STUDY OF GENETIC PARAMETERS AND THE ASSOCIATION OF YIELD COMPONENTS OF SOME EXOTIC GERMPLAM OF TOSSA JUTE (*Corchorus olitorius* L.)

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CERTIFICATE

*This is to certify that thesis entitled, "STUDY OF GENETIC PARAMETERS AND THE ASSOCIATION OF YIELD COMPONENTS OF SOME EXOTIC GERMPLAM OF TOSSA JUTE (**Corchorus olitorius L.**)" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in GENETICS & PLANT BREEDING**, embodies the result of a piece of bona fide research work carried out by **Md. Maksuder Rahman**, Registration No. 06-02177, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by him.

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STUDY OF GENETIC PARAMETERS AND THE ASSOCIATION OF YIELD COMPONENTS OF SOME EXOTIC GERMPLAM OF TOSSA JUTE (*Corchorus olitorius* L.)

ABSTRACT

BY

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Thirty exotic genotypes of tossa jute (*Corchorus olitorious* L.) from different geographic origins were grown at the Central Jute Agricultural Experiment Station of Bangladesh Jute Research Institute (BJRI), Jagir, Manikganj, during April, 2007 to September 2007 to study their variability and genetic correlation coefficient for 9 morphological characters. Significant variation was observed among the tested genotypes for different traits except base diameter. High Genotypic Coefficient of Variation (GCV) was observed for fibre weight, stick weight, green weight without leaves and green weight with leaves. High heritability values with high genetic advance in percentage of mean were obtained for green weight without leaves, green weight with leaves, stick weight and fibre weight. All the genotypes showed maximum increase in plant height from 90 to 105 days of emergence. Genotypic correlation showed positive association of fibre yield with plant height, green weight with leaves, green weight without leaves and stick weight. At phenotypic level, green weight with leaves, green weight without leaves and stick weight did not show significant relation with plant height, base diameter, node number, inter nodal length and leaf area. Significant and high positive associations were observed between fibre yield and green weight with leaves, green weight without leaves and stick weight. Path coefficient analysis indicated maximum direct contribution of stick weight per plant towards fibre yield followed by followed by green weight without leaves per plant, base diameter and leaf area. The genotypes G1, G3, G6, G7, G12, G18 and G20 showed better performance than the check varieties O-9897, O-72 and OM-1 in respect of fibre yield per plant. These genotypes might be utilized in future breeding programmes for improvement of this crop species.

LIST OF CONTENTS

LIST OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

FULL WORD	ABBREVIATION
Agro Ecological Zone	AEZ
Analysis of variance	ANOVA
And others (at elli)	*et al.*
Bangladesh Bureau of Statistics	BBS
Bangladesh Jute Research Institute	BJRI
Centimeter	cm
Coefficient of Variation	CV
Department of Agricultural Extension	DAE
Environmental Coefficient of Variation	ECV
Genetic Advance	GA
Genotypic Coefficient of Variation	GCV
Grand Mean	$\overline{X}$
Heritability in broad sense	h^2b
Mean Sum of Square	MS
Meter	m
Millimeter	mm
Million hectare	m ha
Muriate of Poatsh	MP
Phenotypic Coefficient of Variation	PCV
Randomized Complete Block Design	RCBD
Sher-e-Bangla Agricultural University	SAU
That is	viz.
Triple Super Phosphate	TSP

Chapter 1
Introduction

CHAPTER 1

INTRODUCTION

Jute is an important bast fibre crop in Bangladesh. It earns foreign exchange equivalent to four hundred and sixty five crore taka annually to our national economy (BBS, 2005). About 95 percent of the world's jute is produced in Bangladesh, India and Pakistan. In Bangladesh two kinds of jute viz., white jute (*Corchorus capsularis*) and tossa jute (*Corchorus olitorius*) are mainly grown for commercial purpose. Besides, kenaf (*Hibiscus cannabinus*) and mesta (*Hibiscus sabdariffa*) are also grown in some areas of the country with very low nutrient status. The fibre of tossa jute is finer and stronger. It's price in both national and international market is also high and the growers get better economic return from the cultivation of tossa jute. The quality of fibre is greatly determined by the availability and quality of retting water.

Jute fibre is used extensively in the manufacture of different types of packaging materials for various agricultural and industrial products. It is also used as a raw material for the production of paper and pulp (IJO, 1994). There are various diversified products of jute, such as Handicrafts, Furnishing fabrics and Apparels. The important handicrafts uses are sica, rug, papose, ladies bag, ladies parts, money bag, table mat, caps, hats, ornament box, wall cover, wall hangers etc. The probable furnishing fabrics are table cover, sofa cover, kushon, bed sheet, bed cover, curtain, prayer mat etc. The important apparels are shirting, shooting, fabrics for saloar-kamiz, punjabi, pajama, dopatta, jacket, sweater, denim etc. Jute and jute based products are environment friendly, pollution free and health hazard free. Hence uses are increasing day by day. And result, the price of jute is also increasing simultaneously.

Jute constitutes a major source of employment, which is of prime importance to the rural economy of our country. Although jute exhibits high socioeconomic importance for the producing countries, the global situation is confronted with a number of problems. The prices paid to the farmers are not remunerative and subjected to annual of fluctuation. It appears from the recent records that in Bangladesh, not only the area under cultivation of jute being pushed more and more to the marginal lands. Presently, jute is growing in about 956 thousand acres of land and production is about 732 thousand metric tons annually (BBS, 2005).

Jute belongs to the genus *Corchorus* in the family Tiliaceace. The genus *Corchorus* contains about 100 species which are distributed throughout the tropical regions of Africa, South America, Australia, China and South-East Asia. But only two species, *Corchorus capsularis* L. and *Corchorus olitorius* L. are cultivated for their fibre of commence. *Corchorus capsularis* is called deshi pat or tita pat or white pat and its fibre is ordinarily whitish. *C. capsularis* varieties can grow both on low and high land situation and has better adaptability in flood condition. *Corchorus olitorius* L. is called tossa pat or mitha pat. The fibre of *C. olitorius* is finer, softer, stronger and more lustrous than *C. capsularis* and fibre colour is yellowish, reddish or grayish colour.

Bangladesh Jute Research Institute (BJRI) has got about 6000 germplasm of jute, kenaf and mesta of both exotic and indigenous origin of which *C. capsularis* is 2368 and *C. olitorius* is 1540. Among the C. *olitorius* germplasm exotic is 554 and the rest is indigenous in origin. Study of these indigenous and exotic materials is very important to know the nature and architecture of these materials for utilization in breeding programme. Variability is must for any fruitful breeding programme and the extent of variability and genetic estimates of exotic germplasm *C. olitorius* available at BJRI has not yet been studied.

Variation in environmental factors causes variation in yield and quality of fibre. Therefore, it is important to gain insight about the phenotypic, genotypic and environmental variances for various attributes. This will help to select suitable materials for utilization in crop improvement programme. Genetic estimates of the materials will also help to know the nature of the materials with which breeder is working and would further help in choosing between the alternative and the selection procedures. In cereal crops, reproductive part is the main concern for improvement, but in jute this is the vegetative part ie. the stem bark which need to be improved for higher fibre yield. Roy (1965) stated that plant height and base diameter should be considered for selection of genotype for higher fibre yield. Base diameter along is also a good indicator of yield potential (Eunus and Salam, 1960). Ali (1994) suggested that bark thickness and area of phloem wedges contributed significantly to the fibre yield. Dudley and Moll (1969) suggested partitioning the available variability in a population into its heritable and non heritable components.

Fibre yield in jute is a complex character and is dependent on some morphological and physiological characteristics. These yield contributing characters are correlated with fibre yield and also among themselves. Therefore, the direct and indirect effects of these component characters on fibre yield and ultimately the real contributor for fibre yield can be findout by adopting path analysis. Path coefficient analysis is a standardized partial regression coefficient analysis which splits the various correlation coefficients into the measure of direct and indirect effects of set independent variables on a dependent variable (usually yield). So, it is used to analyze the real contribution of individual complex character in yield.

Swarup and Changale (1962) suggested to study the heritability and genetic gain to obtain better estimate about genetic variation. Knowledge about genetic variation of various morphological and agronomical attributes would be useful to plant breeder for determining important selection criteria.

Keeping the above consideration in view, the present investigation was carried out with the following objectives:

1. To study the morphological and agronomical characteristics of the materials.
2. To study genetic variability, correlation and path coefficient analysis of the attributes.
3. To findout superior genotypes for utilization in breeding programme.

Chapter 2

Review of Literature

CHAPTER 2

RREVIEW OF LITERATURE

Fibre yield in jute are complex characters and are dependent on some morphological and physiological characteristics. Variations in environmental factors cause variation in yield and quality of fibre. Therefore, it is important to gain insight about the phenotypic, genotypic and environmental variances for various attributes. This will help in selecting the right materials for utilization in crop improvement programme.

Jute breeders are trying hard to improve fibre yield of this crop species. Lot of genetic variability has already been reported but desired results so far as yield and quality aspect of this crop are eluding. The relevant literature available on *Corchorus olitorius* has been reviewed and here under being presented.

2.1 Variability

Genetic variability exists in a genotype of a crop species is an index of its genetic dynamism. Plant breeding revolves around selection which can be effectively practiced only in the presence of variability of desired traits. The success of breeding depends entirely upon the variability which may be generated either by direct introduction or in the progenies of suitable crosses among selected parents.

Charles and Smith (1939) separated the genetic variance from total variance by the use of estimates of environmental variance based on non-segregating population and also established possible relations between mean and variance.

