0.007	0.007	0.045
								-0.002	-0.014	-0.006	0.008	0.020	0.012	0.014	-0.001	0.028	0.003	0.058	0.030
8. NNFFB								-	0.010	0.009	-0.205	-0.077	0.126	0.084	-0.051	-0.095	-0.190	-0.214	-0.166
									0.001	-	-0.027	-0.018	0.005	0.013	-0.006	-0.018	-0.006	-0.010	-0.006
									0.001	0.001	-0.015	-0.008	0.007	0.005	-0.002	-0.008	-0.002	-0.007	-0.020
9. NFB									-	0.257	0.567**	0.031	-0.008	0.023	0.045	0.160	-0.258	-0.252	-0.253
										-	0.050	0.005	-0.002	0.002	0.003	0.021	-0.024	-0.008	-0.004
										0.028	0.042	0.003	-0.001	0.001	0.001	0.013	-0.003	-0.008	-0.002
10. NOB2										-	0.519	-0.043	0.032	-0.002	-0.054	0.151	0.088	0.065	0.075
											0.065	-0.007	0.003	0.000	-0.009	0.007	0.002	0.003	0.001
11. NOBPA5											-	0.080	0.093	0.028	-0.098	0.343	0.179	0.109	0.225
												0.020	0.027	0.004	-0.010	0.064	0.006	0.005	0.005
												0.009	0.005	0.002	-0.004	0.033	0.010	0.004	0.002
12. BW												-	0.057	0.359	0.403*	0.315	0.075	-0.063	0.217
													0.030	0.099	0.076	0.106	0.004	-0.005	0.009
													0.032	0.030	0.019	0.039	0.001	-0.003	0.003

Table16 cont'd.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
13. LP													-	0.717**	-0.363	0.385	-0.218	-0.113	0.184
														0.257	-0.089	0.168	-0.016	-0.009	0.008
														0.032	-0.009	0.025	-0.002	-0.005	0.003
14. LI														-	0.370	0.374	-0.304	-0.248	0.048
															0.047	0.086	-0.012	-0.013	0.001
															0.010	0.027	-0.003	-0.006	0.000
15. SI															-	-0.033	-0.147	-0.197	-0.215
																-0.005	-0.004	-0.007	-0.004
																-0.001	-0.001	-0.003	-0.001
16. SCY																-	0.000	0.025	0.124
																	0.000	0.002	0.004
																	0.000	0.001	0.001
17. FL																	-	0.582**	0.672**
																		0.006	0.004
																		0.003	0.001
18. FS																		-	0.388
																			0.003
																			0.002
19. FF																			-

a = characters with no value have negative of s^2_g.
* = significant difference at 5% level of probability.
** = significant difference at 1% level of probability.

Key:

1. DFFP: Days to first flower in the plot
2. DFFP5: Days to first five flower in the plot
3. DFFP2: Days to first flower in the second plant
4. D5FF2: Days to first five flowers on the second plant
5. B05: Days to the opening of the bolls
6. PH: Plant height
7. PHFFB: Plant height to first fruiting branch
8. NNFFB: Number of nodes to first fruiting branch
9. NFB: Number of fruiting branches
10. NOB2: Number of opened bolls on the second plant
11. NOBPA5: Number of opened bolls per plot
12. BW: Boll weight
13. LP: Lint percent
14. LI Lint index
15. SI: Seed index
16. SCY: Seed cotton yield
17. FL: Fibre length
18. FS: Fibre strength
19. FF: Fibre fineness

components, lint percent (0.385), lint index (0.374), seed index (0.027), number of opened bolls in the plot (0.064). Significant phenotypic correlations were found among the flowering period traits, number of days to the first flower in the plot, average number of days to the first five flowers in the plot, number of days to the first flower in the second plant, and number of days to the first five flowers on the second plant. Negative phenotypic correlations were observed between seed cotton yield and the flowering period traits, number of days to the first flower in the plot (rph = -0.350), number of days to the first five flowers in the plot (rph = -426*), number of days to the first flower on the second plant (rph = -0.358), number of days to the first five flowers on the second plant (rph = -0.387). Fibre length showed high positive phenotypic correlations with the two other technological characters, fibre strength (rph = 0.582*) and fibre fineness (rph = 0.672**). Seed cotton yield was phenotypically and positively correlated with fibre strength (rph = 0.025) and fibre fineness (rph = 0.124). There was no correlation between seed cotton yield and fibre length (rph = 0.000). The fibre quality traits studied showed negative phenotypic correlation with all flowering traits except for days to the first five flowers in the plot.

The seed cotton yield was negatively and genotypically correlated with number of days to the first flower in the plot (rg = -0.045), number of days to the first five flower in the plot (rg = -0.225), number of days to the first flower on the second plant (rg = -0.041), number of days to the first five flowers on the second plant (rg = -0.097), number of days to boll opening (average of 5 plants)(rg = -0.003)and number of nodes to first fruiting branch (rg = -0.018).

