Chapter V
SUMMARY AND CONCLUSION

Tossa jute (*Corchorus olitorius* L.) is the most important commercial fibre crop in Bangladesh. Increased pressure is being placed on jute scientists to develop cultivars with high fiber yield potential with superior grade that meet the requirements of the textile industries. In recent years jute yields have plateaued or even declined although production technology has improved significantly. Varietal improvement in jute, as a predominantly self-pollinated plant, has been impaired due to lack of adequate genetic diversity within the available genetic stocks. Circumstances were such that International Jute Organization (IJO) came on the scene and launched its germplasm project in 1987 to collect genotypes from all over the world. To date collections from indigenous sources including breeding lines and mutants have resulted in the acquisition and maintenance of over 2,300 jute germplasm accessions.

5.1 Analysis of variance for 11 different phenotypic characters in Tossa jute

A total of 11 characters were considered to characterize and evaluate 53 germplasms of Tossa jute. Analysis of variance (ANOVA) on 11 characters revealed significant variation existed for each character among the germplasm. The confidence level of significant variation evidenced 95 % for each of the characters. Such variation in the germplasm appeared as an important criterion to promote experimental strategies of the investigation. The LSD, a statistical tool was employed to assess the differences among the genotypes for a particular character. The phenotypic coefficient of variation (PCV) was higher than corresponding genotypic coefficient of variation due to predominant effect of environment upon expression for each of the characters. The highest genetic advance as percentage of mean (44.38%) was estimated against green weight without leaves, suggested it is the main character to enhance fiber and stick yields through selection. It is noted that characters could be selected on phenotypic performances but progress under selection obviously depends upon the genetic make of the concerned characters.

5.2 Genetic diversity analysis of 53 genotypes based on 11 characters of Tossa jute

The variations existed among the genotypes were accounted through principal component analysis (PCA) and principal coordinate analysis (PCoA). Fifty three genotypes were grouped into five clusters. The cluster I comprised with 3, cluster II with 11, cluster III with 18, cluster IV with 14 and cluster V with 7 genotypes. It was observed the distribution patterns of

the genotypes were not correlated with geographical divergence, because the genotypes originated from our country were distributed into different clusters, and moreover, the Indian genotype was included in the same cluster with our locally developed genotypes. Mohalanobis's D^2 statistics was applied to clustering the 53 genotypes. In general, intracluster distances were lower than intercluster distances, suggested less diversity within a cluster but the genotypes under a cluster were far away from the genotypes of other clusters. However, the maximum inter cluster distance (20.616) between the cluster I and cluster V. and the minimum (2.871) between the clusters IV and V. The Mohalanobis's clustering patters were verified by PCA, where the clusters were superimposed on the PCA values though a scattered diagram. The contribution of a particular character toward genetic diversity was assessed by vector analysis. The highest as well as positive vector I and vector II specified the higher contribution toward genetic divergence; accordingly the character, base diameter of the plant appeared as the greatest contributor followed by green bark thickness, green wt. without leaves and plant height in creating genetic divergence among the studied genotypes. The cluster mean for a particular character was estimated to determine potential of a cluster for selection of parents in hybridization. A breeder might select the genotypes from cluster having high mean for the concerned character.

5.3 Interrelationship analysis among different characters of Tossa jute

The associations of commercially important quantitative characters that were statistically determined by correlation coefficients have been quite helpful as basis of selection. Selection pressure could be more easily exerted on any of the characters which reflect close association with fiber yield. The fiber yield by itself may not be the best criterion alone for improving fibre yield of Tossa jute. Correlation studies measured only mutual association between two independed characters and path analysis measures the cause and effect of relationship. Thus, the estimation of correlation coefficients and path analysis gave 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 fiber yield of Tossa jute. However, among 11 independent characters, fifty five correlation coefficients were estimated between all possible pairs of characters. The correlation coefficients were distributed both in positive and negative directions. Overall, the genotypic correlation coefficients were higher than corresponding phenotypic correlation coefficients, suggested inherent associations at genetic level between different pairs of characters. Except, leaf width and leaf angle, other characters showed positive relation with fiber weight/plant but all the

positive associations were not significant; even none of the characters showed positive and significant association both at genotypic and phenotypic levels. From the association studies, it was revealed that plant height, green bark thickness, green weight without leaves and stick weight were the indispensable characters for improving fiber yield in Tossa jute.