Shukla and Singh (1967) studied different plant characters of ten varieties of *Corchorus capsularis* which enabled to compare the amount of variability present in different characters.

Eunus (1968) reported that fibre yield in jute is mainly based on two morphological characters namely plant height and base diameter.

Plant height and base diameter were found to have less genetic variability than stick weight and fibre weight respectively (Singh, 1970).

Joseph (1974) studied genetic parameters in segregating population of *C. capsularis* and noted that green weight and fibre weight had higher genetic variability than plant height, basal diameter and node number.

Ghosdastidar and Dus (1984) reported that the genetic coefficient of variation was higher for fibre weight whereas it was low for node number (12.55) and base diameter in tossa jute.

Chaudhury *et al.* (1981) found that the estimated variance in *C. olitorius* for the characters plant height, basal diameter, node number, internodal length and fibre yield was significant.

Sardana *et al.* (1990) observed higher phenotypic coefficient of variation than the corresponding genetic coefficient of variance value for plant height, basal diameter, number of node and fibre weight.

Dahal (1991) observed that the phenotypic co-efficient of variation was higher than corresponding genotypic co-efficient of variation for all characters.

Begum and Sobhan (1991) observed that the fibre yield and some other morphoagronomic characters, viz., plant height, base diameter, leaf angle, petiole length and internodal length showed high genotypic coefficient of variation.

Ahmed *et al.*(1993) reported that phenotypic coefficient of variation was relatively higher than genotypic one for all characters. Both genotypic and phenotypic coefficients of variation were the highest for fibre yield followed by green weight and lowest for base diameter. Wide and narrow differences between genotypic and phenotypic coefficient of variation were observed in stick weight and petiole length.

According to Ali (1994) high values of genotypic and phenotypic coefficient of variation was observed for fibre yield and bark thickness.

Islam *et al.* (2002) observed variability in tossa jute and revealed significant differences for all characters with wide range of variability. The difference between PCV and GCV were little for all the characters.

Islam and Ahmed (2003) studied variability in jute genotypes and revealed significant differences for all characters with wide range of variability. Considerable amount of genotypic variances were obtained for fibre weight per plant, stick weight per plant and plant height.

Akter *et al.* (2005) observed variability in jute and reported that dry fibre weight, dry stick weight, fresh weight with leaves, fresh weight without leaves and node number had high genotypic coefficient of variation.

2.2 Heritability and genetic advance

Heritability is the degree to which variability of quantitative character is transmitted from parents to offspring. So the estimation of heritability is of great interest to the plant breeders. A quantitative characters having high heritability is transmitted from parent to offspring conveniently. Heritability value alone provides the indication of the amount of genetic progress that would result from selection of best individual.

Robinson *et al.* (1949) defined heritability as the additive variance in percent of total variance in narrow sense.

Comstock and Robinson (1952) and Johnson *et al.* (1955) have reported that the estimates of heritability and prediction of genetic advance become biased by genotype – environment interaction.

According to Johnson *et al.* (1955) heritability along with genetic advance would be more useful in predicting yield under phenotypic selection than heritability estimates alone.

Nei (1960) reported maximum heritability estimates for the characters of days to flowering, plant height, fibre weight, basal diameter and internode length.

Dudley and Moll (1969) reported that the improvement of a crop mainly depends upon the magnitude of genetic variability and the degree to which the yield and its components are heritable.

Singh (1970) observed maximum heritability values for plant height (86.75%) followed by basal diameter (82.46%) and fibre weight

(68.04%). The highest genetic advance was observed in case of fibre weight (22.81%) followed by stick weight (19.31%), basal diameter (11.72%) and plant height (8.20%).

Jana (1972) reported that the estimated heritability value in tossa jute was 39 percent for plant height, 15 percent for basal diameter, and nearly 40 percent for fibre yield.

According to Katiyar *et al.* (1974) heritability value alone provides the indication of the amount of genetic progress that would result from selecting the best individual.

Sobhan (1982) reported highest broad sense heritability in tossa jute for seed yield (78.38%) followed by bark weight (63.92%), fibre yield (49.48%), plant height (38.97%), node number (38.72%), number of branches per plant (31.43%), stick weight (29.59%) and base diameter (15.03%).

Chaudhury (1984) observed that top diameter, internode length and plant height had the highest heritability estimates coupled with moderate genetic advance. Therefore, phenotypic selection for making genetic improvement is expected to be more effective for those three characters.

Ghosdastidar and Das (1984) observed very high heritability (82.43%) and high genetic advance as percent of mean (39.09%) for plant height but node number and base diameter showed low heritability (63.93% and 39.71%) respectively and low genetic advance as percent of mean (20.68 and 15.25). Fibre yield also showed low heritability (53.93%) but high genetic advance as percent of mean (44.95).

Chaudhury *et al.* (1984) reported high heritability value for plant height (64.85%) out of eight agronomic characters in tossa jute. They suggested that the phenotypic selection for these characters would be more effective to achieve high yield. They also observed high genetic advance for fibre yield, plant height, base diameter, lamina breadth, petiole length and internodal length.

Sardana *et al.* (1990) studied genetic parameters in jute and reported that plant height, basal diameter and dry weight had high broad sense heritability coupled with a moderate by high genetic advance indicating the success of direct selection.

Dahal (1991) observed moderate heritability value with low genetic advance for the characters leaf area, petiole length, plant height, base diameter, dry stick weight, harvest index and dry fibre weight.

Talukder and Haque (1992) observed that the estimates of heritability (in broad sense) and genetic advance were greater in biomass yield. Heritability for branches per plant and 1000 seed weight was 2.74 and 3.15 times greater, respectively than that of seed yield per plant.

According to Ahmed *et al.* (1993) highest genetic advance (35.5%) coupled with the highest heritability (52.9%) was observed for fibre yield. They also reported high and low heritability values for petiole length and base diameter. High and low values for genetic advance as percent of mean were obtained for fibre yield and base diameter.

Islam and Ahmed (2003) studied heritability in jute genotypes and showed high heritability and genetic advance for stick weight and fibre weight.

2.3 Correlation between yield and yield contributing characters

Yield, the ultimate goal for a plant breeder, is the outcome of the interaction of a number of factors inherent both in the plants and in the environment in which the plant grows. Yield is a complex character, which is not only polygenically controlled but also influenced by its component characters (Alam *et al.* 1988). Fibre of jute (*C. capsularis* L. and *C. olitorius* L.), kenaf (*Hibiscus cannabinus* L.) and roselle (*H. sabdariffa* L.) are the product of vegetative growth of the plant. Yield of fibre is dependent on various component characters such as plant height, base diameter, node number, fibre percentage, stick weight, days to flower etc. (Sanyal and Dutta, 1961; Sasmol and Chakraborty, 1978; Sinha *et al.* 1986 and Aruna *et al.* 1988). These yield contributing characters are related to fibre yield and also among themselves. Knowledge of the relationship among these characters and with yield is essential for making selection in the breeding programme. The correlation studies can provide information about such relationship among the characters.

High correlation of plant height and basal diameter with fibre yield was reported by Patel (1940).

Ghose and Patel (1945) observed in a population of a *capsularis* variety that plant height and basal diameter have strong positive correlation with fibre yield.

Sanyal and Dutta (1961) have observed high positive correlation between fibre yield and green weight of plants in both the species, *capsularis* and *olitorius*.

Roy (1965) found high positive correlation between basal diameter and fibre yield (0.929) and followed by plant height and fibre yield (0.889).

Shukla and Singh (1967) worked out phenotypic, genotypic and environmental correlation coefficients for different quantitative characters in *capsularis* jute. The correlation coefficient at environmental level indicated that fibre weight was positively correlated with basal diameter, stick weight, green weight and plant height.

Das (1968) found positive correlation between plant height on the one hand and basal diameter and dry fibre weight on the other in *Corchorus capsularis*.

Eunus (1968) observed simple correlation coefficient and indicated that fibre yield in jute was directly correlated with basal diameter while plant height was not a dependable indicator of fibre yield performance.

Paul and Eunus (1974) studied on *Corchorus olitorius* L. and found that phenotypic and genotypic correlation for plant height, base diameter, node numbers, inter nodal length, fruit length, number of seeds per fruit, seed yield per plant, leaf area index, leaf angle and time of flowering were highly significant in a number cases but environmental correlation coefficients were significant only in a few cases.

Maiti and Chakravarty (1977) studied yield components of common Indian bast fibres. Analysis on correlation coefficients revealed that fibre yield was highly positively correlated with plant height and basal diameter.

Maiti *et al.* (1977) observed that the highly significant and positive correlation between green weight and fibre yield might be due to their strong positive direct effect on yield.

Sinhamahapatra and Rakshit (1977) observed that fibre yield per plant was positively correlated both genotypically and phenotypically with plant height, basal diameter, middle diameter, wood diameter, node number and internodal length in tossa jute.

Gupta and Das (1977) measured five characters associated with yield in nine varieties of *C. capsularis*. He reported that fibre yield was significantly correlated with plant height in all varieties.

Srivastava *et al.* (1979) found in *capsularis* jute that the correlation coefficient was insignificant and negative between yield and plant height but positive between yield and node number. It was close to unity between yield and basal diameter.

Chaudhury *et al.* (1981) reported that plant height and basal diameter were positively correlated with fibre yield but node number and internodal length were non-significantly correlated with fibre yield. They also observed genotypic correlation higher than phenotypic correlation.

