Chapter I
INTRODUCTION

Jute, the golden fiber, is an important traditional cash crop in Bangladesh. In fact, jute is the second most important natural fiber in terms of global consumption after cotton (Basu, 2008). For manufacturing diversified value-added industrial products and packaging materials. Royle (1955) believed that the ancient Greeks used to call it "Korkhoros" from which the generic name *Corchorus* has been derived. Jute is a potential cash crop and more than 40 species are available but only two species are commercially cultivated, namely, *Corchorus capsularis* L. (commonly known as white jute) and *C. olitorius* L. (commonly known as Tossa/traditional jute).

The species *C. olitorius* L. is more widely distributed than *C. capsularis* L. in the tropics. From a report on the number of species of *Corchorus* found all over the world, it is evident that in Africa the number is maximum. It may, therefore, be presumed that the center of origin of *C. olitorius* L. is Africa. In tropical Africa alone, there are 30 species, the rest are distributed in the sub-tropical regions of Asia and Central America. In India, only eight species were found. From Africa, it had migrated via Egypt to Syria, Turkey, Arabia, Afghanistan, India, China, Burma, Srilanka and other islands of the Indian Ocean (Husain, 1988). Kundu (1951) concluded that *C. capsularis* L. must be native to Indo-Burma (including South China). Collected information about the global distribution of *Corchorus* indicates that the two cultivated species *C. olitorius* L. and *C. capsularis* L. have distinct primary centers of origin, one is Africa (*C. olitorius* L.) and the second (*C. capsularis* L.) is Indo-Burma including South-China.

Jute is a plant whose all parts are extensively used. It is being grown in Bangladesh from ancient time. It is biodegradable and does not create any adverse effect on ecosystem; rather it maintains an excellent harmony with ecosystem by balancing the nutritional status of soil through leaf shedding from growing to harvesting. It also improves soil nutrient availability and increases the yield of the follow-on crop by breaking the subsoil hard pan caused by continuous cropping of rice, sweeping the environment from the excess load of CO_2 (2.4 t per ton of jute fibre) and freshening the air with the release of oxygen of about 10.66t/ha (De, 1995).

The importance of the jute sector to the Bangladesh economy, in particular, cannot be over-stated, it is a major cash crop for over three million small farm households; the largest

industries are producing about one-third of manufacturing outputs, which are the largest agricultural export commodities in Bangladesh. The livelihood of about 25 million people is dependent on jute - related activities in agriculture, domestic marketing, manufacturing and trade.

The present Government by this time has declared jute and jute products as agricultural products so that the manufacturers could get Government subsidy. Bangladesh Government has already made mandatory use of jute sacks for packing major items like rice, wheat, fertilizer, sugar etc. Jute has many advantages. The value addition of export is highly appreciable and the farmers are beneficiary from export. Foreign exchange earnings of Bangladesh come mostly from jute. Beside, jute is a good source of revenue for the Governments in the form of taxes, levies, sales tax and custom duties on jute goods (Sikdar and Banerjee, 1990).

A revolution is awaiting with discover of a new concept and technique for blending the jute with other fibers like polyester, acrylic, wool etc. to manufacture the diversified yarns with small modification of technologies and machines. These jute blended yarns are already in use for value added product for home textiles, decorative fabrics, handicrafts, geo-textiles, carpet backing cloth, shopping bags etc. The end fabrics got different characteristics of quality, comfort, hygiene and cost benefits.

Jute is grown mainly in Bangladesh for fiber rather than for seed. It is one of the cheapest and the strongest of all natural fibres and considered as fiber of the future. India, Bangladesh, China and Thailand are the leading producers of jute. It is also produced in southwest Asia and Brazil. India is the largest producer of jute goods in the world, while Bangladesh is the largest producer of raw jute (Ghosh and Jethi, 2013). In terms of world export of jute fiber, Bangladesh's share is more than 70%, which makes Bangladesh the largest exporter of jute fiber in the world (http://en.wikipedia.org/wiki/Jute_cultivation).