The relationship between traits explained through character association studies did not provide a clear picture of bonding between fiber yield and its contributing traits. Path analysis provided lucid information of direct and indirect effects of characters and measured the relative importance of each and every character in shaping the final objective, fiber yield. The direct and indirect effects only at phenotypic level showed that the interrelationship between pairs of characters is influenced by prevailing growing conditions.

The results of path coefficient analysis were shown that direct positive effects of plant height, (0.088), base diameter (0.099), green bark thickness (0.094), stick weight (0.486) on fiber yield/plant, green weight with leaves (0.424) and green wt. without leaves (0.012) suggested that these characters would be feasible to improve fiber yield potential in Tossa jute. The direct negative effects exerting characters would not be suitable for improvement. The positive indirect effects of the characters imposed to develop ultimate positive correlation with fiber yield /plant. The negative correlation coefficients of fiber yield with some characters indicated that the indirect effects of the characters had not compensated the direct negative effect to build up correlation with fibre yield.

5.4 Selection of parents for combining ability analysis

Fifty three germplasm of Tossa jute were incorporated in the study to select suitable parents for hybridization. During field evaluation, eight parents were selected based on the characters like stem color, plant height, base diameter, leaf shape, green bark thickness, bud color, sepal color and late flowering were considered to produce diversified segregants were considered to select the parents. Since late flowering offers prolonged vegetative growth, thus character were taken into consideration. Moreover, the clusters developed by Mohalanobis's D^2 statistics proved a thoughtful selection of parents. There were five clusters, accordingly at first one genotype was picked up from one cluster. The rest two genotypes were taken from cluster III comprising 18 genotypes and the last genotype was taken from cluster IV comprising 14 genotypes. The way out of selection of parents shown that two were released varieties (O-9897 and O-795), one Indian variety (JRO- 524) and other five parents were the

advanced accession lines of Tossa jute. The objective of selection of parents mainly was to have desirable segregants.

5.5 Combining ability analysis on 11 characters of Tossa jute

In order to develop an appropriate breeding program it is essential to assess the nature of inheritance of fiber yield and its component characters and the potential performance of the parents in hybrid combinations. Combining ability studies helped in identifying potential lines, which on hybridization gave rise to desirable segregants. Various mating designs have been used for assessing the breeding value of parents. Estimation of variance and combining ability effects and analysis through full diallel cross technique have been used. Through these techniques good general combining lines and best specific crosses were identified along with knowledge of heritable variance due to additive effect provided some insight into the nature of gene action involved. However, appropriate breeding work has been carried out for improving fiber yield and its components in Tossa jute using combining ability

Analysis of variance for eleven characters revealed significant differences in GCA, SCA and reciprocal crosses. The significant effect of reciprocal crosses indicated influence of cytoplasmic genes (mt DNAs and ct DNAs) on the expression of the characters. Out of 8 parents, the released variety, O-795, Indian variety, JRO-524 and the two accession lines, Acc-3533 and Acc-3860 showed positive and significant GCA effects for fiber yield/plant, hence, these four parental lines appeared as excellent combiners in hybridization but fiber yield potential was higher (16.80g/plant) in Acc-3533 and (18.93g/plant) in Acc-3860, therefore, these two accession lines must be consider to produce outstanding hybrids. It is noted that significant GCA effect and along with high mean fiber yield might offer desirable segregants in advanced generations. The QTLs (quantitative trait loci) for polygenic character like fiber yield would independently assort in linkage equilibrium condition. So, additive genetic effect may be exploited for the resultant character, fiber yield in Tossa Jute.

Among twenty eight hybrid combinations, seven combinations exhibited positive and significant SCA effects for fiber yield/plant; the fiber yield potentials of the seven crosses were also appreciable, hence these crosses could be advanced to have desirable segregnts. Moreover, the significant SCAs in positive direction indicated non-additive interactions like dominant × dominant, epistatic × epistatic and dominant × epistatic interactions. But simultaneous consideration of consideration of GCA and SCA effects, suggested all possible additive and non-additive interactions of genes were involved for the expression of the

character, fiber yield in Tossa jute. However, the crosses P_1x P_4 (O-9897 × Acc-2381), P_2 × P_6 (O-795 × Acc-3433), P_2 × P_7 (O-975 × Acc-3533), P_3 × P_4 (JRO-524 × Acc-2381), P_3 × P_5 (JRO-524 × Acc-3423), P_7 × P_8 (Acc-3533 × Acc-3860) and P_5 × P_6 (Acc-3423 × Acc-3433) appeared as outstanding combinations for attaining high fiber yield through conventional breeding in Tossa jute. It is assumed that these seven combinations would result desirable advanced generations and from where suitable varieties of Tossa jute might be evolved.