Ghosdastidar and Bhaduri (1983) observed strong positive genetic association of plant height and basal diameter with fibre yield, but poor correlation was observed between node number and other components in *capsularis* jute.

Ghosdastidar and Das (1984) observed that plant height, base diameter and node number showed significantly high positive correlation with fibre yield per plant.

Das (1987) found that plant height, basal diameter, leaf area and node number showed highly significant correlation coefficient with fibre yield. Petiole length was found to be significantly correlated with leaf area only.

Das and Rakshit (1988) reported highly significant correlation of fibre yield with plant height, basal diameter, node number and leaf area but non-significant correlation with petiole length.

Sardana *et al.* (1990) observed that plant height, basal diameter and node number had highly significant and positive correlation with dry fibre yield per plant.

Manjunathan and Sheriff (1991) observed high genotypic and phenotypic coefficient of variation for dry fibre yield, green weight and stick weight.

Islam and Ahmed (2003) reported significant positive association of fibre yield with all the characters at both phenotypic and genotypic levels. Genotypic correlation was higher than their corresponding phenotypic correlation in all the characters.

Islam *et al.* (2004) observed significant positive genotypic correlation of fibre yield per plant with plant height, base diameter, leaf area, node number, internodal length, fresh weight with leaves, fresh weight without leaves and dry stick weight in tossa jute.

Akter *et al.* (2005) found that plant height, base diameter, fresh weight with leaves, fresh weight without leaves and dry stick weight had significant positive association with dry fibre weight in jute.

2.4 Path analysis

The term path coefficient was coined by Wright (1921) to denote the direct influence of variable (cause) upon another variable (effect) as measured by the standard deviation remaining in the effect after the influence of all other possible paths are estimated except that of cause. Path coefficient analysis is a standardized partial regression coefficient analysis and as such measures the direct influence of one variable upon other and allows the partitioning of correlation coefficient into direct and indirect effects of component characters. So it is used to analyze the real contribution of individual complex character in yield.

Mandal *et al.* (1980) studied path coefficient analysis of 6 characters in *C. olitorius* and reported that plant height, basal diameter and node number had positive direct effects on fibre yield. The effect of plant height was found to be greatest.

Chaudhury *et al.* (1981) reported that plant height contributed maximum direct effect on the fibre yield of tossa jute followed by node number, basal diameter and internode length. Plant height also influenced fibre yield through the indirect paths of internode length, basal diameter and node number respectively at phenotypic level. Plant height contributed the maximum effect at genotypic level whereas basal diameter showed negative direct effects. Plant height also influenced fibre yield through internode length and basal diameter at genotypic level.

Ghosdastidar and Bhaduri (1983) found that plant height and basal diameter had high positive effects on fibre yield of *C. capsularis*. They further observed that in all cases direct positive effects through plant height and also basal diameter had substantial and positive effect on fibre yield.

In a study with tossa jute, Ghosdastidar and Das (1984) reported that only plant height and basal diameter registered high positive direct effect on fibre yield. But in all cases indirect positive effects through plant height on fibre yield were consistently very high.

Biswas (1984) reported that node number and intermodal length had negative direct effect on yield.

Das (1987) observed that plant height had a high positive direct effect on fibre yield followed by basal diameter and leaf area. Rest of the traits such as petiole length, base diameter and node number had low and negative direct effects.

Das and Rakshit (1988) observed that plant height had the highest positive direct effect on yield of tossa jute followed by basal diameter and leaf area. Rest of the characters had low and negative direct effect. The indirect effects of all characters except in petiole length via plant height were all appreciably high.

Sardana *et al.* (1990) reported that plant height had the maximum direct effect on fibre yield followed by base diameter in jute germplasm analysis. Moderate indirect effect was observed only in case of node number through plant height. The effect was negligible.

Thirthamallappa and Sheriff (1991) reported that plant height had maximum direct effect on fibre yield in jute.

Khatun and Sobhan (1992) showed that plant height and bark weight exerted the greatest influence both directly and indirectly upon fibre yield of tossa jute.

Islam *et al.* (2004) carried out an experiment on path analysis in tossa jute. They reported that fresh weight with leaves per plant had the highest positive direct effect on fibre weight.

Akter *et el.* (2005) observed highest direct effects was obtained for fresh weight without leaves on fibre yield in jute.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

The experiment was carried out at Central Jute Agricultural Experiment Station of Bangladesh Jute Research Institute (BJRI), Jagir, Manikganj during the period from April to September, 2007.

3.1 Experimental Site

The experimental site is located in the young Brahmaputra and Jamuna Flood plain (AEZ-8) at 3.4m above sea level and about 60 km west of Dhaka.

3.2 Climate and Soil

The experimental site was situated in the tropical climate zone, characterized by heavy rainfall during the month from May to August and scantly rainfall during most of the year. Mean monthly temperature and rainfall for the growing season are presented in Appendix I.

The soil of the experimental field was sandy loam in texture having a P^H around 6.5. The land was medium high with uniform topography and almost homogenous with respect to soil fertility.

3.3 Experimental Material

The material comprised of 30 germplasm accessions of tossa jute (*C. olitorius* L.) including three standard varieties, 0-9897, OM-1 and var. 0-72. The genetically pure and physically healthy seeds of these genotypes were collected from the Gene Bank of Bangladesh Jute Research Institute (BJRI), Dhaka. Origin of the selected genotypes is shown in Table 1.

Table 1. Origin of 30 selected genotypes of tossa jute

Genotype No.	Accession No.	Country of origin / Place of collection
G1	1332	Japan
G2	1334	Japan
G3	1336	Germany
G4	1351	India
G5	1356	USSR
G6	1360	Denmark
G7	1481	Sri lanka
G8	1507	India
G9	1508	India
G10	1509	India
G11	1523	Sri lanka
G12	1524	Sri lanka
G13	1525	Sri lanka
G14	1526	ICRISAT
G15	1561	ICRISAT
G16	1807	India
G17	1861	Zambia
G18	3705	Kenya
G19	3717	Kenya
G20	3723	Kenya
G21	3733	Kenya
G22	3760	Kenya
G23	3771	Kenya
G24	3775	Kenya
G25	3783	Syria
G26	3777	Kenya
G27	3990	Syria
G28	O-9897	Bangladesh
G29	OM-1	Bangladesh
G30	O-72	Bangladesh

3.4 Design and Layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each plot had a single row of 3m length. Space between rows was 0.30m and block to block distance was 1m. The genotypes were randomly distributed to each plot within each block.

3.5 Land Preparation

The experimental plot was prepared by deep ploughing followed by harrowing and laddering. The recommended doses of fertilizers such as 170kg/ha Urea, 51 kg/ha TSP and 80 kg MP. The whole amount of TSP and MP and half of the Urea were applied as broadcast during final land preparation. The remaining half of the Urea was top dressed twice after first and final weeding.

3.6 Sowing and Intercultural Operation

Seeds were sown on 08 April, 2007. Thinning and weeding were done twice, after 15 and 35 days of sowing to maintain uniform plant population. Insecticide was not applied but hand picking was practiced to control the jute hairy caterpillar at larval and pupal stage.

3.7 Collection of Data

The following data on morphological characters were recorded from 10 randomly selected plants of each genotype from each replication at the time of harvest at 120 days crop age.

1. Plant height (m): It was measured from the base of the plant to the tip of the main shoot in meter.
2. Base diameter (mm): Base diameter was measured at the base of the stem in mm using slide calipers.
3. Nodes per plant: Total Number of nodes per plant was counted and expressed in number.

4. Internodal length (cm): Internodal length was measured from the middle portion of the plant.
5. Leaf area (sq. cm): Length and breadth (at the middle portion of lamina) of five laminae per plant was measured in cm and leaf area was computed with the help of following formula as suggested by Gopalkrishna and Sasmal (1974).

   Leaf area = k x Length x Maximum breadth

   Here the value of k was 0.6604
6. Green weight with leaves (g) per plant: Green weight of the plants with leaves per plant was recorded.
7. Green weight without leaves (g): Green weight of the plants without leaves was recorded.
8. Dry stick weight (g): Weight of sundried stick per plant was measured in gram.
9. Dry fibre weight (g): Weight of fibre per plant after retting, extraction and drying was measured in gram.

3.8 Statistical Analysis

All the collected data of the present study were statistically analyzed. For each character, analysis of variance was done individually by F test (Panse and Shukhatme, 1978) and mean values were separated by DMRT (Steel and Torrie, 1980). The mean square (MS) at error and phenotypic variances were estimated as per Johnson *et al.* (1955). The error MS was considered as error variance (σ^2e). Genotypic variances (σ^2g) were derived by subtracting error MS from the genotype MS and dividing by the number of replications as shown below:

$$\sigma^2 g = \frac{(GMS - EMS)}{r}$$

Where,

GMS and EMS are the genotypic and error mean square and r is the number of replication.

