VARIABILITY AND PATH COEFFICIENT ANALYSIS IN JUTE (*Corchorus olitorius* L.) OF INDIGENOUS ORIGIN

BY

MOHAMMAD MOINUL ISLAM

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Approved by:

(Dr. M. Abbas Ali)
Principal Scientific Officer
Breeding Division
Bangladesh Jute Research Institute
Supervisor

(Dr. Md. Shahidur Rashid Bhuiyan)
Professor
Department of Genetics and Plant Breeding
Sher-e-Bangla Agricultural University
Co-supervisor

(Firoz Mahmud)
Chairman
Examination Committee

Government of the People's Republic of Bangladesh
BANGLADESH JUTE RESEARCH INSTITUTE
Manik Mia Avenue, Dhaka – 1207

CERTIFICATE

This is to certify that thesis entitled, **"VARIABILITY AND PATH COEFFICIENT ANALYSIS IN JUTE (*Corchorus olitorius* L.) OF INDIGENOUS ORIGIN"** 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 **Mohammad Moinul Islam,** Registration No. 06-02176 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.

Dated: December, 2007
Place : Dhaka, Bangladesh

(Dr. M. Abbas Ali)
Principal Scientific Officer
Breeding Division
Bangladesh Jute Research Institute
Supervisor

Dedicated to
My
'Beloved Parents'

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ABSTRACT

BY

MOHAMMAD MOINUL ISLALM

Forty one indigenous genotypes of tossa jute (*Corchorus olitorious*) including three commercially cultivated varieties as checks were evaluated to study their variability, correlation and path coefficient analysis with 09 different morphological characters at the Central Jute Agricultural Experiment Station, Jagir, Manikganj of Bangladesh Jute Research Institute (BJRI) during April to September 2007. Significant variation was observed among the genotypes tested in respect of plant height, base diameter, number of nodes per plant, leaf area, green weight with leaves per plant, green weight without leaves per plant, stick weight per plant and fibre weight per plant except internode length. Considering genetic parameters high Genotypic Coefficient of Variation (GCV) values were observed for green weight without leaves per plant followed by stick weight per plant, green weight with leaves per plant and fibre weight per plant. High heritability values with high genetic advance in percentage of mean were obtained for stick weight per plant, green weight with leaves per plant, green weight without leaves per plant and fibre weight per plant. All the genotypes showed maximum growth rate from 90 to 105 days of emergence. Correlation study revealed positive significant association of fibre yield with all the characters at genotypic level, except plant height and green weight with leaves per plant. At phenotypic level, green weight with leaves per plant, green weight without leaves per plant and stick weight per plant showed significant positive relationship with fibre yield. Path coefficient analysis indicated maximum direct contribution of stick weight per plant towards fibre yield followed by internode length, green weight without leaves per plant, plant height and green weight with leaves per plant. Genotypes, G_1 and G_{13} showed better yield performance indicating the possibility of using them in future breeding programme.

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LIST OF ABBREVIATIONS

FULL WORD	ABBREVIATION
Agro Ecological Zone	AEZ
Analysis of variance	ANOVA
And others	*et al.*
Bangladesh Bureau of Statistics	BBS
Bangladesh Jute Research Institute	BJRI
Centimeter	cm
Coefficient of Variation	CV
Duncan's Multiple Range Test	DMRT
Environmental Coefficient of Variation	ECV
Error Mean Square	EMS
Food and Agricultural Organization	FAO
Genetic Advance	GA
Genotype	G
Genotypic Coefficient of Variation	GCV
Genotypic Mean Square	GMS
Gram	g
Heritability in Broad Sense	H_b
International Jute Organization	IJO
Kilogram	kg
Least Significant Difference	LSD
Mean Square	MS
Meter	m
Millimeter	mm
Hectare	ha
Muriate of Poatsh	MP
Phenotype	P
Phenotypic coefficient of Variation	PCV
Randomized Complete Block Design	RCBD
Residual Effect	R
Square Centimeter	sq. cm
That is	viz.
Triple Super Phosphate	TSP

Chapter 1
Introduction

CHAPTER 1

INTRODUCTION

Jute, *Chorchorus* species, is the most important cultivated fibre crop in the world. It is an agricultural commodity that singly earns foreign exchange equivalent to four hundred and sixty nine crore taka annually to our national economy (BBS, 2005). It is also the most important natural fibre crop next to cotton (Singh, 1976). Because of its cheapness, high strength and non-elastic properties, it 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 paper pulp (IJO, 1994). Now a days novotex, blanket, fabrics, shopping bags, knitwear, nursery sheet and pot, micro crystal cellulose for pharmaceutical products, geo-jute and photostable dye etc. are being made from jute (Islam, 1997). Jute constitutes a major source of employment, which is of prime importance to rural economy of the country where it is grown. Now a day, in the international market jute and jute goods have been facing strong competition with synthetics.

The genus *Corchorus* belongs to the family Tiliaceae consists of about 100 species (Wills, 1966). Out of these, only two species, *Corchorus capsularis* L. and *C. olitorius* L. yield fibre of commerce and are now being cultivated throughout this country. *C. capsularis* is called 'deshi pat' or 'tita pat' or 'white pat' and its centre of origin is Indo-Burma, whereas *C. olitorius* is called 'tossa pat or 'mitha pat' and it is originated in North Africa. Of these two species *C. olitorius* produce better quality fibres i.e.; finer, softer, stronger and lustrous than those of *C. capsularis* (Dahal, 1991). The fibres of *C. capsularis* are ordinarily whitish whereas that of *C. olitorius* the fibres are either yellowish golden or grayish in color.

Only three of the Asian countries namely, Bangladesh, India and China together account for about 80% of the world production of jute and allied fibres. This crop is also important in Thailand, Vietnam, Nepal, Burma and Indonesia. Outside Asia, Brazil is the only country which produces jute on a commercial scale. In Bangladesh, jute singly earns foreign exchange contributing approximately between 6-7% to our national economy (BBS, 2004). In the year 2004, about 965 thousand acres of land were cultivated by jute and the production was around 732 thousand metric tons (BBS, 2005) and its 70-75% is *C. olitorius*. Market price of *C. olitorius* fibre is higher for its better quality than that of *C. capsularis*. As a result, *C. olitorius* jute cultivation is increasing day by day and has a great demand to the farmers.

Although jute exhibits high socio-economic importance for the producing countries, the global situation is confronted with number of problems. The prices paid to the farmers are not remunerative and subjected to annual fluctuations. It appears from the recent records that in almost all the jute producing countries, not only the area under jute declining, the crop is also being pushed more and more to the marginal lands. Moreover, poor adaptability in multiple cropping systems is also a major constraint. As a result, jute yield in this country is not satisfactory.

The average yield of jute in our country is only 1.72 tons/ha which is low as compared to other jute producing countries like India (1.81 tons/ha; FAO, 1997). There are many constraints to higher and stable yield. However, yield has not been increased remarkably mainly for the availability of only a limited number of jute varieties, lack of suitable and superior germplasm in the crop species and for strong incompatibility with other cultivated species. Therefore, improvement in yield and other morphological and agronomical characters are important for increasing productivity of this crop species and for that, genetic variability is important.

In order to increase the frequency of desired genotypes in breeding progenies, superior parents with high breeding values are needed. However development of such parents is a long term and tedious job. When the variability in a population is largely genetic nature with least environmental effects, the probability of isolating superior genotypes is high. An understanding of genetic variability in any breeding programme is a must because it provides not only a basis for selection but also some valuable information regarding selection of desired parents to be used in a hybridization programme (Dixit and Dubey, 1985). So the study of the present germplasm material is important for searching variability and to isolate desirable genotypes which can be used successfully in crossing programme for improvement of the crop species.

Yield in jute is a complex character and depends upon the interaction results of a number of yield contributing characters. Therefore, the real contributor for yield may be searched by adopting path analysis. Path coefficient analysis is simply a standardized partial regression coefficient analysis which is helpful in partitioning the total correlation into direct and indirect effect. Although a few reports (Chaudhury *et al.* 1981; Ghosdastidar and Bhaduri, 1983; Roy, 1965 and Roy, 1967) in this aspect have so far been made, efficiency of index selection in *C. olitorius* jute has not yet been established. Yield is the prime aim of any breeding programme. As such the aim of the study is to contribute information regarding yield enhancement. Therefore, this study was conducted with the following objectives:

1. To study variability of various attributes of local germplasm of tossa jute
2. To perform correlation and path coefficient analysis of various attributes
3. To identify the materials for future use.