5.6 Reciprocal cross effects

Out of twenty eight reciprocal crosses, seven crosses had positive and significant SCA effects for fiber yield in Tossa jute and the crosses were P_6 × P_3 (Acc-3438 × JRO-524), P_6 × P_4 (Acc-3438 × Acc-2381), P_6 × P_5 (Acc-3438 × Acc-3423), P_7 × P_5 (Acc-3533 × Acc-3423), P_8 × P_2 (Acc-3880 × O-795), P_8 × P_4 (Acc-3850 × Acc-2361) and P_5 × P_2 (Acc-3423 × O-795).The positive and significant reciprocal SCA effects indicated predominant effects genes present in mitochondria and/or chloroplast. Since the mega gametes (female gametes) carried cytoplasm during fertilization, both directions crosses were carried out to obtain desirable segregants through all possible genetic makes for fiber yield of Tossa jute. It is interesting to state that none of the combination showed beneficial SCA effects both in normal and reciprocal crosses. So, the transmission of cytoplasmic genes was cross specific not in general.

5.7 Selection of superior cross combinations

The continuous selection of traits of interest, generation after generation, permits the accumulation of favourable alleles for the traits being improved (increase of allelic frequency). Thus, heterozygous allelic pairs subject to fix with advancing the generations. Hence, this method is to be perfect on a medium-to-long-term basis, and it might produce genetic improvement in Tossa jute. To develop varieties and take advantage of the genetic variability available in each segregating generation within the population improvement process, ten cross combinations were selected based on the positive and significant GCA results of the eight parents for plant height, base diameter, green wt. without leaves and fibre weight/plant. The variability like mean range, mean and variance for each of the selected characters were compared between based population (300) and selected population (30) for a single character. In general, means values of selected characters were higher in selected populations under each of 10 crosses compared to base populations .The progenies of the cross, P_8 x P_4 (Acc-3850 × Acc-2361) produced the highest fiber weight (23.53 g), which was followed by the cross, P_3 x P_4 (JRO-524 × Acc-2381) further it produced the highest base

diameter (20.16 mm), suggested the appreciable potential of the two crosses to evolve outstanding advanced lines.

The significant paired t test was implied apparently for the improvement of the selected characters. Therefore, the selected lines might be promoted to evolve outstanding segregants at the end of selection operation and from where new varieties of Tossa jute may be released in future.

5.8 Conclusions

1. The selected 11 characters including fiber yield showed wide variation among 53 germplasms of Tossa jute (*Corchorus olitorius* L)
2. Base diameter, green bark thickness, plant height and green weight without leaves were the important fiber yield enhancing characters; therefore, jute breeders might exploit these characters for improving fiber yield in Tossa jute.
3. The 53 germplasms were grouped into five clusters by D^2 statistics which were superimposed on PCA values to confirm the clustering pattern of the genotypes.
4. Stem color, plant height, base diameter, leaf shape, green bark thickness, bud color, sepal color and late flowering along with clustering patters were considered to select 8 parents for combining ability analysis.
5. The local variety O-795, the Indian variety JRO-524 and two accession lines, Acc-3533 and Acc-3860 appeared as the good general combiners but simultaneous consideration of mean performances, the two accession lines were the outstanding combiners to attain high fiber yield in Tossa jute.
6. Seven hybrid combinations of normal hybrid series and seven combinations from reciprocal hybrid series had positive and significant SCA effects, Therefore, both nuclear genetic makeup and extra-nuclear genetic effects must be considered for the improvement of fibre yield in Tossa jute.
7. Two crosses such as P_8 x P_4 (Acc-3850 × Acc-2361) and P_3 x P_4 (JRO-524 × Acc-2381) have the excellent potential to produce desirable segregnts. Though above two crosses initially exhibited high potential to increase fibre yield, but due to 1^{st} segregating generation (F_2), the progenies derived from other 8 crosses should be simultaneously advanced to evolve desirable advanced lines of Tossa jute in future.