The phenotypic variances (σ^2p) were derived by adding genotypic variances (σ^2g) with error variances (σ^2e) as given by the following formula:

$$\sigma^2p = \sigma^2g + \sigma^2e$$

3.8.1 Estimation of genotypic and phenotypic coefficient of variation

Genotypic and phenotypic coefficient of variation were calculated as reported by Burton (1952),

Genotypic coefficient of variation (GCV) = $\frac{\sigma_g}{\bar{x}} \times 100$

Where,

σ_g = Genotypic standard deviation

$\bar{X}$ = Population mean

Similarly, the phenotypic coefficient of variation was calculated from the following formula:

Phenotypic coefficient of variation (PCV) = $\frac{\sigma_p}{\bar{X}} \times 100$

Where,

σ_p = Phenotypic standard deviation

$\bar{X}$ = Population mean

3.8.2 Estimation of heritability

Broad sense heritability was estimated by the formula suggested by Hanson *et al.* (1956) and Johnson *et al.* (1955).

$$\text{Heritability } (H_b) = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where,

H_b = Heritability in broad sense

σ^2_g = Genotypic variance

σ^2_p = Phenotypic variance

3.8.3 Estimation of genetic advance

The expected genetic advance for different characters under selection was estimated using the formula suggested by Lush (1949) and Johnson *et al.* (1955).

$$\text{Genetic advance (GA)} = \frac{\sigma_g^2}{\sigma_p^2} \times k \times \sigma_p$$

Where,

k = Selection differential, the value of which is 2.06 at 5% selection intensity

σ_p = phenotypic standard deviation

3.8.4 Estimation of genetic advance in percentage of mean (GA % mean)

Genetic advance as percentage of mean was calculated from the formula suggested by Comstock and Robinson (1952).

$$\text{GA\% mean} = \frac{\text{Gentic advance}}{\text{Population mean}} \text{ x } 100$$

3.8.5 Estimation of genotypic and phenotypic correlation coefficient

For calculating the genotypic and phenotypic correlation coefficient for all possible combination the following formula suggested by Miller *et al.* (1958), Johnson *et al.* (1955) and Hanson *et al.* (1956) were adopted.

The genotypic covariance component between two traits and the phenotypic covariance component were derived in the same way as for the corresponding variance components. The covariance components were used to compute genotypic and phenotypic correlation between the pairs of characters as follows:

$$\text{Genotypic correlation } (r_{gxy}) = \frac{\sigma^2_{gxy}}{\sqrt{(\sigma^2_{gx} \times \sigma^2_{gy})}}$$

Where,

σ^2_{gxy} = Genotypic covariance between the traits x and y

σ^2_{gx} = Genotypic variance of the trait x

σ^2_{gy} = Genotypic variance of the trait y

$$\text{Phenotypic correlation } (r_{pxy}) = \frac{\sigma^2_{pxy}}{\sqrt{(\sigma^2_{px} \times \sigma^2_{py})}}$$

Where,

σ^2_{pxy} = Phenotypic covariance between the traits x and y

σ^2_{px} = Phenotypic variance of the trait x

σ^2_{py} = Phenotypic variance of the trait y

3.8.6 Estimation of path coefficient

Correlation coefficients were further partitioned into component of direct and indirect effect by path co-efficient analysis originally developed by Wright (1921) and later described by Dewey and Lu (1959) using the following simultaneous equation:

$r_{15} = p_{15} + r_{12}p_{25} + r_{13}p_{35} + r_{14}p_{45}$

$r_{25} = r_{12}p_{15} + p_{25} + r_{23}p_{35} + r_{24}p_{45}$

$r_{35} = r_{13} P_{15} + r_{23}p_{25} + p_{35} + r_{34}p_{45}$

$r_{45} = + r_{14}p_{15} + r_{24}p_{25} + r_{34}p_{35} + p_{45}$

Where, r_{12}, r_{13}, r_{14} etc. are the estimates of simple correlation coefficients between variable x_1 and x_2, x_1 and x_3, x_1 and x_4 etc. respectively, and p_{15}, p_{25}, p_{35} and p_{45} are the estimates of direct effects of variables x_1, x_2, x_3 and x_4 respectively on the dependent variable x_5 (effect).

Residual effect, $P^2R_5 = \sqrt{\{1 - (p_{15}\, r_{15} + p_{25}\, r_{25} + p_{35}\, r_{35} + p_{45}\, r_{45})\}}$

Path coefficient was estimated for 8 morphological and agronomical characters related to fibre yield viz. plant height, base diameter, number of nodes per plant, internode length, leaf area, green weight with leaves per plant, green weight without leaves per plant and stick weight per plant.

Chapter 4
Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

Data pertaining to nine morphological characters were computed and statistically analyzed and the results thus obtained were presented and discussed separately under the following heads:

1. Analysis of variance and genetic parameters
2. Correlation coefficient
   2.1 Simple correlation coefficient
   2.2 Genotypic and phenotypic correlation coefficient
3. Path coefficient

4.1 Analysis of variance and genetic parameters

The extent of variation among the genotypes in respect of 9 characters was studied (Table 2) and the mean value, range, standard deviation and coefficient of variation have been presented in Table 3. Variance of the genotypes, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV), hereditability and genetic advance have been presented in Table5.

4.1.1 Plant height

Significant differences were observed among the genotypes for plant height which ranged from 2.61 m (G1) to 3.43 m (G7). Genotypes viz. G4 (2.89m), G6 (2.87m), G9 (2.89m), G10 (2.89m), G25 (2.89m) and G26 (2.90m) were statistically similar for plant height (Table 2). The estimated phenotypic and genotypic variances were 0.06 and 0.02 (Table 4). In case of plant height the phenotypic coefficient of variation (8.56%) and genotypic coefficient of variation (4.86%) were close to each other indicating less environmental influence and the heritability was moderate (Table 4). Therefore, selection based upon phenotypic expression of this character would be effective for the improvement of this crop species.

Plant height of the genotypes was also measured at 15 days intervals i.e. at 75, 90, 105 and 120 days to assess their relative growth rate. The mean values were 2.37 m, 2.41 m, 2.71 m and 2.88 m in 75, 90, 105 and 120 days of growth stage respectively (Table 5).

The result showed that the increase of plant height from 75-90 was 1.95%, from 90-105 days was 12.50% and from 105-120 days was 6.20%. This indicated that the maximum increase of plant height occurred from 90 to 105 days ages of the plants and at that stage the increase rate was maximum i.e.; 12.50%. The genotype G28 showed the highest rate of growth 18.39% at 90-105 days and the G5 showed the lowest rate of growth (4.83%) at this stage. Genotypes G10, G11, G27, G28, G29 and G30 (Table 5) also showed higher rate of growth. The differences in the growth rates of the genotypes at different stages clearly indicate the differences in the vegetative growth of the genotypes. Quick growing genotype has a breeding importance in developing short duration variety. In that sense G10, G11 and G27 of the exotic materials studied may be utilized in crossing programme for producing varieties with quick growth rate.

Therefore, the rate of vegetative growth may be considered as an important criterion for characterizing and selecting exotic germplasm of tossa jute.

Table 2. Mean performance of nine morphological characters for 30 genotypes of tossa jute

Genotypes	Plant height (m)	Base diameter (mm)	Nodes/plant (no.)	Internodal length (cm)	Leaf area (sq. cm)	Green weight per plant (g)		Stick weight (g/plant)	Fibre weight (g/plant)
						With leaf	Without leaf		
G1	2.61 h	15.40	55.00 i	5.69 a	34.22 b-k	126.89 a	97.13 a	33.30 a	10.77 c-e
G2	2.84 f-h	15.75	67.33 h	4.31 b-e	33.45 c-k	94.46 f-i	77.24 de	18.04 d-f	8.75 fg
G3	2.84 e-h	15.69	78.00 b-h	4.15 b-e	35.63 a-j	118.02 abc	86.35 bcd	23.04 c	10.03 de
G4	2.89 d-h	15.27	77.00 b-h	4.07 b-e	39.60 a-c	100.71 d-h	66.71 fg	19.27 d	8.33 g
G5	2.99 b-g	15.38	80.33 b-g	4.38 b-e	41.23 a	81.79 i-l	61.86 gh	15.34 g-i	7.58 g-j
G6	2.87 d-h	15.78	71.67 e-g	3.80 e	34.75 a-k	123.72 a	92.22 abc	24.83 bc	10.75 c-e
G7	3.43 a	15.34	84.67 b-d	4.05 b-e	37.14 a-g	116.97 a-d	94.55 ab	31.44 a	13.48 a
G8	3.08 b-e	14.79	67.67 h	4.35 b-e	37.05 a-g	88.96 f-j	56.19 hij	17.65 df	6.56 i-l
G9	2.89 d-h	13.72	72.00 e-h	4.23 b-e	40.00 a-c	68.58 k-n	45.59 kl	14.09 i-k	6.49 j-l
G10	2.89 d-h	13.77	67.67 h	3.86 de	37.52 a-e	64.77 mn	44.55 kl	14.50 i-k	6.30 kl
G11	3.19 a-d	14.55	88.00 ab	4.08 b-e	41.06 a	87.04 f-j	58.82 ghi	17.33 d-g	8.39 fg
G12	3.28 ab	15.41	97.33 a	4.29 b-e	39.77 a-c	119.09 ab	84.70 cd	25.95 b	12.35 ab
G13	3.10 a-e	15.43	82.33 b-e	4.07 b-e	39.00 a-d	75.71 j-m	49.41 jkl	15.93 f-i	6.89 h-k
G14	3.03 b-f	15.16	77.00 b-h	4.30 b-e	40.52 ab	120.50 a	88.25 abc	25.30 b	10.95 cd
G15	3.06 b-e	14.69	69.00 gh	4.52 b	37.35 a-f	96.15 f-i	66.33 fg	18.13 de	8.72 fg
G16	3.08 b-e	14.12	73.33 d-h	4.48 bc	37.31 a-f	66.23 l-n	45.76 kl	12.94 j-l	6.73 h-k
G17	2.95 b-g	17.10	81.00 b-g	4.48 bc	32.57 d-k	59.01 mn	39.99 l	10.25 m	5.07 m
G18	2.71 f-h	13.44	69.33 gh	4.08 b-e	29.42 jk	102.08 c-g	66.70 fg	22.74 c	11.48 bc
G19	2.94 c-h	14.28	74.33 c-h	4.43 b-d	35.16 a-k	100.71 d-h	74.56 ef	26.01 b	10.00 de
G20	3.03 b-f	14.40	82.00 b-f	4.02 b-e	32.62 d-k	117.28 a-d	85.06 cd	24.21 bc	11.15 b-d
G21	3.02 b-g	15.88	86.33 a-c	4.15 b-e	36.06 a-i	85.04 g-k	61.53 gh	16.87 e-h	7.72 g-i
G22	3.25 a-c	17.72	86.33 a-c	4.44 b-d	30.63 g-k	112.08 a-e	78.61 de	24.36 bc	10.11 de
G23	3.02 b-g	15.25	82.67 b-e	4.23 b-e	36.83 a-h	73.59 j-n	51.20 ijk	14.93 h-j	6.07 k-m
G24	2.84 e-h	14.91	72.33 b-h	3.92 c-e	30.42 h-k	83.89 h-k	63.75 gh	16.81 e-h	7.78 gh
G25	2.89 d-h	13.91	70.00 f-h	3.92 b-e	32.83 d-k	102.71 b-f	77.66 de	18.28 de	9.59 ef
G26	2.90 d-h	14.55	72.00 e-h	4.36 b-e	28.89 k	100.25 d-h	77.86 de	18.00 d-f	10.84 cd
G27	2.72 f-h	12.46	67.33 h	4.29 b-e	32.15 e-k	60.10 mn	45.80 kl	12.43 kl	5.90 k-m
G28	2.80 e-h	14.34	69.33 gh	4.10 b-e	30.12 i-k	57.89 n	41.84 kl	11.64 lm	5.82 k-m
G29	2.68 gh	14.35	67.00 hi	4.19 b-e	32.30 e-k	63.72 mn	47.14 jkl	12.71 kl	5.49 lm
G30	2.71 f-h	14.65	71.67 e-h	4.46 bc	30.84 f-k	60.24 mn	45.01 kl	12.59 kl	6.02 k-m
Mean	**2.95**	**14.90**	**75.00**	**4.26**	**35.21**	**90.94**	**65.75**	**18.97**	**8.54**
CV%	**7.04**	**12.01**	**9.91**	**8.55**	**9.44**	**9.79**	**7.89**	**6.94**	**8.64**
$LSD_{(0.05)}$	**0.339**	**NS**	**12.20**	**0.594**	**5.433**	**14.82**	**8.48**	**2.15**	**1.205**