Chapter 2
Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

Fibre yield in tossa jute (*C. olitorius*) is a complex character and is controlled by many genes. It is correlated with a number of yield contributing characters such as plant height, base diameter, internode length, number of nodes per plant, leaf area, green weight with leaves, green weight without leaves, stick weight etc. Selection for yield may not be effective unless the association between other yield components influencing it directly or indirectly are clearly known and taken into consideration. Selection should be based on yield components which are least affected by non-genetic factors (Chaudhury *et al.*, 1981). Scientists are trying hard to improve the contents and quality of fibre of this crop species. Lot of genetic variability in *Corchorus* has already been reported. The relevant literature available on *Corchorus olitorius* have been reviewed and presented below.

2.1 Variability

The extent of genetic variability in 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 derived traits and the success of breeding depends upon the extent of variability present in the crop species.

Robinson *et al.* (1951) stressed the need to estimate genotypic and phenotypic variances from various characters from choosing individuals based on phenotypic expression with an aim to identify superior genotypes.

Singh (1970) observed less genetic variability of plant height and base diameter than stick weight and fibre weight respectively in *C. olitorius.*

Ghosdastidar and Das (1984) found that the genetic coefficient of variance was higher for fibre weight (33.01) where as it was low for node number (12.55) and base diameter (11.75) in *C. olitorius*.

Chaudhury *et al.* (1985) observed appreciable variability for plant height, base diameter, node number, internode length and fibre yield in *C. olitorius*.

Sardana *et al.* (1990) observed a higher phenotypic coefficient of variation than the corresponding genetic coefficient of variation value for plant height, base diameter, node number and dry fibre weight in jute germplasm.

Dahal (1991) observed that the phenotypic coefficient of variation was higher than their corresponding genotypic coefficient of variation for all characters in *C. olitorius*.

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

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.

Roy *et al.* (1998) observed a wide range of variation in six yield related traits in thirteen stable recombinants of white jute (*C. capsularis* L.) which was selected from intervarietal crosses.

Bordoloi and Das (1999) studied twelve genotypes of tossa jute and found moderate estimates of genotypic coefficient of variation for fibre yield and green weight.

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

Prakash *et al.* (2003) studied with 80 germplasm lines of white jute (*C. capsularis*) and found that the phenotypic coefficient of variation was, in general, higher than the genotypic coefficient of variation, which indicated the role of environment in the expression of plant height and base diameter.

Dastidar (2003) studied genetic variability in white jute and observed that the number of persistent leaf, dry weight of leaf, leaf angle, petiole length, leaf area index and fibre yield were likely to be operated by additive genes.

Ghoshdastidar and Das (2003) screened fifty *C. olitorius* germplasm for their resistance to premature flowering. Genetic variability study revealed that plant height was highly affected by high degree of environmental variability masking the genotypic difference.

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

Akter *et al.* (2005) observed variability in tossa jute. They 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 characters is transmitted from parents to offspring. So the estimation of heritability is of great interest to the plant breeders. A quantitative character having high heritability is transmitted from parent to offspring conveniently. Heritability percentage estimated from the total genetic variance without taking into consideration inadditive component is referred to as heritability in broad sense.

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.

Robinson (1966) categorized the heritability values into low (below 10%), moderate (10-30%) and high (above 30%).

Rahman (1968) observed 25% heritability for fibre yield in tossa jute.

In a study with *C. olitorius* L. 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 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 highest heritability estimates coupled with moderate genetic advance for top diameter, internode length and plant height in jute. Therefore, phenotypic selection for making genetic improvement is expected to be more effective for those three characters.

Ghosdastidar and Das (1984) observed 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%) 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.* (1985) 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 intermodal length (39.90, 21.72, 15.60, 28.65, 26.43 and 27.99).

Sardana *et al.* (1990) studied genetic parameters in jute. Plant height, basal diameter and dry fibre weight had high broad sense heritability coupled with moderately high genetic advances indicating the success of direct selection. Node number was found to have low heritability and genetic advance.

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

According to Ahmed *et al.* (1993) highest genetic advance (35.5%) coupled with the highest heritability (52.9%) was observed for fibre yield in tossa jute. They also reported high and low heritability values for petiole length and base diameter.

Bordoloi and Das (1999) reported moderate heritability combined with moderate or low genetic advance for fibre yield, green weight and plant height in 12 genotypes of tossa jute (*C. olitorius*).

Islam and Ahmed (2003) studied heritability in tossa jute genotypes and showed high heritability and genetic advance for stick weight and fibre weight. Plant height had high heritability with moderate genetic advance and green weight had moderate heritability and high genetic advance.

Prakash *et al.* (2003) found high heritability, high GCV and high genetic advance (GA %) for base diameter, and high heritability, low GCV and low GA% for plant height, in 80 germplasm lines of white jute (*C. capsularis*).

Ghosdastidar and Das (2003) showed a high amount of genetic coefficient of variation, heritability and genetic advance as percent over mean in the case of highly susceptible genotypes of *C. olitorius*.

Akter *et al.* (2005) observed heritability value coupled with high genetic advance in percentage of mean for plant height, base diameter, fresh weight with leaves, fresh weight without leaves and dry stick weight in *C. olitorius*.

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 of plants and environment. Yield is a complex character, which is not only polygenically controlled but also influenced by its component characters (Alam *et al.* 1988). 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 Datta, 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.

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

Paul and Eunus (1974) studied with *Corchorus olitorius* L. and found that phenotypic and genotypic correlation for plant height, base diameter, node numbers, internode 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 of cases but environmental correlation coefficients were significant only in a few cases. In this study, partial and multiple correlation analysis indicated that fibre yield was dependent on base diameter, plant height and leaf angle. Environmental correlation was significant for plant height, base diameter, leaf area index and internode length.

Maiti *et al.* (1977) observed highly significant and positive correlation between green weight and fibre yield in jute.

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

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

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

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

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 in tossa jute.

Khandakar *et al.* (1988) observed best correlation between total dry matter production and bark weight followed by stick weight in jute.

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

Bordoloi and Das (1999) observed highly significant positive correlation for fibre yield per plant with green weight and plant height, and for plant height with green weight and basal diameter in 12 genotypes of tossa jute (*C. olitorius*).

Prakash *et al.* (2003) showed that the genotypic correlation was slightly higher in magnitude than the phenotypic correlation which indicated inherent association between height and base diameter in white jute (*C. capsularis*).

Dastidar (2003) studied 8 cultivars, 3 exotic collections and 2 local collections of *C. capsularis* and indicated that fibre yield could be increased through selection of any leaf characters such as number of persistent leaf, dry leaf angle and short petiole length.

Islam and Ahmed (2003) showed that fibre yield in tossa jute had significant positive association with all the characters at both phenotypic and genotypic levels. Genotypic correlations were higher than their corresponding phenotypic correlation in all the characters.

Roy and Dastidar (2004) observed that plant height, base diameter, leaf length and petiole length had positive and significant correlation with fibre yield in a 9 parent diallel population of tossa jute.

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

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 tossa 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.

Bordoloi and Das (1999) suggested that plant height and green weight had highly positive direct effects, while basal diameter had a negative direct effect on fibre yield in 12 genotypes of tossa jute.

Ghosdastidar and Das (2003) showed that plant height and base diameter had strong positive direct effect on fibre yield in the case of resistant and susceptible genotypes of tossa jute (in respect to premature flowering) respectively.

Roy and Dastidar (2004) carried out path coefficient analysis in F_1 and F_2 generations in a 9 parent diallel population of tossa jute. The analysis clearly indicated that plant height, base diameter and leaf length had good positive direct effect and positive indirect effects via other characters towards fibre yield in both generations.

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.

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 Floodplain (AEZ-8) at 3.4m above sea level and about 60km 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 September 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 in soil fertility.

3.3 Experimental Material

The material comprised of 41 germplasm accessions of tossa jute (*C. olitorius* L.) of indigenous origin including 3 standard check varieties, namely var. O-9897, var. OM-1 and var. O-72. The genetically pure and physically healthy seeds of these genotypes were collected from the Gene

Bank Department of BJRI, Dhaka. Origins of the selected genotypes are shown below in Table 1.