Top ten jute producers, by metric ton, as in 2019 (FAOSTAT – Crops, 2019) India (1,968,000 MT), Bangladesh (1,349,000 MT), People's Republic of China (45,500 MT), Uzbekistan (20,000 MT), Nepal (18,000 MT), Myanmar (17,000 MT), Thailand (12,000 MT), Vietnam (12,000 MT), Sudan (3,350 MT) and Egypt (2,508 MT), only.

Bangladesh is recognized as one of the best jute producing and exporting countries in the world (Islam *et al*., 2013). Over the last 20-25 years it did slide down to the seventh position.

Now it has regained to come to the forth position (Abdullah, 2013). Bangladesh and India are the two major jute-growing countries, contributing almost 85% of the world jute production and the area cultivated (Gupta *et al*., 2009). It cultivates nearly 39% of total raw jute supplied to the total global jute area, with an average yield of 1.53 t/ha during the period of 1961-2002 (Gupta *et al.,* 2009). Jute used to be a dominant export item in Bangladesh during the early years of independence, but its importance has declined gradually due to development of synthetic fibers. Nevertheless, with over 2.5 million tons of fiber being grown per annum, the processing industry remains a major business in Bangladesh and India (Mackie, 2005).

There is a dearth of information about the jute sector in Bangladesh. Recently Rahman (2010) noted that the area under jute remained stagnant during the period of 1960-1985 and then declined at the rate of 0.3% per annum (p.a.) ($p < 0.01$) during the period of 1986-2006, but the yield per ha increased marginally at the rate of 0.1% p.a. ($p < 0.01$) for the same period. The main reason behind the declining share of jute area in Bangladesh is the competition for land of high yielding varieties (HYVs) of rice, as well as falling demand in the market of jute fiber due to the increase in the use of synthetic fibers.

The study of genetic variability using morphological traits is quite reliable over the other methods. According to Cantini *et al*. (1999), morphological characterization is the first step for the description and classification of germplasm, Morphological traits are used for thorough investigation of the genetic variability in germplasm collections and contribute valuable information to conservation efforts and breeding programs (Gupta *et al.,* 1991).

In the past, very few researches have been carried out related to morpho –agronomic diversity and relationships in jute with diverse geographical origins. Palit *et al*. (1996) studied germplasm diversity and genetic advance in *C. olitotius* L. accessions focusing on 4 morpho-physiological traits; Plave and Sinha (2005) used 6 accessions of *C. capsularis* L. and 7 accessions of *C. olitorius* L. for their study. Recently, Benor *et al.* (2012) used only *C. olitorius* L. species to study genetic diversity and relationships inferred from molecular and morphological data. Moreover, multivariate methods particularly principal component analysis (PCA) have proven to be useful for characterizing, evaluating and classifying germplasm when a large number of accessions are assessed for several characteristics of agronomic importance (Peeters and Martinelli, 1989; Badenes *et al.,* 2000).

Genetic improvement of jute was initiated in 1904 by the then Government of Bengal and continued for a number of years (Dempsey 1975). Dudley and Moll (1969) reported that the

improvement of a crop mainly depended upon the magnitude of genetic variability and the degree to which the yield and its components were heritable.

Geographically distant parents for hybridization can enrich genetic constitution and help to develop new cultivars that accord with the breeding target. According to Ghosh (1983) improvement of yield potential in jute has been possible only through straight selection and by intervarietal hybridization involving distant geographic types. Dahal (1991) reported that the quantitative characters were the best indicator of yield. Yield is a complex character which is affected by a number of its components as well as by the environment in which the crop is grown. The quantitative characters that contribute to yield are also influenced by environmental factors. Thus selection for fibre yield becomes difficult unless the association between the yield contributing characters is known.