The means followed by common letter are statistically similar with each other at 5% level of significance.

Table 3. Range, mean, standard deviation (SD) and coefficient of variation (CV %) of 9 morphological characters of 30 genotypes of tossa jute.

Characters	Range	Mean	SD	CV%
Plant height (m)	2.61-3.43	2.95	0.187	7.04
Base diameter (mm)	12.50-17.70	14.90	1.040	12.01
Node/plant	55.00-97.00	75.00	8.555	9.91
Internodal length (cm)	3.80-5.69	4.26	0.335	8.55
Leaf area (sq. cm)	28.89-41.23	35.21	3.736	6.1
Green wt. with leaves/plant (g)	57.89-126.89	90.94	22.304	9.79
Green wt. without leaves /plant (g)	39.99-97.13	65.75	17.776	7.89
Stick wt./plant (g)	10.25-33.30	18.97	5.898	6.94
Fibre wt./plant (g)	5.07-13.48	8.54	2.296	8.64

Table 4. Estimation of genetic parameters of 9 morphological characters for 30 genotypes of tossa jute

Characteristics	Genetic variance	Phenotypic variance	Environmental variance	Heritability	Genetic advance (5%)	Genetic advance (5%) in percent mean	GCV	PCV	ECV
PH	0.02	0.06	0.04	32.27	0.17	5.69	4.86	8.56	7.04
BD	0.12	1.81	1.09	39.73	1.10	7.37	5.68	9.01	6.99
NP	54.62	110.35	55.74	49.49	10.71	14.22	9.81	13.94	9.91
IL	0.07	0.20	0.13	33.88	0.31	7.34	6.12	10.52	8.55
LA	10.28	21.33	11.05	48.20	4.59	13.02	9.11	13.11	9.44
GWW	473.59	545.24	71.65	86.86	41.18	45.94	23.93	25.68	9.31
GWO	303.17	329.71	26.54	91.95	34.39	52.31	26.48	27.62	7.84
SW	34.23	35.90	1.67	95.34	11.77	62.05	30.85	31.59	6.82
FW	5.10	5.62	0.52	90.69	4.43	51.88	26.45	27.77	8.47

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internodal length (cm), LA = Leaf area (sq. cm), GWW =Green weight with leaves/plant (g), GWO = Green weight without leaves/plant (g), SW = Stick weight/plant (g) and FW = Fibre weight/plant (g).

Table 5. Growth rate of 30 genotypes of tossa jute at 15 days intervals (75 days, 90 days, 105 days and 120 days)

Genotypes	Plant height (m) at different days				Increase (%) of plant height at different days		
	75	90	105	120	75-90	90-105	105-120
G1	1.88	1.94	2.15	2.27	3.18	10.83	5.58
G2	2.17	2.18	2.46	2.56	0.45	12.85	4.07
G3	2.22	2.47	2.62	2.76	11.25	6.08	5.34
G4	2.45	2.46	2.76	3.10	0.40	12.20	12.32
G5	2.44	2.49	2.61	3.07	2.04	4.83	17.63
G6	2.35	2.40	2.67	2.86	2.12	11.26	7.12
G7	2.56	2.60	2.87	2.98	1.55	10.39	3.83
G8	2.39	2.42	2.74	2.93	1.25	13.23	6.93
G9	2.28	2.31	2.64	2.75	1.31	14.29	4.17
G10	2.34	2.40	2.75	2.87	2.55	14.59	4.36
G11	2.37	2.40	2.75	2.93	1.26	14.59	6.55
G12	2.77	2.83	3.17	3.22	2.16	12.02	1.58
G13	2.39	2.43	2.77	3.01	1.66	14.00	8.67
G14	2.40	2.43	2.73	2.92	1.24	12.35	6.96
G15	2.47	2.52	2.82	3.02	2.01	11.91	7.09
G16	2.43	2.45	2.76	2.94	0.81	12.66	6.52
G17	2.48	2.52	2.80	2.95	1.60	11.12	5.36
G18	2.45	2.49	2.82	2.94	1.62	13.26	4.26
G19	2.39	2.41	2.61	2.92	0.83	8.30	11.88
G20	2.51	2.55	2.85	2.93	1.58	11.77	2.81
G21	2.31	2.35	2.61	2.73	1.72	11.07	4.60
G22	2.46	2.50	2.83	2.98	1.62	13.20	5.30
G23	2.60	2.64	2.92	3.08	1.53	10.61	5.48
G24	2.37	2.46	2.77	2.87	3.79	12.60	3.61
G25	2.39	2.42	2.74	2.94	1.25	13.23	7.30
G26	2.37	2.39	2.73	2.90	0.83	14.23	6.23
G27	2.22	2.25	2.63	2.78	1.34	16.89	5.70
G28	2.21	2.23	2.64	2.81	0.89	18.39	6.44
G29	2.21	2.24	2.62	2.73	1.35	16.97	4.20
G30	2.14	2.21	2.55	2.65	3.26	15.39	3.92
Mean	**2.37**	**2.41**	**2.71**	**2.88**	**1.95**	**12.50**	**6.20**
SD	**0.16**	**0.16**	**0.17**	**0.18**	**1.92**	**2.86**	**3.14**
CV%	**10.98**	**10.78**	**11.46**	**10.98**	**9.41**	**4.09**	**8.41**