Table 1. Origin of the selected indigenous genotypes of tossa jute

Accession No.	Place of collection	Accession No.	Place of collection
1232(G1)	Chittagong	3053(G23)	Meherpur
1291(G2)	Sylhet	3060(G24)	Chuadanga
1880(G3)	Tangail	3089(G25)	Kushtia
1896(G4)	Manikganj	3172(G26)	Comilla
1941(G5)	Kurigram	3189(G27)	Chittagong
2099(G6)	Shirajganj	3263(G28)	Jamalpur
2174(G7)	Panchagar	3277(G29)	Dhaka
2196(G8)	Nawgoan	3297(G30)	Dhaka
2335(G9)	Pabna	3306(G31)	Maulovibazar
2345(G10)	Natore	3413(G32)	Rajbari
2478(G11)	Narail	3432(G33)	Faridpur
2524(G12)	Khulna	3433(G34)	Faridpur
2541(G13)	Bagerhat	3483(G35)	Mymensingh
2554(G14)	Magura	3541(G36)	Madaripur
2563(G15)	Magura	3802(G37)	Chittagong
2580(G16)	Satkhira	3856(G38)	Chittagong
2585(G17)	Jessore	3888(G39)	Khagrachari
2586(G18)	Barisal	3894(G40)	Bandarban
2602(G19)	Pirojpur	3907(G41)	B.baria
2691(G20)	Bagerhat	O-9897(G42)	Bangladesh
2717(G21)	Jhenidah	OM-1(G43)	Bangladesh
2744(G22)	Pirojpur	O-72(G44)	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 100 kg/ha MP were applied. The whole amount of TSP and half of the Urea were applied as broadcast during final land preparation. The remaining half of the Urea was top dressed after 30 days of sowing.

3.6 Sowing and Intercultural Operation

Seeds were sown on April 07, 2007. Thinning and weeding were done twice after 15 and 30 days of sowing to maintain uniform plant population. Two irrigation was given, one before sowing and another after 15 days of emergence. 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 of crop age. Besides plant height of each accession at 75 days, 90 days, 105 days and 120 days were also recorded.

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 millimeter using slide calipers.
3. Number of nodes per plant: Number of node was counted from the base of stem to apex of the shoot.
4. Internode length (cm): Internode length was measured from the middle region of the plant; taking length of five different internodes in centimeter, i.e. length between two nodes.
5. Leaf area (sq. cm): Length and breadth (at the middle portion of lamina) of five laminae per plant was measured in centimeter and leaf area was computed with the help of following formula as suggested by Gopalkrishna and Sasmol (1974).

   Leaf area = k x Length x Maximum breadth

   In this case the value of 'k' was 0.6604.

6. Green weight with leaves per plant (g): Green weight was recorded per plant with leaves in gram.
7. Green weight without leaves per plant (g): Green weight was recorded per plant without leaves in gram.
8. Stick weight per plant (g): Weight of sun dried stick per plant was measured in gram.
9. Fibre weight per plant (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 (σ^2_p) were estimated as per Johnson *et al.* (1955). The error MS was considered as error variance (σ^2_e). Genotypic variances (σ^2_g) were derived by subtracting error MS from the genotype MS and dividing by the number of replications as shown below:

Genotypic variance (σ^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 were derived by adding genotypic variances with error variances as given by the following formula:

Phenotypic variance (σ^2_p) = $\sigma^2_g + \sigma^2_e$

3.8.1 Estimation of genotypic and phenotypic coefficient of variation

Genotypic and phenotypic coefficients of variation were calculated according to Burton (1952).

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

Where,

σ_g = Genotypic standard deviation

$\overline{X}$ = Population mean

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

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

Where,

σ_p = Phenotypic standard deviation

$\overline{X}$ = 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).

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 combinations, the following formula suggested by Al-Jibouri *et al.* (1958), 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 character 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).

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

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

This chapter comprises the presentation and discussion of the findings obtained from the study. The data pertaining to nine morphological characters were computed and statistically analyzed and the results thus obtained were presented and discussed separately under the following subheads:

1. Variability analysis
2. Correlation coefficient
3. Path coefficient

4.1 Variability analysis

The genotypes differed significantly for all the morphological characters except internode length (Table 2). The extent of variation among the genotypes for a morphological character was studied and range, mean value, standard deviation and coefficient of variation have been presented in Table 3. Variances of the genotypes, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV), heritability and genetic advance have been presented in Table 4. Besides growth rate of different genotypes at 15 days intervals (75, 90, 105and 120 days) and mean values, standard deviation and coefficient of variation at different intervals were also computed and presented in Table 5. Performance of genotypes is described below for each character.

4.1.1 Plant height

Significant differences were observed among the genotypes for plant height which ranged from 2.27m (G2) to 2.95 m (G22) (Table 3). Genotypes viz. G3(2.70m), G5 (2.72m), G7(2.72m), G9(2.72m), G10(2.72m), G21(2.72m), G28 (2.76m), G 43 (2.72m) and G 44 (2.71) were statistically similar for plant height (Table 2). The estimated phenotypic and genotypic variances were 0.03 and 0.01 (Table 4). The phenotypic coefficient of variation (PCV) (6.73%) and genotypic coefficient of variation (GCV) (4.33%) were close to each other indicating less influence of environmental factors on expression of this character. Therefore, selection based upon phenotypic expression of this character would be effective for the improvement of this crop. The heritability was found to be moderate (41.49%) for this character.

In the study of growth rate of different genotypes at 15 days intervals (75, 90, 105, and 120 days), the mean values of plant height at different days were found 2.23 m (75 days), 2.34m (90 days), 2.65m (105 days) and 2.78m (120 days) (Table 5). Mean values for percent increase in growth at different intervals were 5.14% (75-90 days), 13.49% (90-105 days) and 4.99% (105-120 days). All the genotypes except G3 (5.51%), G19 (6.47%) and G27 (4.33%) showed maximum growth rate between 90 to 105 days. The genotypes viz. G1 (19.73%), G2 (17.36%), G32 (19.09%), G34 (18.71%), G41 (35.46%) and G43 (17.29%) showed considerably higher growth rate between 90 to 105 days. This clearly indicates that the genotypes can be easily selected as fast growing superior parents for utilization in hybridization programme for selection purpose and plant breeders have no need to wait till harvest (120 days) period. This will considerably reduce time and labour for selecting quick growing genotypes. A diagrammatic

Table 2. Mean performance of morphological and agronomical characters of different indigenous genotypes of tossa jute