Seed cotton yield was positively and genotypically correlated with plant height (rg = 0.022), height of first fruiting branch (rg = 0.055), number of fruiting branches (rg = 0.021), number of opened bolls per plot (average of 5 plants)(rg = 0.064), boll weight (rg = 0.106), lint percent (rg = 0.168), lint index (rg = 0.086). Lint percent was positively and genotypically associated with lint index (rg = 0.257), fibre fineness (rg = 0.008) but negatively associated with seed index (rg = -0.089), fibre length (rg = -0.016) and fibre strength (rg = -0.009). The environmental correlation values were very low for all the characters measured.

CHAPTER 5

DISCUSSION

It was observed from the result that the mean performance of the different cotton lines for the two years combined presented a wide range of variation for all the characters measured. The cotton lines also revealed differences in performance from the first year to the second year. The mean number of days to the opening of the bolls (BO5) in 1996 were higher than in 1997. The same observation was noted for plant height. The height to first fruiting branch and seed cotton yield were different for the two years but seed cotton yield appeared better in 1997. Prasad and Katarki (1969), Singh *et al.* (1969) studying the variability in quantitative characters of cotton have reported similar results. The coefficient of variation was less than 10 per cent for 53 per cent of the traits measured but a high coefficient of variation was recorded for number of opened bolls on the second plant, the seed cotton yield (kg/ha) and number of opened bolls per plot (average of 5 plants). A similar result was obtained by Kalsy *et al.* (1978), who suggested that the high degree of variability for these characters may be partly due to genetic and partly due to environmental causes.

The significant mean squares of entries noted for days to first flower in the plot, days to first five flowers on the plot, days to first flower on the second plant, days to boll opening, plant height, number of nodes to first fruiting branch, boll weight, lint percent, lint index, seed index, seed cotton yield (kg/ha), fibre length and fibre fineness confirmed that there was the

presence of variability in the lines studied. The differences in year were not significant for number of days to the first five flowers on the second plant, number of open bolls on the second plant in the plot, boll weight, lint percent, seed cotton yield (kg/ha), suggesting that these traits are more stable and may not change in different environments. The genotype x environment (year) interaction variance was not significant for all traits except for lint percent and seed index which were significant and for seed cotton yield (kg/ha) that appeared highly significant. Thus indicating that the environment influences the determination of these characters. A similar result was reported by Abou-El-Fittouch *et al.* (1967) for lint percent and seed index. Lint percent and seed index are the main components of yield. And environmental variation on yield components should affect the yield itself.

For planned breeding programme to improve yield potential, information on genetic variability is necessary. Thus, in order to quantify the availability of variability present in the cotton lines studied, the phenotypic, genotypic and environmental variances were estimated.

In general the estimates of genetic components were low and sometimes showed negative values for some characters. The negative estimates obtained could be the results of the mathematical computation of obtaining the estimates from the analysis of variance. From the results obtained, the negative mean square values for estimating the genotype x year interaction was greater than genotype mean square; thus, resulting in a negative σ_g^2 estimate. This may happen in quantitative genetic studies especially where only years or locations are considered for the genotype x

environment interaction (Comstock and Moll, 1963; Cockerham, 1963). In this study, it was impossible to separate the total genetic variance into its various components (additive, dominance and epistatic) because of the type of experimental material and design used. But a negative genetic variance could mean one or more of the following: (a) negative estimate of σ^2_D higher than σ^2_A; (b) negative estimate of σ^2_A higher than σ^2_D; (c) negative estimate of both variances.

A negative genotypic variance was estimated for number of opened bolls on the second plant in the plot while number of days to boll opening (average of the first opening of 5 plants), number of fruiting branches, number of opened bolls per plot (average of 5 plants) and boll weight showed a negative genotype x environment (year) interaction. The genotype x environment (year) variance for the seed cotton yield (kg/ha) was high. This suggests that the character would vary with years over a wide area. Cockerham (1963) pointed out that a large interaction component of variance could be the result of the genetic variance being larger in one environment than the other, and this could be true in this study.

Heritability expresses the proportion of the total variance that is attributable to the average effects of genes, and thus help to determine the degree of resemblance between relatives. In other words, heritability indicates the effectiveness with which selection of genotypes can be based on phenotypic performance. In this study, broadsense heritability estimate was high for boll weight, lint percent, lint index, fibre length and plant height. Similar results were reported by Bhardwaj *et al.* (1968), Ma *et al.* (1992), and

Tomar *et al.* (1992). Moderate heritability estimates were recorded for number of nodes to first fruiting branch, number of days to the first five flowers in the plot, number of days to the first flower on the second plant, height of the first fruiting branch, seed cotton yield (kg/ha), number of fruiting branches. The estimates were low for the other characters. The high and moderate heritability found in this study tend to suggest the possibility of applying any suitable modified selection procedure to the population of cotton lines in order to make a selection for desired characters since the heritability expressed showed that there was a close correspondence between genotype and phenotype due to a relatively smaller contribution of environment to the phenotype.