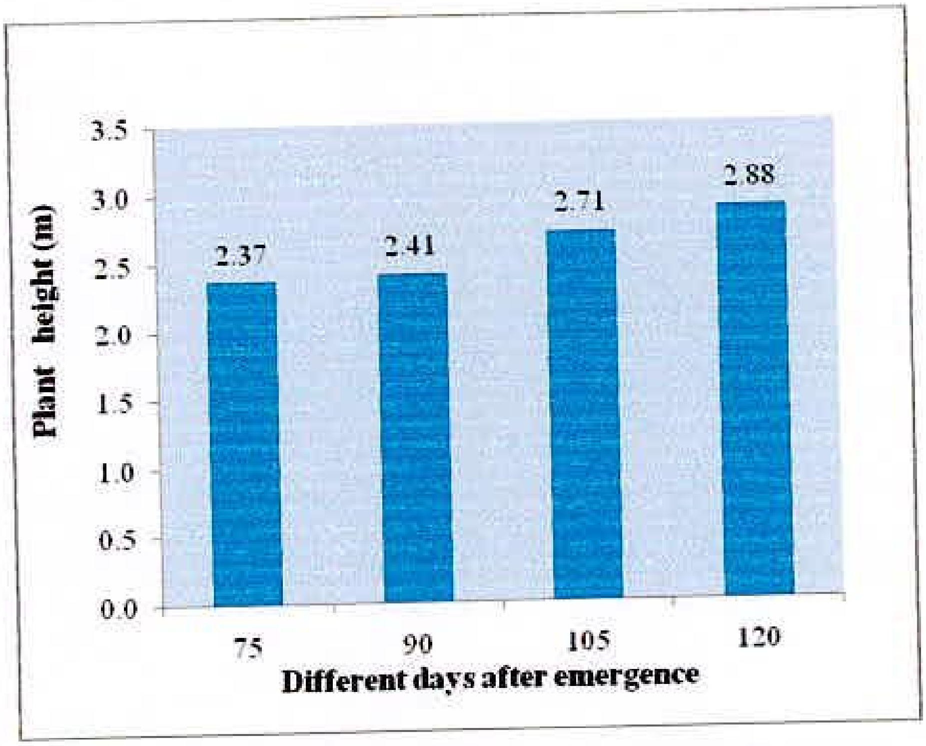

Fig. 1: Plant height at different days after emergence

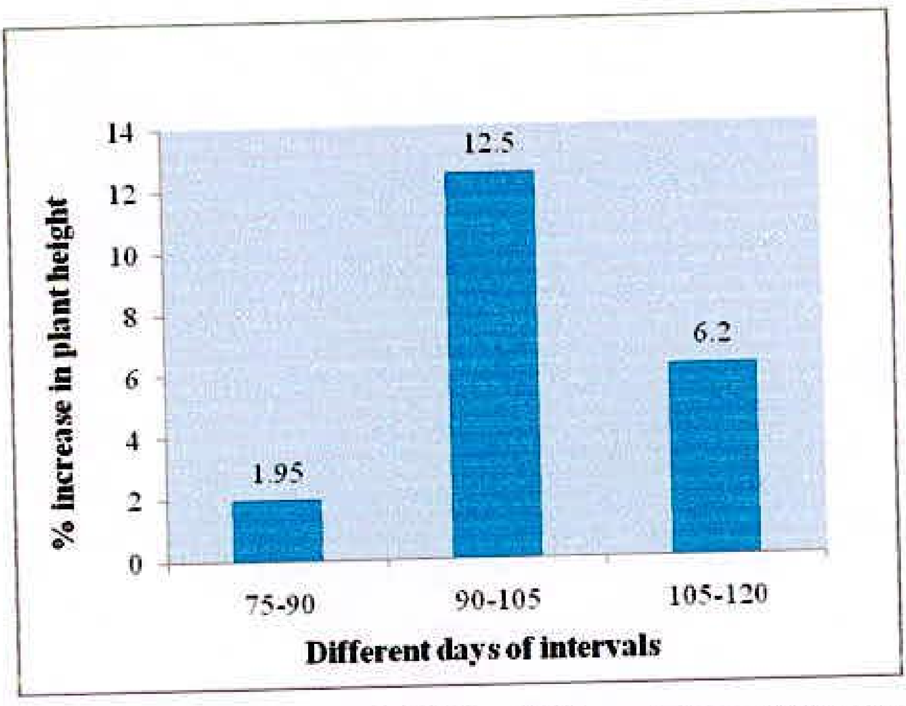

Fig. 2: Increase in plant height at different days of intervals

4.1.2 Base diameter

Analysis of variance showed non-significant differences among the genotypes for basal diameter. The highest and lowest base diameter were observed in G22 (17.72 mm) and G27 (12.46mm) respectively (Table 2). This trait showed highest differences between estimated phenotypic coefficient of variation (PCV) than the corresponding genotypic coefficient of variation (GCV) (Table 4). The highest differences between PCV and GCV suggested that the expression of character was mostly under the control of environment. The moderate heritability (39.73%) together with low genetic advance in percent of mean (7.37%) indicated that selection for this character would not be effective. The results of this experiment support the findings of Dahal (1991) who found higher PCV than the corresponding GCV value and moderate heritability coupled with low genetic advance for base diameter.

4.1.3 Number of nodes per plant

Significant differences among the genotypes were observed for nodes per plant. The maximum nodes per plant (97.33) was observed in the genotype G12 followed by G11, G21 and G22 (Table 2). The minimum nodes per plant (55.00) was found in G1, followed by G29 (67.0) genotypes, which were statistically similar. The phenotypic coefficient of variation (13.94%) was higher than the genotypic coefficient of variation (9.81%) (Table 4). Moderate heritability (49.49%) with genetic advance in percent of mean (14.22%) indicated that this trait might be taken into consideration during the selection process. Similar results were also reported by Ghosdastidar *et al.* (1984) and Johnson *et al.* (1955).

4.1.4 Internodal length

The mean values for inter nodal length showed significant differences among the genotypes. The highest internodal length was observed in G1 (5.69 cm) and the lowest internodal length was found in G6 (3.80 cm)

(Table 2). The phenotypic variance (0.20) was much higher than the genotypic variance (0.13) (Table 4). Heritability (33.88%) was moderate and genetic advance as percent of mean was low (7.34%), with such moderate heritability and low genetic advance, selection of genotype based on internodal length would be judicious.

4.1.5 Leaf area

Significant differences among the genotypes were observed from the analysis of variance for leaf area. The highest leaf area (41.23 sq. cm) was found in the genotype G5, followed by G11 (41.06 sq. cm), G4 (39.60 sq. cm), G9 (40.00 sq. cm), G12 (39.77 sq. cm), G13 (39.00 sq. cm) and G14 (40.52 sq. cm), which were statistically similar. The minimum leaf area (28.89 sq. cm) was observed in the genotype G26 (Table 2).

The phenotypic variance (21.33) for leaf area was higher than the genotypic variance (10.28) and this indicates the environmental influences on leaf area (Table 4). The differences between phenotypic coefficient of variation (13.11%) and genotypic coefficient of variation (9.11%) were minimum which indicates genetic control of this trait. Heritability (48.20%) and genetic advance in percent of mean (13.02%) was high for these characters. High heritability coupled with high genetic advance indicated good scope of selection for improving this trait.

4.1.6 Green weight with leaves per plant

The genotypes differed significantly from each other in respect of green weight. This ranged from 57.89 g (G28) to 126.89 g (G1) with a mean value of 90.94 g (Table 3).

The genotypes viz. G3 (118.02 g), G6 (123.72 g), G7 (116.97 g), G12 (119.09 g), G14 (120.50 g), G20 (117.28 g) and G22 (112.08) were statistically similar for green weight with leaves (Table 2). The phenotypic coefficient of variation (25.68%) and genotypic coefficient of variation (23.93%) were close to each other, indicating less environmental effect on this trait (Table 4). High heritability (86.86%) with high genetic advance in percentage of mean (45.94%) indicated that this trait might be taken into consideration while selecting genotype for breeding programme.

4.1.7 Green weight without leaves per plant

The genotypes showed significant differences for air dry matter. The green weight without leaves ranged from 39.99 g (G17) to 97.13 g (G1) with a mean value 65.75 g (Table 3). The Genotypes, viz. G2 (77.24 g), G22 (78.61 g), G25 (77.66 g) and G26 (77.86 g) were statistically similar for green weight without leaves (Table 2). The phenotypic variance was higher than the environment and genotypic variance (Table 4). The phenotypic coefficient of variation and genotypic coefficient variation were (27.62%) and (26.48%), respectively. The estimated heritability was high (91.95%) and genetic advance as percent of mean (52.31%) was also high. High heritability coupled with high genetic advance indicated that selection base on this character would be effective.

4.1.8 Stick weight per plant

Stick weight revealed significant differences among the genotypes. The maximum and minimum stick weight were observed in genotypes G1 (33.30 g) and G17 (10.25 g), respectively (Table 3). The genotypes viz. G 6 (24.83 g), G12 (25.95 g), G14 (25.30 g), G19 (26.01 g), G 20 (24.21 g) and G22 (24.36 g) were statistically similar for stick weight (Table 2). The genotypic variance (34.23), phenotypic variance (35.90) and heritability (95.34%) were higher for this character (Table 4). The phenotypic coefficient of variation (31.59%) and genotypic coefficient of variation (30.85%) were close to each other. The higher heritability with high genetic advance in percent of mean (62.05%) indicated that selection of genotype based on this character would be effective.

4.1.9 Fibre weight per plant

Fibre weight showed significant differences among the genotypes (Table 3) and it ranged from 5.07 g (G17) to 13.48 g (G7). The genotypes, viz., G1 (10.77 g), G6 (10.75 g), G14 (10.95 g) and G26 (10.84 g) were statistically similar for fibre weight (Table 2). The phenotypic and genotypic coefficients of variation were 27.77% and 26.45% respectively. The heritability value (90.69%) as well as genetic advance as percent of mean (51.88%) was higher (Table 4). The high heritability with high genetic advance provided opportunity for selection of high valued genotypes.

4.2 Correlation coefficient

4.2.1 Simple correlation coefficient

Correlation coefficient among yield and eight yield contributing characters of tossa jute genotypes are presented in (Table 6). Fibre yield showed significant positive correlation with green weight with leaves (0.920**), green weight without leaves (0.921**) and stick weight (0.898**). Fibre yield showed in significant but positive correlation with plant height (0.334), base diameter (0.164), node number (0.238), internodal length (0.041) and leaf area (0.011). Similar results were also reported by several authors in jute (Singh, 1970; Chaudhury *et al.*, 1981).

Green weight with leaves showed significant positive correlation with green weight without leaves (0.972**), stick weight (0.922**) and fibre weight (0.920**). Green weight without leaves showed significant positive correlation with stick weight (0.914**) and fibre weight (0.921**). This relationship indicated that fairly strong inherent association was present between fibre yield and green weight with leaves, green weight without leaves and stick weight.

Therefore, these characters might be considered for selecting progeny or parental lines for high fibre yield.