Genotypes	Plant height (m)	Base diameter (mm)	Number of nodes/plant	Internode length (cm)	Leaf area (sq. cm)	Green weight with leaves /plant (g)	Green weight without leaves /plant (g)	Stick weight /plant (g)	Fibre weight /plant (g)
G1(1232)	2.38 h-l	13.05 j-p	38.67 q	4.97	24.65 k	73.13 cd	46.06 g-i	15.01 e-h	8.59 a
G2(1291)	2.27 l	12.31 op	40.67 q	4.29	34.43 b-g	57.51 h-l	39.50 k-p	9.93 s-t	5.40 i-k
G3(1880)	2.70 a-f	14.36 c-k	60.00 no	4.44	34.56 b-g	67.11 d-f	51.75 c-l	16.19 c-e	6.90 de
G4(1896)	2.51 f-i	11.67 p	54.33 op	4.56	24.17 k	54.73 j-n	44.02 h-l	12.38 k-o	5.93 g-i
G5(1941)	2.72 a-f	13.77 d-n	66.33 h-n	4.17	29.43 g-k	66.28 d-g	54.55 b-d	16.69 cd	6.73 ef
G6(2099)	2.77 a-e	13.69 d-o	71.67 c-j	4.29	36.52 b-e	63.91 e-i	49.53 g-j	14.07 hi	5.68 h-k
G7(2174)	2.72 a-f	12.51 n-p	65.67 j-n	4.04	26.63 i-k	58.36 h-l	45.12 c-e	12.22 k-p	6.17 f-h
G8(2196)	2.78 a-e	13.38 g-o	72.00 c-j	4.17	32.68 c-h	69.24 de	52.38 g-i	17.15 c	6.67 ef
G9(2335)	2.72 a-f	13.42 e-o	68.33 g-m	4.02	32.65 c-h	58.17 h-l	45.83 q-i	12.20 k-p	5.51 i-k
G10(2345)	2.72 a-f	12.83 lm	66.00 i-n	4.08	35.73 b-f	46.24 o-q	33.05 q-s	11.13 o-s	5.66 h-k
G11(2478)	2.88 a-c	13.39 f-o	77.33 c-p	4.54	34.89 b-g	61.18 f-k	45.90 g-i	14.17 g-i	6.64 ef
G12(2524)	2.84 a-e	13.33 g-o	76.33 b-e	4.51	36.91 b-e	80.23 bc	56.92 bc	16.60 cd	6.70 ef
G13(2541)	2.86 a-d	13.64 d-o	76.67 a-d	4.39	31.23 e-j	89.07 a	68.23 a	20.20 b	8.53 a
G14(2554)	2.88 a-c	13.46 e-o	71.67 c-j	4.62	43.46 a	67.89 d-f	48.67 e-h	12.97 i-m	7.69 bc
G15(2563)	2.82 a-e	13.01 k-p	70.00 e-l	4.42	32.07 d-i	66.22 d-g	45.24 g-j	12.47 k-m	5.15 k-m
G16(2580)	2.91 ab	13.96 c-m	71.00 d-k	4.27	37.45 b-d	69.67 de	59.36 b	16.38 cd	7.06 c-f
G17(2585)	2.80 a-e	13.18 h-o	74.33 b-g	4.45	32.42 d-h	48.72 m-q	35.04 o-s	11.89 l-q	5.79 h-k
G18(2586)	2.84 a-e	12.77 m-p	74.33 b-g	4.36	35.79 b-f	68.15 d-f	42.68 i-m	13.91 h-j	5.97 g-i
G19(2602)	2.80 a-e	13.30 g-o	72.33 c-i	4.05	29.26 g-k	45.26 pq	30.24 s	13.99 h-j	5.59 h-k
G20(2691)	2.68 b-g	13.97 c-m	68.00 gh	4.25	28.41 h-k	78.81 bc	50.00 d-g	15.40 d-g	7.20 c-e
G21(2717)	2.72 a-f	14.70 a-g	83.00 a	4.45	35.90 b-f	80.00 bc	58.84 b	20.97 b	8.20 ab
G22(2744)	2.95 a	15.93 a	74.33 b-g	4.21	35.53 b-f	58.61 g-l	39.28 l-p	15.74 d-f	6.54 e-g
G23(3053)	2.83 a-e	15.26 a-c	74.00 b-g	4.62	38.56 a-c	65.21 e-h	46.71 f-i	14.81 f-h	7.01 de
G24(3060)	2.87 a-c	14.90 a-d	78.00 a-c	4.28	32.99 c-h	62.41 e-j	40.46 j-n	14.84 f-h	5.81 h-j
G25(3089)	2.80 a-e	14.44 b-j	78.00 a-c	4.56	37.53 b-d	58.00 h-l	36.79 n-p	12.67 j-n	5.68 h-k
G26(3172)	2.85 a-e	14.31 c-k	76.33 b-e	4.43	35.61 b-f	52.66 l-p	39.93 j-p	13.91 h-j	5.52 h-k
G27(3189)	2.61 d-g	14.41 b-k	62.33 mn	4.22	35.33 b-f	36.85 r	24.20 t	7.76 u	3.58 o
G28(3263)	2.76 a-f	14.48 b-h	71.67 c-j	4.41	37.09 b-e	52.37 l-p	36.69 n-r	13.13 i-l	5.67 h-k
G29(3277)	2.86 a-d	15.35 a-c	74.33 b-g	4.35	35.36 b-f	90.79 a	70.13 a	23.54 a	7.46 cd

Table 2. (Cont'd)

Genotypes	Plant height (m)	Base diameter (mm)	Number of nodes/plant	Internode length (cm)	Leaf area (sq. cm)	Green weight with leaves /plant (g)	Green weight without leaves /plant (g)	Stick weight /plant (g)	Fibre weight /plant (g)
G30(3297)	2.82 a-e	13.54 d-o	75.00 b-f	3.97	34.83 b-g	54.67 j-n	38.45 m-p	14.10 g-i	5.75 h-k
G31(3306)	2.59 e-h	14.22 c-l	62.00 mn	4.04	36.26 b-e	56.50 i-m	42.70 i-m	10.42 r-t	4.25 n
G32(3413)	2.84 a-e	14.79 a-f	73.33 c-g	4.69	34.05 b-h	58.19 h-l	40.35 j-o	14.17 g-i	5.55 h-k
G33(3432)	2.67 b-g	12.74 m-p	65.00 k-n	4.54	32.33 d-h	65.00 e-h	42.96 i-m	11.72 m-r	4.52 mn
G34(3433)	2.89 a-c	15.79 ab	83.00 a	4.43	37.10 b-e	55.96 j-m	37.77 m-r	13.26 i-k	5.84 h-j
G35(3483)	2.91 ab	14.45 b-i	80.00 ab	4.60	34.53 b-g	51.48 l-p	36.30 n-r	12.88 i-n	5.39 i-k
G36(3541)	2.91 ab	14.70 a-g	77.33 a-d	4.69	36.67 b-e	46.70 o-q	34.72 p-s	10.77 q-s	4.70 l-n
G37(3802)	2.83 a-e	14.12 c-m	73.33 c-g	4.37	32.38 d-h	51.91 l-p	42.51 i-m	12.24 k-p	5.65 h-k
G38(3856)	2.64 c-g	13.06 i-p	63.00 mn	4.01	25.71 jk	43.07 qr	29.92 s	9.38 t	4.43 n
G39(3888)	2.44 g-i	12.39 n-p	48.33 p	4.07	29.29 g-k	47.07 n-q	32.50 rs	11.59 n-r	5.22 j-l
G40(3894)	2.77 a-e	14.46 b-i	69.67 f-l	4.02	33.01 c-h	55.60 j-m	44.79 g-k	13.35 i-k	5.40 i-k
G41(3907)	2.64 c-g	14.50 b-h	72.67 c-h	4.23	30.25 f-j	84.68 ab	66.57 a	17.22 c	6.78 ef
G42(O-9897)	2.70 a-g	14.03 c-m	62.33 mn	4.09	39.63 ab	60.94 f-k	45.02 g-j	12.05 k-q	5.60 h-k
G43(OM-1)	2.72 a-f	14.81 a-e	64.33 l-n	4.12	35.12 b-g	53.35 k-o	38.10 m-q	12.53 k-n	5.34 i-l
G44(O-72)	2.71 a-f	13.70 d-o	68.00 g-m	3.93	33.94 b-h	64.09 e-l	38.79 l-p	11.02p-s	5.36 i-k
Mean	**2.75**	**13.87**	**69.20**	**4.32**	**33.69**	**61.27**	**44.29**	**13.84**	**6.02**
CV%	**5.88**	**6.24**	**5.88**	**9.69**	**13.70**	**9.98**	**7.45**	**9.89**	**6.75**
LSD$_{(0.05)}$	**0.262**	**1.404**	**6.609**	**NS**	**4.757**	**7.853**	**5.354**	**1.324**	**0.659**

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

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

Characters	Range	Mean	SD	CV%
Plant height(m)	2.27-2.95	2.75	0.197	5.88
Base diameter (mm)	11.67-15.93	13.87	1.205	6.24
Number of nodes/plant	38.67-83.00	69.20	10.078	5.88
Internode length (cm)	3.93-4.97	4.32	0.479	9.69
Leaf area (sq. cm)	24.17-43.46	33.69	4.649	13.70
Green weight with leaves/plant (g)	36.85-90.79	61.27	12.391	9.98
Green weight without leaves/plant (g)	24.20-70.13	44.29	10.366	7.45
Stick weight/plant (g)	7.76-23.54	13.84	3.057	9.89
Fibre weight/plant (g)	3.58-8.59	6.02	1.124	6.75

Table 4. Estimation of genetic parameters of morphological characters of different genotypes of tossa jute

Characters	Genetic variance	Phenotypic variance	Environmental variance	Heritability	Genetic advance (5%)	Genetic advance (5%) in percent mean	GCV	PCV	ECV
PH	0.01	0.03	0.02	41.49	0.16	5.75	4.33	6.73	5.14
BD	0.60	1.46	0.85	41.35	1.03	7.41	5.60	8.70	6.67
NP	85.86	103.06	17.20	83.31	17.42	25.18	13.39	14.67	5.99
IL	0.03	0.29	0.26	14.03	0.14	3.21	4.17	11.12	11.88
LA	12.62	21.71	9.10	58.11	5.58	16.56	10.54	13.83	8.95
GWW	142.57	155.45	12.88	91.12	23.56	38.45	19.49	20.35	5.86
GWO	96.82	109.00	12.18	88.82	19.10	43.14	22.22	23.57	7.88
SW	8.80	9.48	0.68	92.87	5.89	42.55	21.43	22.24	5.94
FW	1.12	1.28	0.17	87.08	2.03	33.73	17.55	18.80	6.76