Initial breeding on jute was just to develop some jute varieties studied to the local conditions of the then Bengal. After partition of India in 1947, variety development goal was mainly to increase fibre yield per unit area. During that period, some hybridization programs were undertaken for detecting effective crosses between two cultivated species at different levels, but the attempt ended in failure. However, these approaches did not produce a type distinctly better than those of existing varieties. The isolating mechanisms that seem to be operating between these species are low pollen germination, low rate of pollen tube growth, and flower abscission before fertilization, zygote mortality and hybrid in viability those were probably due to abnormal embryo and endosperm development. Both pre and post fertilization barriers were in operation in these crosses and embryo abortion was mainly due to the interaction between the genome and plasmone, which resulted in a lack of nutrient supply and ultimately the degeneration of different tissues in the embryo sac (Datta, 1995). Hybrid variety development in jute has been tried by Swami Nathan *et al.* (1961). X-irradiated mutants and colchicine induced tetraploids were also exploited in the selection programme for yield, but none could yield a better strain than the existing ones (Mahtabuddin, 1988). Through mutation breeding three varieties of *C. capsulsris* have been developed by the Bangladesh Institute of Nuclear Agriculture (BINA). In recent years, there has been policy decision to work on breeding methods shifting from selection to pedigree or back cross method involving different crossing schemes: single, double, three-way, multiple and diallel crosses. As a result, a good number of jute varieties of both *C. olitorius* and *C. capsularis* jute having desirable agronomic traits were evolved during this period (Mahtabuddin, 1988).

Though a good number of jute varieties have been developed through conventional breeding, but like other crops such as rice, wheat and maize, no real breakthrough has yet been achieved in the sector of jute husbandry. Moreover, cultivation of jute is increasingly shifting to less productive land, thus creating challenges in dealing with new emerging production constraints.

Generally, the success of any crop improvement program largely depends on the magnitude of genetic variability, genetic advance, character association, direct and indirect effects on yield and its attributes. Correlation and path coefficient analysis of traits will also assist in component characters in a breeding programme whose selection would result in the improvement of complex traits that are positively correlated. Genetic variability and inter-relationship studies have been made in a wide range of fibre crops e.g. kenaf (Mostofa *et al*., 2002; Echekwu and Showemino, 2004 and Ghodke and Wadikar, 2011), roselle (Pullibai *et al*., 2005; Ibrahim and Hussein, 2006; Rani *et al*., 2006; Bhajantri *et al*., 2007; Ibrahim *et al*., (2013) and Satya Narayana *et al*., 2015), jute (Palve and Sinha, 2005 and Bhattacharya *et al*., 2007) and okra (Murtadha *et al*., 2004; Adeniji *et al*., 2007 and Nwangburuka *et al*., 2012) and provided the information on genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability, genetic advance and genetic advance as per cent mean (GAM), correlation between different characters with yield along with their direct and indirect effects on yield. In this context, the present investigation was undertaken to assess the genetic variability, heritability and genetic advance, character association and path coefficient analysis of the fibre yield and its attributing traits of tossa jute by utilizing fifty three genotypes.

The association of commercially important quantitative characters that are statistically determined by correlation coefficient has been quite supportive as a basis of selection. Selection pressure can be more easily exerted on any of the characters which reflect close association with yield. The yield by itself may not be the best criterion for selection (Yassin *et al*., 1973). Correlation studies measure only mutual association between two traits and path analysis for the cause and effect of relationship (Kumar *et al*., 2013 a; Reddy *et al*., 2013). Thus, the estimation of correlation and path analysis provide a clear picture about the association between two characters and partitioning of the relationship into direct and indirect effects showing the relative contribution of each of the causal factors towards the yield (Pervin *et al*., 2012). In this regards, a good number of research works in jute have been reported by many workers (Islam *et al*., 2001; Alam *et al*., 2011). Hence, present experiment

was undertaken to study the correlation and path coefficient between yield and its attributing traits and to find out the extent of direct and indirect effects of fibre yield components of fifty three genotypes of Tossa jute. Yield by itself may not be the best criterion for selection (Yassin, 1973). It is quantitatively inherited and influenced by genetic factors as well as environment. Rao *et al*. (1990) reported that yield is a complex character and is the resultant of many factors, which are relatively and simply inherited.