Table 6 : Simple correlation coefficient (r) among 9 morphological characters of 30 genotypes in tossa jute

Characters	PH	BD	NP	IL	LA	GWW	GWO	SW	FW
PH	-	0.383*	0.771**	-0.216	0.492**	0.260	0.209	0.256	0.334
BD		-	0.442*	0.184	0.057	0.319	0.307	0.251	0.164
NP			-	-0.339	0.381*	0.162	0.105	0.104	0.238
IL				-	-0.032	0.134	0.157	0.273	0.041
LA					-	0.095	0.020	0.093	0.011
GWW						-	0.972**	0.922**	0.920**
GWO							-	0.914**	0.921**
SW								-	0.898**
FW									-

*Significant at the 0.05 level **Significant at the 0.01 level of probability

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internodal length (cm), LA = Leaf area (sq. cm), GWW =Green weight with leaves/plant (g), GWO = Green weight without leaves/plant (g), SW = Stick weight/plant (g) and FW = Fibre weight/plant (g).

4.2.2 Genotypic and phenotypic correlation coefficient

Genotypic and phenotypic correlation coefficient for fibre weight and yield contributing morphological characters are presented in (Table 7).

Positive and highly significant genotypic correlation was observed between plant height and node number (0.999**) followed by green weight with leaves and green weight without leaves (992**); green weight with leaves and stick weight (0.942**); green weight without leaves and stick weight (0.930**); green weight with leaves and fibre weight (0.767**); green weight without leaves and fibre weight (767**); stick weight and fibre weight (0.704**); plant height and leaf area (0.690**); node number and leaf area (0.587**); base diameter and node number (0.521**); plant height and base diameter (0.441*); base diameter and green weight with leaves (0.387*); Base diameter and green weight without leaves (0.370*); internodal length and stick weight (0.363*); significant but negative correlation was observed between plant height and internodal length (-0.420*); node number and internodal length (-0.449*).

Positive and highly significant phenotypic correlation was observed between green weight with leaves and green weight without leaves (0.931**) followed by green weight without leaves and stick weight (0.886**); stick weight and fibre weight (0.877**); green weight with leaves and stick weight (0.887**); green weight without leaves and stick weight (0.886**); green weight with leaves and fibre weight (0.878**); green weight without leaves and fibre weight (0.885**); plant height and nodes number (0.548**); base diameter and node number (0.374*); significant but negative correlation was observed with plant height and internodal length (-0.810**).

Table 7. Genotypic and phenotypic correlation coefficient among 9 morphological characters for 30 genotypes in tossa jute

		BD	NP	IL	LA	GWW	GWO	SW	FW
PH	G	0.441*	0.999**	-0.420*	0.690**	0.306	0.228	0.311	0.355
	P	0.342	0.548**	-0.810**	0.340	0.227	0.205	0.213	0.266
BD	G		0.521**	0.335	0.032	0.387*	0.370*	0.288	0.171
	P		0.374*	0.073	0.079	0.253	0.243	0.220	0.114
NP	G			-0.449*	0.587**	0.165	0.127	0.135	0.261
	P			-0.251	0.180	0.162	0.088	0.064	0.184
IL	G				-0.115	0.179	0.191	0.363*	-0.033
	P				0.035	0.093	0.131	0.191	0.015
LA	G					0.093	-0.002	0.093	-0.005
	P					0.099	0.051	0.096	0.009
GWW	G						0.992**	0.942**	0.767**
	P						0.931**	0.887**	0.878**
GWO	G							0.930**	0.767**
	P							0.886**	0.885**
SW	G								0.704**
	P								0.877**

*Significant at the 0.05 level, **Significant at the 0.01 level of probability

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internodal length (cm), LA = Leaf area (sq. cm), GWW =Green weight with leaves/plant (g), GWO = Green weight without leaves/plant (g), SW = Stick weight/plant (g) and FW = Fibre weight/plant (g).

Results revealed that the genotypic correlation coefficient obtained between pairs of character in all possible combination was higher than their corresponding phenotypic correlation coefficient except between internodal length and node number, green weight without leaves and leaf area and, green weight without leaves and fibre weight. This indicated fairly strong inherent association between yield and the characters studied. Similar results were also reported by several authors in jute materials (Singh, 1970; Sinhamahapatra and Rakshit, 1977; Chaudhury *et al.* 1981). Therefore these characters should get preference for selecting a progeny or parental line for high fibre yield.

4.3 Path Coefficient

In order to findout a clear picture of the interrelationship between fibre yield and other yield components direct and indirect effects were worked out using path analysis. Fibre weight per plant considered as a resultant (dependent) variable and plant height, base diameter, number of nodes per plant, internodal length, leaf area, green weight with leaves per plant, green weight without leaves per plant and stick weight per plant were independent variables.

The association of characters for eight causal variables with fibre weight per plant related to genotypic path coefficient analysis had been presented in Table 8 and also showed diagrammatically in Fig. 3.

4.3.1 Plant height

Plant height had negative direct effect on fibre weight per plant (-0.103) at genotypic level and it has also positive correlation with fibre weight (0.3551*). Plant height contributed indirectly through base diameter (0.111), intermodal length (0.239), leaf area (0.055), green weight without leaves (0.202) and stick weight (0.311) at genotypic level. Negative direct effect of plant height may be nullified by positive indirect effect of plant height via these characters. So selection should be done not only based on plant height but other associated characters must also be considered.

Table8. Path coefficient showing direct (bold value) and indirect effects of 8 morphological characters on fibre yield at genotypic level for 30 genotypes of tossa jute.

Characters	PH	BD	NP	IL	LA	GWW	GWO	SW	FW
PH	**-0.103**	0.111	-0.153	0.239	0.055	-0.306	0.202	0.311	0.3551**
BD	-0.045	**0.252**	-0.075	-0.190	0.003	-0.387	0.328	0.288	0.1714
NP	-0.109	0.131	**-0.145**	0.255	0.046	-0.165	0.113	0.135	0.2615
IL	0.043	0.084	0.065	**-0.569**	-0.009	-0.179	0.169	0.363	-0.0333
LA	-0.071	0.008	-0.085	0.006	**0.079**	-0.093	-0.002	0.093	-0.0051
GWW	-0.032	0.097	-0.024	-0.102	0.007	**-1.000**	0.879	0.942	0.7674**
GWO	-0.023	0.093	-0.018	-0.109	0.000	-0.992	**0.886**	0.930	0.7670**
SW	-0.032	0.072	-0.020	-0.206	0.007	-0.942	0.824	**1.000**	0.7042**

** Significant at 1% level of probability

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internodal length (cm), LA = Leaf area (sq. cm), GWW =Green weight with leaves/plant (g), GWO = Green weight without leaves/plant (g), SW = Stick weight/plant (g) and FW = Fibre weight/plant (g).

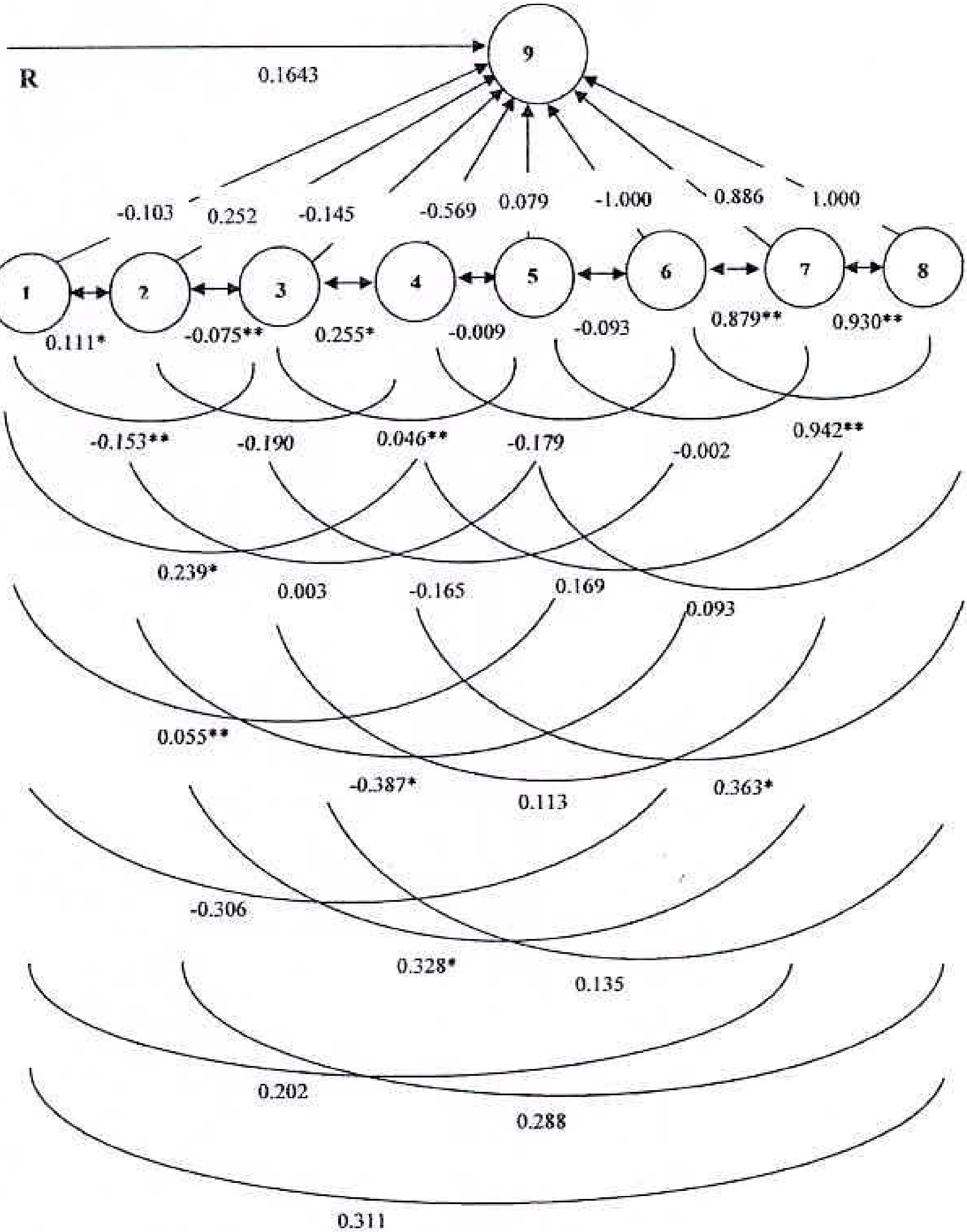

Fig. 3. Path diagram of 8 yield contributing traits in tossa jute

*Significant at 5% and ** Significant at 1% level of probability

1= Plant height (m), 2 = Base diameter (mm), 3 = Number of nodes/plant, 4 = internodal length (cm), 5 = Leaf area (sq. cm), 6=Green weight with leaves/plant (g), 7= Green weight without leaves/plant (g), 8= Stick weight/plant (g) and 9= Fibre weight/plant (g).