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internode 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 different indigenous 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 at different intervals		
	75 days	90 days	105 days	120 days	(75-90)	(90-105)	(105-120)
G1(1232)	1.76	1.86	2.23	2.33	5.70	19.73	4.49
G2(1291)	1.78	1.87	2.19	2.29	5.06	17.36	4.57
G3(1880)	2.12	2.25	2.38	2.52	6.51	5.51	6.04
G4(1896)	2.00	2.12	2.45	2.58	5.83	15.61	5.45
G5(1941)	2.14	2.33	2.59	2.67	9.36	11.02	3.22
G6(2099)	2.16	2.23	2.47	2.56	2.97	11.08	3.64
G7(2174)	2.13	2.31	2.62	2.70	9.00	13.26	2.93
G8(2196)	2.14	2.27	2.53	2.65	6.09	11.30	4.88
G9(2335)	2.24	2.36	2.82	2.91	5.68	19.19	3.43
G10(2345)	2.18	2.26	2.53	2.63	3.68	12.09	3.69
G11(2478)	2.37	2.47	2.83	2.92	4.41	14.44	3.18
G12(2524)	2.26	2.34	2.57	2.67	3.55	10.00	3.76
G13(2541)	2.20	2.37	2.71	2.77	7.77	14.33	2.21
G14(2554)	2.31	2.42	2.73	2.82	4.77	12.68	3.30
G15(2563)	2.23	2.33	2.62	2.72	4.49	12.76	3.69
G16(2580)	2.34	2.43	2.68	2.79	3.71	10.44	3.98
G17(2585)	2.09	2.24	2.52	2.68	7.24	12.50	6.35
G18(2586)	2.38	2.47	2.79	2.87	3.93	12.82	2.87
G19(2602)	2.12	2.33	2.48	2.64	9.92	6.47	6.73
G20(2691)	2.39	2.47	2.85	2.95	3.63	15.37	3.51
G21(2717)	2.49	2.61	2.86	3.00	4.96	9.71	4.89
G22(2744)	2.58	2.70	2.98	3.09	4.53	10.63	3.57
G23(3053)	2.55	2.66	2.97	3.06	4.45	11.52	3.14
G24(3060)	2.51	2.59	2.96	3.07	3.18	14.01	3.73
G25(3089)	2.50	2.61	2.93	3.04	4.41	12.28	3.99
G26(3172)	2.50	2.60	2.92	3.03	4.17	12.29	3.76
G27(3189)	1.86	2.01	2.10	2.31	8.55	4.33	10.22
G28(3263)	2.35	2.42	2.70	2.85	2.86	11.71	5.43
G29(3277)	2.42	2.55	2.83	2.94	5.12	11.00	3.89
G30(3297)	2.31	2.38	2.64	2.75	3.03	10.77	4.29
G31(3306)	2.12	2.22	2.48	2.60	4.87	11.86	4.83
G32(3413)	2.57	2.64	3.14	3.23	2.74	19.09	2.86
G33(3432)	2.20	2.31	2.62	2.89	5.00	13.27	10.45
G34(3433)	2.55	2.67	3.17	3.30	4.99	18.71	3.89
G35(3483)	2.46	2.55	2.96	3.05	3.66	16.06	2.82
G36(3541)	2.40	2.44	2.77	2.87	1.69	13.82	3.49
G37(3802)	2.36	2.48	2.82	2.97	5.25	13.71	5.32
G38(3856)	2.09	2.14	2.50	2.59	2.40	16.87	5.27
G39(3888)	1.82	1.98	2.18	2.52	9.03	9.75	15.93
G40(3894)	2.11	2.30	2.54	2.65	9.37	10.58	4.06
G41(3907)	1.56	1.64	2.22	2.56	5.20	35.46	15.49
G42(O-9897)	2.11	2.27	2.63	2.78	7.98	15.56	5.84
G43(OM-1)	2.17	2.24	2.62	2.73	3.25	17.29	4.07
G44(O-72)	2.16	2.20	2.54	2.70	2.02	15.44	6.31
Mean	**2.23**	**2.34**	**2.65**	**2.78**	**5.14**	**13.49**	**4.99**
SD	**0.23**	**0.23**	**0.25**	**0.23**	**2.14**	**4.80**	**2.89**
CV%	**9.58**	**10.65**	**5.71**	**5.43**	**26.95**	**12.82**	**21.24**

presentation of plant height at different days of growth and plant height increment over different intervals has been presented in Fig. 1 and Fig. 2 respectively.

4.1.2 Base diameter

Significant differences among the genotypes were observed for base diameter. The highest and lowest base diameter were observed in G22 (15.93 mm) and G4, (11.67mm), respectively (Table 2). Genotypes viz. G6 (13.69 mm), G13 (13.64 mm), G30 (13.54 mm) and G44 (13.70 mm) were statistically similar for base diameter. This trait showed higher estimates of phenotypic coefficient of variation (8.70%) than the corresponding genotypic coefficient of variation (5.60%) (Table 4). The higher differences between PCV and GCV suggested that the expression of this character was mostly under the control of environment. The moderate heritability (41.35%) 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

The variance due to nodes per plant showed that the genotypes differed significantly. The maximum nodes per plant was found in G21 and G34 (83.0) genotypes and minimum nodes per plant was found in G1 (38.67) genotype. Genotypes viz. G17, G18, G22, G29 (74.33) and G23 (74.00) were found statistically similar for nodes per plant. Least difference was observed between phenotypic coefficient of variation (14.67%) and genotypic coefficient of variation (13.39%). High heritability (83.31%) with