Research on development as well as evaluation of advanced generations in jute is very important in formulating a successful breeding program for evolving varieties superior in both yield and quality to cater to the increasing demand of value added jute products in the domestic and international markets. In the present study an attempt to be made to identify suitable genotypes for a breeding program, from a collection of fifty three Tossa jute germplasm accessions. The crop demands the immediate attention of plant breeders. The available elite lines of Tossa jute are essentially derived either through pure line selection or hybridization followed by selection from a swarm of diverse accessions. Varietal improvement in jute, a predominantly self-pollinated crop, has been impaired due to lack of adequate genetic diversity within the available genetic stock (Singh, 1980, Joshua and Thakare, 1984).

Rapid genetic improvement of crop depends on the availability of sufficient genetic diversity, which could be selected and combined in various forms to produce reasonable improvement (Denton and Nwangburuka, 2011; Wani, 2011). Various methods have been in the determination of heritability estimates (Wray and Visscher, 2008; Nwangburuka, *et al*., 2012). Estimates of heritability values become more reliable and meaningful when combined with genetic advance (Denton and Nwangburuka, 2011). High heritability and high genetic advance in a trait indicates the presence of additive genes in such trait and further suggests reliable crop improvement through selection of such a trait. Similarly, information on character association between yield and yield related characters in crops is important for effective and rapid progress in selection and crop improvement (Binodh *et al*., 2008; Denton and Nwangburuka, 2011).

Diallel mating designs provide information regarding combining ability, heterosis and genetic parameters useful in planning future breeding programmes. Based on the combining ability analysis, characters with high GCA effect indicate to additive gene effects and high SCA effect indicates dominant gene effects controlling those characters. And non-significance of

GCA and SCA effects indicate the presence of non-allelic interactions controlling those characters (Fehr, 1993). The mean performances along with significant GCA are considered for selection of outstanding parents, whereas high mean performance and significant SCA are considered for selection of desirable combination from a hybrid swarm. But understanding the genetic parameters for fibre yield and yield attributing characters would allow the breeders to precisely execute their breeding and selection programmes. Current study was managed to estimate the genetic parameters and the mode of inheritance for fibre yield and yield attributing traits of *Corchorus olitorius* through a set of full diallel crosses.

Tossa jute is a highly self-pollinated crop, pertains minimum diversity in the genetic resources, thereby new variability may be brought through hybridization, mutation or gene transformation. The very effective method is the hybridization between two genetically diverse parents because the F_1 hybrid receives contrasting alleles from both male and female parents. The breeders usually do not carry out hybridization between randomly selected parents, the superior parents are selected before commencing the crossing series. Moreover, breeders wish to transfer target characters from the male parents to female parents, hence the F_1 hybrid shows wide segregation after selfing. The maximum segregants are observed in F_2 and then heterozygosity gradually decreases with advancing the selfing generation. At the end of F_6 or F_7 generation of selfing almost all advanced lines become genetically homozygous or pure. Therefore, after creating the 1^{st} segregating generation (F_2) different methods like pedigree method, bulk method, mass bulk method or singe seed descent (SSD) method may be exercised prior to release a new pure line variety. If the breeders keep parent to offspring relationship through a clear cut record in Tossa jute then pedigree method is the most appropriate to develop new high fiber yielding varieties of the cash crop.

Whatsoever, the objectives of the study are as follows-

1. Assessment of genetic diversity as well as similarity among the Tossa jute accessions.
2. Identification of yield contributing characters in Tossa jute.
3. Study of combining ability of yield and yield contributing characters in F_1 generations of selected parents of Tossa jute.
4. Selection of potential segregants from F_2 generations.