Correlation studies between yield and other traits have been of immense help in selecting suitable plant type. According to Robinson *et al.* (1951) most of the characters of economic importance such as yield, are complex in inheritance and may involve several related characters and hence the degree of phenotypic and genotypic correlations of the characters is important. Genetic correlations are a measure of the association of genes controlling two characters. That is to say,if two characters have no genes in common, their genetic correlation would be expected to be zero (Mode and Robinson, 1959). The selection for one character results in a progress for all positively correlated characters but a regress to all negatively correlated characters.

There were negative phenotypic and genotypic associations between seed cotton yield and number of days to the first flower in the plot, number

of days to the first five flowers in the plot, number of days to the first flower on the second plant, number of days to the first five flowers on the second plant, and number of nodes to first fruiting branch. These imply that seed cotton yield and these earliness traits have independent behaviour. The selection of early maturing cotton lines may not consequently improve seed cotton yield. There were positive phenotypic and genotypic correlations, between seed cotton yield and plant height, height of first fruiting branch, number of fruiting branches, number of open bolls per plot (average of 5 plants), boll weight, lint percent and lint index. These correlations indicate that the improvement of these traits may certainly increase the seed cotton yield thus will be useful in a selection programme. The low environmental correlations for the traits, suggest that the traits were less influenced by the environment. The significant phenotypic correlations between number of days to the first flower in the plot and number of days to the first five flowers in the plot, number of days to the first flower in the second plant, on one hand, and on the other hand, significant phenotypic associations between number of days to the first five flower in the plot and number of days to the first flower as the number of the first five flowers on the second plant implies that these traits do not behave independently of one another. Similar observation has been made by Alabi (1982). The low positive phenotypic and genotypic correlations observed between number of days to the first flower in the plot and lint percent; lint index and seed index, indicating that the selection of early cotton lines based on days to first flower per plot with lint percent, lint index and seed index will increase the yield since these traits are

components of yield. Fibre length, fibre strength and fibre fineness were negatively associated with the earliness characters. This reveals that the selection of early maturing cotton lines will not improve the fibre length, fibre strength and fibre fineness of the materials since these characters behave in opposite directions. The significant correlations between fibre length, fibre strength and fibre fineness suggest that the selection of cotton lines for these characters can be carried out simultaneously. The lint percent showed significant positive and negative correlation with lint index and fibre length, respectively. This is in agreement with the findings of Bhandari *et al.* (1969). The number of opened bolls per plot (average of 5 plants) positively correlated with boll weight and fibre length. A similar result was observed by Kyei and Kea (1968).

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 Summary

The twenty-five cotton lines (*Gossypium hirsutum* L.) composed of 9 multi-adversity resistant lines from USA and 16 F5 lines derived from crosses between the variety S295 and the multi-adversity lines were evaluated using a 5 x 5 triple lattice design at the Institute for Agricultural Research Farm, Samaru during rainy seasons of 1996 and 1997. Observations were recorded on nineteen characters. Analysis of variance and covariance were computed for those characters.

For each character, significant variation was observed among the lines. The coefficient of variation ranged from 2.60% for number of days to boll opening (average of the first opening of 5 plants) to 51.81% for seed cotton yield (kg/ha). Significant differences were observed for years for all characters except number of days to the first five flowers on the second plant, number of opened bolls on the second plant in the plot, boll weight, lint percent and seed cotton yield. The mean performances of the cotton lines were also significantly different for all characters except number of days to the first five flowers on the second plant, height to first fruiting branch, number of fruiting branches, number of open bolls on the second plant in the plot, number of opened bolls per plot (average of 5 plants) and fibre strength. The genotype x year interactions were only significant for lint percent, seed index and highly significant for seed cotton yield and fibre fineness.

Genetic variance estimates among cotton lines were positive for all character except number of opened bolls on the second plant in the plot. The genotype x year interaction variance was positive for every character except days to boll opening (average of the first opening of 5 plants), number of fruiting branches, number of opened bolls per plot (average of 5 plants), boll weight.

The estimates of heritability suggest that a range of variability existed in the cotton lines studied which can be improved through a breeding programme. The positive phenotypic and genotypic correlations between seed cotton yield and plant height, plant height to first fruiting branch, number of fruiting branches, number of opened bolls per plot (average of 5 plants), boll weight, lint percent, lint index indicated that the improvement of these yield component characters may certainly increase the seed cotton yield and so they will be useful in a selection programme.

6.2 Conclusion

The parameters used in this study revealed that a wide range of variability existed in the materials for the various characters. This variability could be exploited to improve some lines of interest. The positive correlation between yield and number of opened bolls, boll weight, lint percent, lint index should be taken into account to improve the yield of any line in this study. Also the positive correlation among earliness traits showed that any of these traits could be used as a measure for earliness in the breeding programme.

The lines (S295 x TAMCOT-CAMD-E) 32(95), (S295 x TX-CDP-37 HH-1-83) 1175(95), (S295 x TAMCOT SP 21S) 239(95), TX-CDP 37 HH-1-83, (S295 x TX-CDP 37 HH-1-83) 119(95), TX-CABCUS-2-84 and (S295 x TAMCOT SP 21S) 299(95) could be exploited in future breeding programme.

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