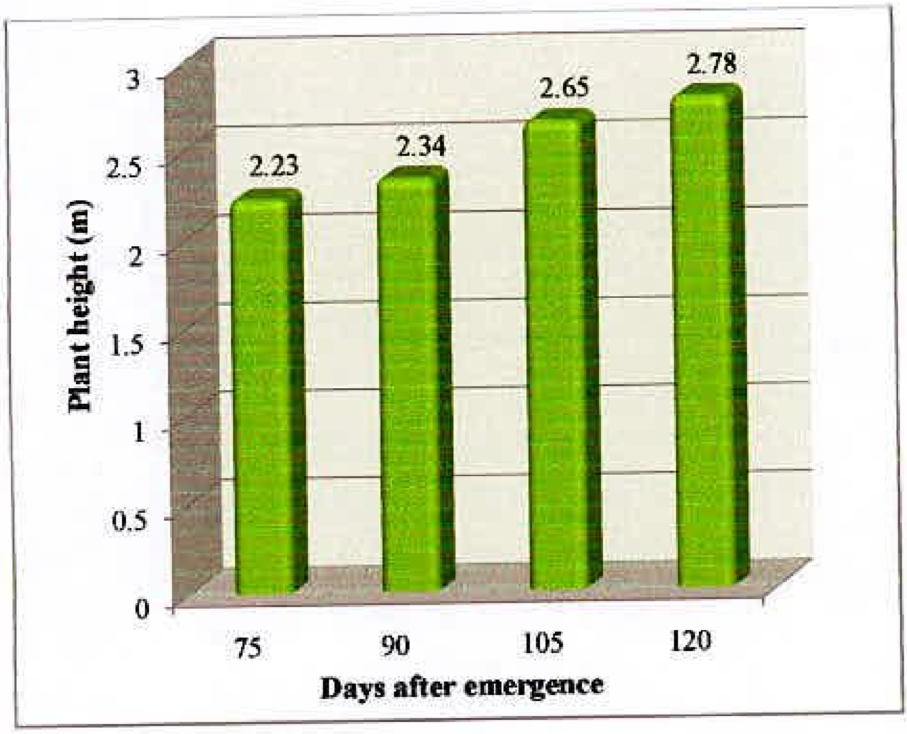

Fig. 1: Plant height at different days of growth

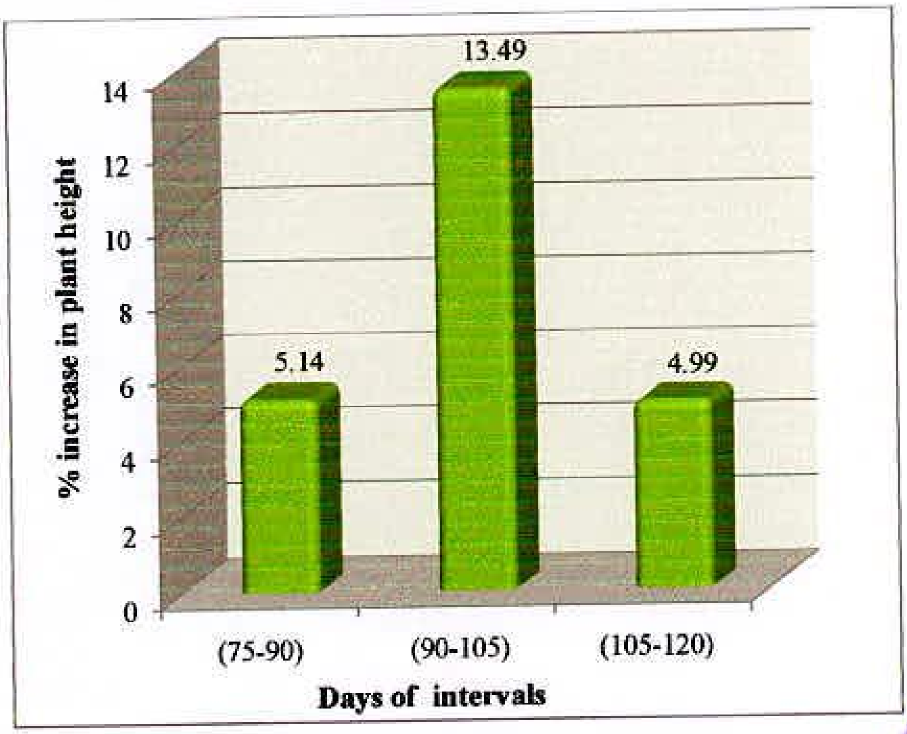

Fig. 2: Plant height increment over different intervals

high genetic advance in percent of mean (25.18%) for this trait might be taken into consideration while selecting a suitable line (as suggested by Johnson *et al.* 1955). Similar result was found in Ghosdastidar and Das (1984).

4.1.4 Internode length

The differences among the genotypes for internode length were found statistically non significant (Table 2). The highest internode length was observed in G1 (4.97cm) and the lowest internode length was found in G44 (3.93cm). The phenotypic variance (0.29) was much higher than the genotypic variance (0.03). Heritability (14.03%) as well as genetic advance as percent of mean (3.21%) was also low (Table 4). With such low heritability and low genetic advance, selection based on this trait (intermode length) would not be judicious.

4.1.5 Leaf area

Significant differences among the genotypes were observed for leaf area. The maximum leaf area (43.46 sq cm) was found in G14 and the minimum leaf area (24.17 sq. cm) was observed in G4 genotype (Table 2). Genotypes viz. G10 (35.73 sq. cm), G26 (35.61 sq. cm) were statistically similar for leaf area. The least difference between phenotypic coefficient of variation (13.83%) and genotypic coefficient of variation (10.54%) indicates the genetic control of this trait (Table 4). Heritability (58.11%) and genetic advance (16.86%) were found moderate. With such moderate estimates of heritability and genetic advance there is a good scope of selection for this trait.

4.1.6 Green weight with leaves per plant

The variance due to green weight with leaves per plant showed that the genotypes differed significantly. Green weight with leaves ranged from 36.85 g (G27) to 90.79 g (G29) with a mean value of 61.27 g (Table 2). The genotypes viz. G7 (58.36 g), G9 (58.17 g), G2 (57.51 g), G25 (58.0 g) and G32 (58.19) were statistically similar for this trait. The phenotypic (155.45) and genotypic (142.57) variances were close to each other indicating negligible environmental influence on green weight with leaves. The difference between phenotypic (20.35%) and genotypic (19.49%) coefficient of variation were also very minimum (Table 4) and this indicates genetic control of this trait. Estimated heritability (91.12%) was very high with considerable genetic advance (38.45%). Higher estimates of heritability and genetic advance in percentage of mean provided a better opportunity for selecting high valued genotype for breeding programme.

4.1.7 Green weight without leaves per plant

The genotypes varied significantly for green weight without leaves per plant and ranged from 24.20 g (G27) to 70.13 g (G 29), with a mean value of 44.29 g (Table 2). The phenotypic (109.0) and genotypic (96.82) variances were close to each other and PCV (23.57%) and GCV (22.22%) were also close to each other which indicated less environmental influences on this character. The estimated heritability (88.82%) and genetic advance over mean (43.14%) were high (Table 4). The high heritability, high GCV and high GA% indicated that the character is mostly governed by additive genes. Therefore, selection based on green weight without leaves per plant would be suitable for future breeding programme.

4.1.8 Stick weight per plant

Stick weight showed significant differences among the genotypes. The maximum and minimum stick weight per plant were observed in genotypes G29 (23.54 g) and G27 (7.76 g), respectively. Both the values differed statistically with rest of the genotypes (Table 2). The genotypes viz. G 18 (13.91 g), G19 (13.99g) and G26 (13.91g) were statistically similar and very close to mean value (13.84g). The phenotypic (23.57%) and genotypic (22.22%) coefficient of variation were very close to each other. Heritability was maximum (92.87%) for this trait. Besides GA% over mean (42.55%) was also high (Table 4). High heritability and high genetic advance indicated that selection based on this character would be judicious.

4.1.9 Fibre weight per plant

Significant differences were observed among the genotypes for fibre yield (g/plant) which ranged from 3.58 g (G27) to 8.59 g (G1) with a mean value of 6.02 g (Table 2). The genotypes viz. G6 (5.52 g), G17 (5.79g), G19 (5.59 g), G25 (5.68 g), G26 (5.52 g), G 28 (5.67 g), G 30 (5.75 g), G 32 (5.55 g), G 37 (5.65 g) and G42 (5.60 g) were statistically similar in respect of fibre weight. The phenotypic (1.28) and genotypic (1.12) variances were very close to each other indicated less environmental influences on this trait. The PCV (18.80%) and GCV (17.55%) were also very close. The high heritability (87.08%) along with considerable GA% over mean (33.73%) provided opportunity for selecting high valued genotypes based on fibre weight per plant.

4.2 Correlation coefficient

Phenotypic and genotypic correlation coefficient for fibre weight per plant and eight yield contributing characters of tossa jute genotypes are presented in Table 6. In most cases the genotypic correlation coefficients was higher than their corresponding phenotypic correlation coefficient indicating a fairly strong inherent relationship among the characters. The lower estimates of phenotypic correlation coefficient suggested that the environment in those cases did not have appreciable influences over the expression of this character. On the other hand, lower estimates of genotypic correlation coefficient suggested that the expression of those characters was appreciably influenced by the environment. Similar result was obtained by Islam and Ahmed (2003) who found higher genotypic correlation than their corresponding phenotypic correlation in all the characters studied.

4.2.1 Genotypic correlation coefficient

Plant height showed highly significant positive correlation with base diameter (0.710**), number of nodes per plant (0.999**), leaf area (0.595**) and significant positive correlation with stick weight per plant (0.370*). Base diameter showed highly significant positive correlation with plant height (0.710**), number of nodes per plant (0.687**), leaf area (0.599**), stick weight per plant (0.407**) and fibre weight per plant (0.929**). Number of nodes per plant showed highly significant positive correlation with plant height (0.999**), base diameter (0.687**), leaf area (0.494**), stick weight per plant (0.371**) and fibre weight per plant (0.623**). Internode length showed highly significant positive correlation with fibre weight per plant (0.425**). Leaf area showed highly significant

Table 6. Genotypic (G) and phenotypic (P) correlation coefficients among different pairs of morphological characters of different genotypes of tossa jute

Characters		BD	NP	IL	LA	GWW	GWO	SW	FW
PH	G	0.710**	0.999**	0.280	0.595**	0.133	0.156	0.370*	0.201
	P	0.388**	0.736**	-0.040	0.376*	0.085	0.142	0.299	0.147
BD	G		0.687**	0.073	0.599**	0.145	0.162	0.407**	0.929**
	P		0.399**	0.085	0.368*	0.086	0.063	0.249	0.093
NP	G			0.108	0.494**	0.161	0.176	0.371**	0.623**
	P			0.028	0.383**	0.147	0.177	0.351**	0.099
IL	G				0.231	0.258	0.081	0.233	0.425**
	P				0.016	0.132	0.135	0.096	0.154
LA	G					0.028	0.022	0.026	0.657**
	P					0.028	0.036	0.031	0.008
GWW	G						0.946**	0.843**	0.164
	P						0.891**	0.781**	0.720**
GWO	G							0.861**	0.765**
	P							0.791**	0.693**
SW	G								0.825**
	P								0.765**

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

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internode 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).

positive correlation with plant height (0.595**), base diameter (0.599**), number of nodes per plant (0.494**) and fibre weight per plant (0.657**). Green weight with leaves per plant showed highly significant positive correlation with green weight without leaves per plant (0.946**) and stick weight per plant (0.843**). Green weight without leaves per plant showed highly significant positive correlation with green weight with leaves per plant (0.946**), stick weight per plant (0.861**) and fibre weight per plant (0.765**). Stick weight per plant showed highly significant positive correlation with base diameter (0.407**), number of nodes per plant (0.371**), green weight with leaves per plant (0.843**), green weight without leaves per plant (0.861**), fibre weight per plant (0.825**) and significant positive correlation with plant height (0.370*). Fibre weight per plant showed highly significant positive correlation with base diameter (0.929**), number of nodes per plant (0.623**), internode length (0.425**), leaf area (0.929**), green weight without leaves per plant (0.765**) and stick weight per plant (0.825**).