4.3.2 Base diameter

Base diameter had positive (0.252) direct effect on fibre weight per plant and also positive correlation with fibre weight (0.1714). The indirect positive effect was through leaf area (0.003), green weight without leaves (0.328) and stick weight (0.288). Direct positive effect of base diameter on fibre weight per plant was reported by several authors (Mandal *et al.*, 1980; Chaudhury *et a.*, 1981).

4.3.3 Number of nodes per plant

The direct effects of number of nodes per plant on fibre weight per plant was negative (-0.145) at genotypic level. Nodes per plant contributed indirectly through base diameter (0.131), intermodal length (0.255), leaf area (0.046), green weight without leaves (0.113) and stick weight (0.135). The indirect effect was through plant height (-0.109) and green weight with leaves (-0.165). Similar results were reported by Dahal (1991) in jute. Biswas (1984) reported that node number and intermodal length had negative direct effect on yield.

4.3.4 Internodal length

Intermodal length had negative (-0.569) direct effect at genotypic level. Intermodal length has contributed indirectly via stick weight per plant (0.363), green weight without leaves per plant (0.169), base diameter (0.084), nodes per plant (0.065) and plant height (0.043). Chaudhury *et al.* (1981) reported that internodal length had negative direct effect at genotypic level but positive direct effect at phenotypic level, which supported these results.

4.3.5 Leaf area

The direct effect of leaf area on fibre weight per plant was small and positive (0.079) at genotypic level. Leaf area has contributed indirectly through stick weight (0.093), leaf area (0.066) and base diameter (0.008). Other indirect effects were negligible.

4.3.6 Green weight with leaves per plant

Green weight with leaves per plant had negative (-0.1000) direct effect on fibre weight per plant but it had high significant positive correlation with fibre weight per plant (0.7674**). The indirect positive effects on fibre weight per plant were via base diameter (0.097), leaf area (0.007), green weight without leaves (0.879) and stick weight (0.942). Negative effect may be nullified by indirect positive effects and for that correlation coefficient with fibre weight per plant showed highly significant positive value.

4.3.7 Green weight without leaves per plant

Green weight without leaves per plant had positive (0.886) direct effect on fibre weight per plant and it had also highly significant positive correlation (0.7670**). It had positive indirect effects via base diameter (0.093) and stick weight per plant (0.930) whereas, negative indirect effects were via plant height (-0.018) and green weight with leaves per plant (-0.992). The negative effects may be nullified by positive effects. So, this trait might be considered while selecting high valued genotypes for hybridization programmes.

4.3.8 Stick weight per plant

The direct effect of stick weight per plant on fibre weight per plant was high and positive (1.000) and it had also highly significant positive correlation (0.7042**) with fibre weight per plant. Stick weight had contributed indirectly through base diameter (0.072), leaf area (0.007) and green weight without leaves (0.824). Therefore, selection based on this character would be effective and judicious for future breeding programmes.

The residual effect was 0.1643, which indicated that there were other responsible traits for contribution to fibre weight per plant but not taken into consideration in the present study.

Chapter 5
Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The present piece of work was undertaken to study the genetic parameters for morphological and agronomical traits viz., plant height, base diameter, node number, internodal length, leaf area, green weight with leaves, green weight without leaves, stick weight and fibre weight of 30 exotic genotypes of *Corchorus olitorius*.

All the genotypes varied significantly with each other for all the characters except base diameter. The genotypes G7 and G1 showed maximum and minimum plant height 3.43m and 2.61m, respectively. The base diameter was highest in G22 (17.72 mm) and was lowest in G27 (12.46 mm). Nodes per plant ranged from 55.00 (G1) to 93.33 (G12). The highest internodal length was in G1 (5.59 cm) and lowest in G6 (3.80cm). The maximum and minimum leaf area were obtained in G5 (41.23 sq. cm) and in G26 (28.89 sq.cm). Green weight with leaves ranged from 57.89 g (G28) to 126.89 g (G1). The highest green weight without leaves was obtained from G1 (97.13g) and lowest in G17 (39.99 g). The range of dry stick weight was 10.25 g to 33.30 g.

Fibre weight was highest in G7 (13.48 g) and was lowest in G17 (5.07 g), respectively. The genotypes G7, G12, G18 and G20 also gave higher fibre yield compared with the check varieties O-9897, O-72 and OM-1.

Therefore these genotypes might be considered as prospective parents for utilization in future breeding programme.

The phenotypic variance was higher than corresponding genotypic variance for all the characters studied. Least differences between genotypic and phenotypic coefficient of variation were observed in plant height (4.86-8.56), base diameter (5.68-9.01), node number (9.81-13.94), internode length (6.12-10.52), leaf area

(9.11-13.11), green weight with leaves (23.93-25.68), green weight without leaves (26.68-27.62), stick weight (30.85-31.59) and fibre weight (26.45-27.77). Relatively high coefficient of variation value was observed in green weight with leaves, green weight without leaves, stick weight and fibre weight. Moderate heritability was observed in node number (49.49%), leaf area (48.20%), green weight with leaves (86.86%), green weight without leaves (91.95%), stick weight (95.34%) and fibre weight (90.69%).

High heritability coupled with high genetic gain in percentage of mean was observed in green weight with leaves (45.94%), green weight without leaves (52.31%), stick weight (62.05%) and fibre weight (51.88%).

Simple correlation study revealed that fibre yield was significantly and positively correlated with green weight with leaves, green weight without leaves and stick weight per plant. Genotypic and phenotypic correlation study also gave the same results. So, these characters should get preference for selection of parental lines for utilization in breeding programme.

Path coefficient analysis revealed that stick weight per plant had the highest positive (1.000) direct effect on fibre weight per plant at genotypic level followed by green weight without leaves per plant (0.886), base diameter (0.252) and leaf area (0.079).

Significant variation was observed among the genotypes for all the characters studied except base diameter. The phenotypic and genotypic coefficient of variation were high for green weight with leaves, green weight without leaves, stick weight and fibre weight. These characters also showed less environmental coefficient of variation. High heritability along with high genetic advance in percent of mean was observed in green weight with leaves, green weight without leaves, stick weight and fibre weight. These characters were under additive gene effect and therefore selection of genotypes based on these characters may be effective.

Positive and significant association was observed between fibre yield and most of its components. The genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficient for most of the character pairs. Stick weight per plant proved to be the most important fibre yield contributing character in tossa jute.

As a whole, the investigation revealed that no single quantitative trait had major contribution to the fibre yield. Integrated approach of improving quantitative traits would consequently help to increase yield potential of jute.

Based on the results of the present study the following recommendations were made:

1. The characters like green weight with leaves, green weight without leaves and stick weight showed strong genetic association with fibre weight. These traits also exhibited high heritability coupled with high genetic gains. Those parameters might be considered as primary selection criteria for the improvement of this crop species.
2. Other characters like plant height, base diameter, number of nodes per plant and leaf area also exhibited high heritability values but with moderate genetic gains. Therefore, these characters may be considered as secondary selection criteria for improving fibre yield in jute.
3. The genotypes G7 (Acc. No 1481), G12 (Acc. No. 1524), G18 (Acc. No. 3705 and G20 (Acc. No 3723) showed better performance in respect of yield and other morphological characters. Therefore, these four genotypes might be used in future breeding programme.

Chapter 6
References

CHAPTER 6

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Appendices

Appendix I: Monthly temperature and rainfall during the cropping season at Central Jute Agricultural Experiment Station, Jagir, Manikganj, Bangladesh.

Month	Rainfall (mm)	Temperature (°C)	
		Maximum	Minimum
April 2007	026	34.42	23.35
May 2007	079	35.30	25.50
June 2007	638	32.81	26.11
July 2007	833	31.62	26.21
August 2007	252	32.31	27.34
September 2007	114	32.33	26.96

Source: Physiology department, BJRI, Dhaka.

Appendix II: Area and production of jute in Bangladesh

Year	Area in '000' acre	Production in '000' m.tons
1994-95	1383	961
1995-96	1133	737
1996-97	1253	883
1997-98	1427	1057
1998-99	1181	812
1999-00	1008	711
2000-01	1107	821
2001-02	1128	859
2002-03	1079	800
2003-04	1008	794
2004-05	965	732

Source: BBS, 2005