4.2.2 Phenotypic correlation coefficient

Plant height showed highly significant positive correlation with base diameter (0.388**), number of nodes per plant (0.736**) and significant positive correlation with leaf area (0.376*). Base diameter showed highly significant positive correlation with plant height (0.388**), number of nodes per plant (0.399**) and significant positive correlation with leaf area (0.368*). Number of nodes per plant showed highly significant positive correlation with plant height (0.736**), base diameter (0.399**), leaf area (0.383**) and stick weight per plant (0.351**). Internode length showed insignificant but negative correlation with plant height and insignificant positive correlation with rest of the characters. Leaf area showed significant positive correlation with plant height (0.376*), base diameter (0.368*) and highly significant positive correlation with number of nodes per plant (0.383**). Green weight with leaves per plant showed highly significant positive correlation with green weight without leaves per plant (0.891**), stick weight per plant (0.781**) and fibre weight per plant (0.720**). Green weight without leaves per plant showed highly significant positive correlation with green weight with leaves per plant (0.891**), stick weight per plant (0.791**) and fibre weight per plant (0.693**). Stick weight per plant showed highly significant positive correlation with number of nodes per plant (0.351**), green weight with leaves per plant (0.781**), green weight without leaves per plant (0.791**) and fibre weight per plant (0.765**). Fibre weight per plant showed highly significant positive correlation with green weight with leaves per plant (0.720**), Green weight without leaves per plant (0.693**) and stick weight per plant (0.765**).

Results revealed that fibre weight per plant was significantly and positively correlated with green weight without leaves per plant and stick weight per plant at both genotypic and phenotypic level, where as it was significantly and positively correlated with base diameter, number of nodes per plant, internode length and leaf area at genotypic level and green weight with leaves per plant at phenotypic level. Therefore, these characters should get preference for selecting a progeny or parental line for higher fibre yield. Similar results were also reported by several authors with *Corchorus* species (Paul and Eunus, 1974; Maiti *et al.* 1977; Ghosdastidar and Das, 1984; Das, 1987 Islam *et al.* 2004; Akter *et al.* 2005)

4.3 Path coefficient

Path coefficient analysis is used to find out a clear picture of the interrelationship between yield and yield contributing characters. The direct and indirect effects of yield contributing characters on fibre yield were worked out by using path analysis. Here fibre weight per plant was considered as effect (dependent) variable and 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 were treated as causes or 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 7 and also showed diagrammatically in Fig. 3.

4.3.1 Plant height

Plant height had positive direct effect on fibre weight per plant (0.128) at genotypic level; it had also positive correlation with fibre weight per plant (0.120). Plant height has contributed indirectly through internode length (0.090), green weight with leaves per plant (0.028) and stick weight (0.255) at genotypic level. The highest indirect negative effect was found via number of nodes per plant (-0.270), the others were negligible. The indirect negative effects of plant height may be nullified by positive indirect effects. Direct positive effect of plant height on fibre weight per plant was also reported by several authors (Mandal *et al.* 1980; Chaudhury *et al.* 1981; Bordoloi and Das, 1999).

Table7. Partitioning of genotypic correlation coefficient into direct (bold faced) and indirect effects by path analysis

Characters	PH	BD	NP	IL	LA	GWW	GWO	SW	FW
PH	**0.128**	-0.106	-0.270	0.090	-0.007	0.002	0.028	0.255	0.120
BD	0.091	**-0.149**	-0.174	0.023	-0.007	0.002	0.029	0.281	0.096
NP	0.136	-0.102	**-0.253**	0.035	-0.006	0.003	0.031	0.256	0.100
IL	0.036	-0.011	-0.027	**0.321**	-0.003	0.004	0.014	0.161	0.495**
LA	0.076	-0.089	-0.125	0.074	**-0.012**	0.000	0.004	0.018	-0.054
GWW	0.017	-0.022	-0.041	0.083	0.000	**0.016**	0.168	0.582	0.803**
GWO	0.020	-0.024	-0.045	0.026	0.000	0.015	**0.177**	0.595	0.765**
SW	0.047	-0.060	-0.094	0.075	0.000	0.014	0.153	**0.691**	0.825**

** Significant at 1% level of probability

PH= Plant height (m), BD = Base diameter (mm), NP = Number of nodes/plant, IL= Internode 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).

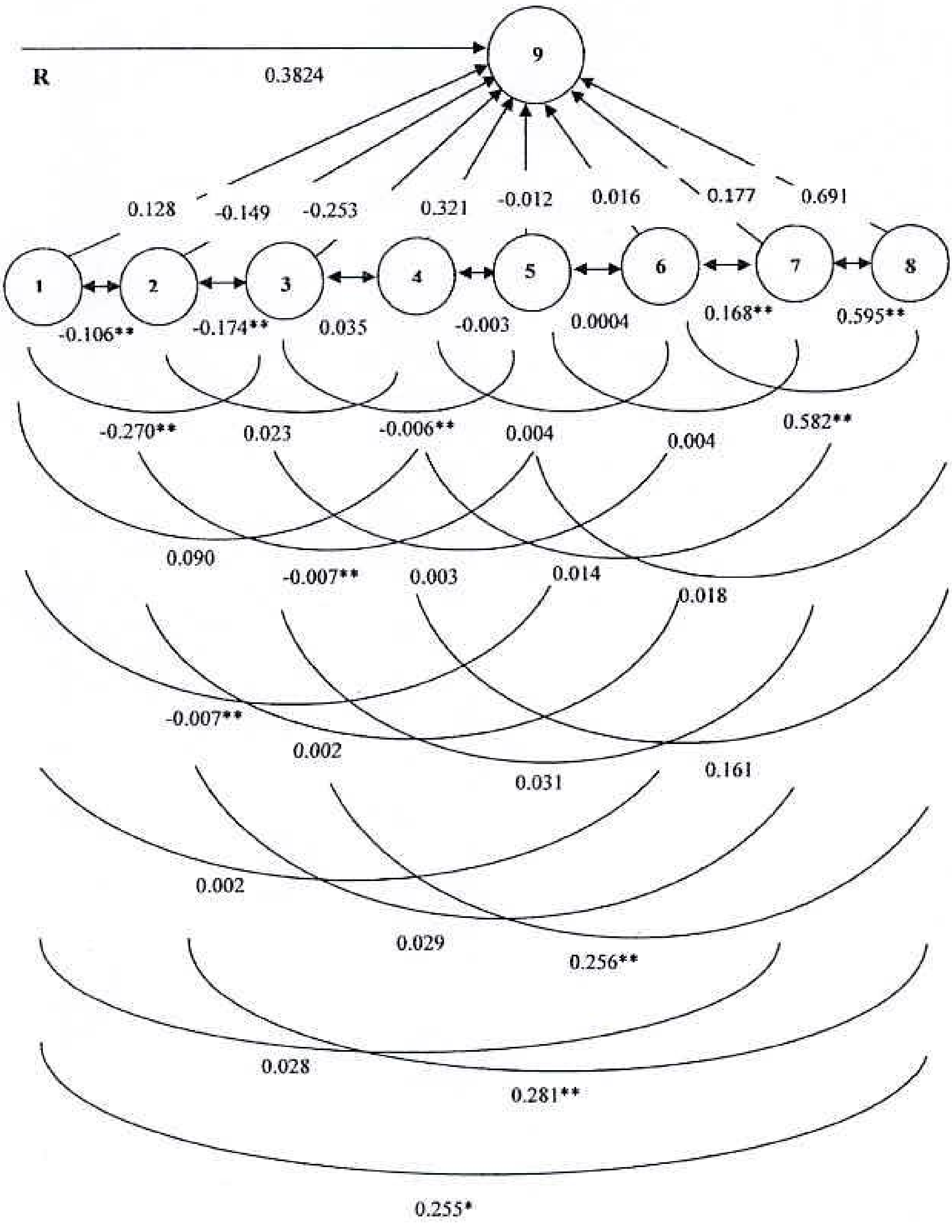

Fig. 3. Path diagram of 8 yield contributing traits in tossa jute

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

1= Plant height (m), 2 = Base diameter (mm), 3 = Number of nodes/plant, 4 = internode 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 negative direct effect on fibre weight per plant (-0.149), but it had positive correlation with fibre weight per plant (0.096). Base diameter contributed indirectly through plant height (0.091), internode length (0.023), green weight without leaves per plant (0.029) and stick weight per plant (0.281). This indicated that selection should be done not only based on base diameter but other associated characters such as stick weight, plant height etc. must also be considered. Chaudhury *et al.* (1981) and Bordoloi and Das (1999) reported negative direct effect of base diameter at genotypic level which supported the present findings.

4.3.3 Number of nodes per plant

The direct effect of number of nodes per plant on fibre weight per plant was negative (-0.253). But it showed positive correlation with fibre weight per plant (0.100). Node number has contributed indirectly through plant height (0.136), internode length (0.035), green weight with leaves per plant (0.003) and green weight without leaves per plant (0.256). Similar results were reported by Biswas (1984) and Dahal (1991) in jute.

4.3.4 Internode length

Internode length had positive direct effect (0.321) on fibre weight per plant and it had also positive significant correlation with fibre weight per plant at both levels (0.495**). Internode length had positive indirect effects via plant height (0.036), green weight with leaves (0.004), green weight without leaves (0.0414) and stick weight (0.161). So, selection of tall genotypes with higher internode length will be judicious and more effective in future breeding programme.

4.3.5 Leaf area

Leaf area showed negative direct effect (-0.012) on fibre weight per plant and it had also negative correlation (-0.054) with fibre weight per plant. Leaf area has contributed indirectly through plant height (0.076) and internode length (0.074), and other indirect effects were negligible. Similar result was observed by Islam *et al.* (2004) who found negative direct effect of leaf area on fibre weight per plant.

4.3.6 Green weight with leaves per plant

Green weight with leaves per plant had small positive direct effect (0.016) on fibre weight per plant. But it showed highly significant positive correlation (0.803**) with fibre weight per plant. The indirect positive effects on fibre yield were via plant height (0.017), internode length (0.083), green weight without leaves per plant (0.168) and stick weight per plant (0.582).

4.3.7 Green weight without leaves per plant

Green weight without leaves per plant had positive (0.177) direct effect on fibre weight per plant and had also positive significant correlation with fibre weight per plant at both levels (0.765**). It showed the highest positive indirect effect through stick weight per plant (0.595) followed by internode length (0.026), plant height (0.020) and green weight with leaves per plant (0.015).

4.3.8 Stick weight per plant

Stick weight per plant contributed the highest positive direct effect (0.691) at genotypic level on fibre weight per plant. It had also the highest positive significant correlation with fibre weight per plant at both levels (0.825**). It contributed indirectly through plant height (0.047), internode length (0.075), green weight with leaves (0.014) and green weight without leaves (0.153). Other indirect effects were negligible. The indirect effects of all the traits via stick weight were considerably high and positive. Therefore, selection based on this trait will be judicious and more effective in future breeding programme.

In the present study of path coefficient analysis, stick weight per plant proved to be the most important fibre yield contributor in tossa jute which had the highest positive direct effect (0.691) on fibre weight per plant followed by intermodal length (0.321), green weight without leaves per plant (0.177), plant height (0.128) and green weight with leaves per plant (0.016). On the other hand, base diameter, number of nodes per plant and leaf area showed negative direct effect on fibre weight per plant.

The genotypic residual effect was 0.3824, 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 investigation was undertaken with an objective to study variability and correlation among various yield attributing characters such as, 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, stick weight per plant and fibre weight per plant in 41 indigenous genotypes of tossa jute including three check varieties.

All the genotypes varied significantly from each other for all the characters except internode length. The genotypes G22 (2.95 m) and G2 (2.27 m) exhibited maximum and minimum plant height respectively. The highest base diameter was obtained from G22 (15.93 mm) and lowest in G4 (11.67 mm). Number of nodes per plant ranged from 38.67 (G1) to 83.0 (G21, G34). The highest and lowest internode length was 4.97 cm (G1) and 3.93 cm (G44), respectively. The genotypes G14 (43.46 sq cm) and G4 (24.17 sq.cm) obtained the maximum and minimum leaf area, respectively. The maximum and minimum green weight with leaves was found in G29 (23.54 g) and G27 (7.76 g) genotypes, respectively. The genotypes G1 and G13 gave higher fibre yield compared with the check varieties O-9897, OM-1 and O-72.

The range of variation was wider and highest for leaf area followed by green weight with leaves per plant, stick weight per plant and internode length.

Significant variation was found for plant height, number of nodes per plant and base diameter.

Study of growth rate of different genotypes at different intervals revealed that all the genotypes, except G3 (5.51%), G19 (6.47%) and G27 (4.33%), exhibited maximum increase in plant height between 90 to 105 days. Among them the genotypes viz. G1 (19.73%), G2 (17.36%), G32 (19.09%), G34 (18.71%), G41 (35.46%) and G43 (17.29%) showed considerably higher growth rate from 90 to 105 days of emergence which indicated that selection of superior plants between 90 to 105 days would be more effective and judicious.

The phenotypic coefficient of variation was higher for all the characters than their corresponding genotypic coefficient of variation. Among the characters the highest genotypic coefficient of variation was recorded for green weight without leaves per plant followed by stick weight per plant, green weight with leaves per plant, fibre weight per plant, number of nodes per plant, leaf area, base diameter and internode length. Comparatively high genetic coefficient of variation, high heritability value and high genetic advance over mean were recorded for the characters green weight with leaves per plant, green weight without leaves per plant, stick weight per plant and fibre weight per plant which suggested that these characters were mostly controlled by additive genes. Moderate heritability value with moderate genetic advance over mean were found for number of nodes per plant, leaf area and base diameter indicating these characters possibly under the control of non additive genes.

Correlation study revealed that genotypic correlation coefficients were higher in most cases than their corresponding phenotypic correlation coefficients. Fibre weight per plant was significantly and positively correlated with green weight without leaves per plant and stick weight per plant at both genotypic and phenotypic level, where as it was significantly and positively correlated with base diameter, number of nodes per plant, internode length and leaf area at genotypic level and green weight with leaves per plant at phenotypic level. Therefore, selection based on these characters should get preference for identifying superior parental line for future breeding programme. Highly significant and positive inter association at genotypic and phenotypic levels were obtained for plant height, base diameter, number of nodes per plant, leaf area and fibre weight per plant.

Path coefficient analysis revealed that stick weight per plant had the highest positive (0.691) direct effect on fibre weight per plant at genotypic level followed by internode length (0.321), green weight without leaves per plant (0.177), plant height (0.128) and green weight with leaves per plant (0.016). On the other hand, base diameter, number of nodes per plant and leaf area showed negative direct effect on fibre weight per plant. In practice taller genotypes should be preferred for crossing and subsequent selection in order to attain high stick weight.

Results of the present investigation indicated significant variation among the genotypes for all the characters except internode length. The difference between the corresponding phenotypic and genotypic coefficient of variation was narrow for most of the characters. High heritability coupled with high genetic advance was observed for all the characters except plant height, base diameter and internode length. Therefore selection of plant materials based on these characters would be effective for future improvement.

Correlation studies showed positive and significant association between fibre yield and most of its components. The genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients for most of the character pairs indicating less environmental influence and strong inherent association among characters. Path analysis showed the highest positive direct effect of stick weight per plant on fibre weight per plant.

On the 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 experimental results, the following recommendations might be drawn -

1. Tall genotypes with higher internode length, high green weight with leaves and without leaves, high stick weight, less number of nodes and less leaf area should be considered as selection criteria for improving fibre yield of tossa jute
2. Considering yield and other yield contributing characters the genotypes G1 (Acc. No. 1232) and G13 (Acc. No. 2541) showed better performance. These two genotypes might be used in future breeding programmes.

Chapter 6
References

CHAPTER 6

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Appendices

Appendix I. Monthly summarized maximum and minimum temperature and monthly rainfall during the cropping season at Central Jute Agricultural Experiment Station, Jagir, Manikganj

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

Source: Physiology department, BJRI, Dhaka.

Appendix II Acreage 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