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Research Article

Genetic Divergence and Character Association for Yield and Quality Attributing Characters in Tossa Jute (*Corchorus olitorius* L.)

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Abstract
In the present investigation an attempt has been made to evaluate the eighteen released and common knowledge varieties of tossa jute to study the genetic divergence and association of different component characters associated with fibre yield. The experimental materials were grown in Randomized Block Design with three replications at Central Research Institute for Jute & Allied Fibres, Baarrackpore, India during 2009-10 for recording data of eight yield and quality contributing characters *viz*., plant height, basal diameter, node no., fibre weight, stick weight, fibre strength, fibre fineness and fibre percentage. High heritability with high genetic advance exhibited by plant height, fibre strength, fibre fineness, fibre weight and basal diameter indicated the influence of mainly additive gene action. All the varieties irrespective of their origin were grouped into 5 different clusters. The clustering pattern revealed meager amount of genetic diversity between the varieties studied in tossa jute. Inter-cluster distance was maximum between I and IV. Fibre fineness, fibre %, stick weight and basal diameter were the potent characters that influence the genetic diversity. Plant height, node number, basal diameter, stick weight, fibre fineness and fibre percentage had significant and positive correlation with fibre weight. Only character fibre strength exhibited negative correlation.

Key words
Tossa jute, Variability, Diversity, Path coefficient, Correlation

Introduction

In Indian subcontinent jute is the second most important natural fibre after cotton (*Gossypium* sp. L.). Tossa jute (*Corchorus olitorius*) is an Afro-Arabian variety and fibre is softer, silkier and stronger than white jute (*Corchorus capsularis*). This variety astonishingly showed good sustainability in the climate of the Ganges Delta. However, the crop demands the immediate attention of plant breeders. The available elite cultivars of tossa jute are essentially derived either through pure line selection or hybridization followed by selection from a few common accessions. Varietal improvement in jute, a predominantly self pollinated crop, has been impaired due to lack of adequate genetic diversity within the available gentic stock (Singh, 1980, Joshua and Thakare, 1984).

Information on the nature and magnitude of genetic variability for the desired characters in the base material and interrelationship among them is useful in breeding for high yield (Kumar *et al*., 2008). The genetically diverse parents are likely to produce high heterotic effects and desirable segregates. Considering this, jute breeders have become more aware of the needs of maintaining genetic diversity among varieties and improving the management of genetic resources through the conservation of traditional land races and germplasm. Information on quantum of genetic divergence in tossa jute is lacking. Estimation of genetic diversity on the basis of morpho-physiological attributes has been carried out by some workers (Sobhan, 1982; Dastidar *et al*. 1993; Palit *et al*., 1996 and Islam *et al*., 2002).Yield by itself may not be the best criterion for selection. It is quantitatively inherited and influenced by genetic factors as well as environments. Rao *et al*., (1990) reported that yield is a complex character and is the resultant of many factors, which are relatively and simply inherited. In order to have a good choice of character for selection of desirable genotypes under planned breeding programme, the knowledge of nature and magnitude of variation existing in available breeding materials, the association of component characters with fibre yield and their exact contribution through direct and indirect effects are very important. In this regard a good number of research works in jute has been reported by many workers (Chaudhury *et al*., 1981; Sardana *et al*., 1990; Khatun and Sobhan, 1992; Ahmed *et al*., 1994; Islam *et al*., 2001).

Keeping this in view, the present investigation was undertaken to measure the genetic variability, genetic diversity of 18 released and common knowledge varieties in tossa jute for yield and quality contributing characters and interrelationship among them to identify suitable breeding methods and parents for improvement of this species.

Materials and methods

The material for the present study comprised of 18 released and common knowledge varieties of tossa jute (Table 1) collected from Plant Genetic Resource Unit of Crop Improvement Division, Central Research Institute for Jute & Allied Fibres, Baarrackpore, India. The experimental materials were grown in Randomized Block Design with three replications at Central Research Institute for Jute & Allied Fibres, Baarrackpore, India. The plot size for each genotype was 6.0 m x 1.60 m. There were 4 lines of 6 m length in each plot. Row to row and plant to plant distances were 40 cm and 7 cm, respectively. Standard package of practices were followed to raise the crop. Net plots were harvested at 120 days crop age and data were recorded for eight yield and quality contributing characters viz. plant height (cm), basal diameter (cm), node no., fibre weight (g/plant), stick weight (g/plant), fibre strength (g/tex), fibre fineness (tex) and fibre percentage. Plant height was recorded as height of the main stem measured from ground level to the point of forking at pre bud stage (before development of first flower). Fibre fineness was measured by Airflow Fibre Fineness Tester (NIRJAFT, Kolkata) from the replicated samples by Airflow method which is broadly followed everywhere for assessing fibre fineness in natural fibres. Fibre strength was determined by fibre bundle strength tester (NIRJAFT, Kolkata). In this case an average value of fibre strength of different fibre samples was measured. The dry fibre weight to dry fibre plus dry stick weight was considered as an approximate measure of fibre percentage.

Results and discussion

Analysis of variance was run on the means of the selected plants from three replications (Indostat Statistical Software Package developed by Indostat Pvt. Ltd., Hydrabad, India). Fibre percentage was transformed to angular values for final analysis. The genetic divergence among genotypes was computed by means of Mahalanobis' D^2 technique (Mahalanobis, 1936). The difference between the varieties for the set of characters taken was tested according to the procedure of Wilks (1932). The genotypes were grouped into different clusters following Tocher's method as described by Rao (1952). The relative contribution of characters towards divergence was estimated using canonical analysis. Significance of differences of genotypes was tested using Wilk's criterion (Wilks, 1932). Genetic variability parameters and correlation were analysed as proposed by Johanson *et al*. (1955). Path coefficient analysis was carried out as described by Dewey and Lu (1959) with fibre weight as a dependent variable.

The analysis of variance revealed remarkable variation and significant differences for almost all the characters viz. Plant height, Basal diameter, node number, fibre strength, fibre fineness and fibre weight except stick weight and fibre % (Table 2.). This indicated the presence of adequate variability among the 18 tossa jute varieties studied. In general phenotypic variances for characters were higher than genotypic variances indicating the role of environmental variance in the expression of characters. In this study also phenotypic coefficient of variation (PCV) for all the characters were higher than genotypic coefficient of variation (GCV). The highest PCV was observed for the character stick weight (30.37). The coefficients of variation at phenotypic and genotypic level were higher for fibre weight, Basal diameter, fibre strength and plant height and low for character fibre %, fibre fineness and node number. Heritability was highest for fibre strength (0.95) followed by plant height (0.91) and fibre fineness (0.86). Similar results were also reported by Sobhan *et al*., 1993; Islam *et al*., 2002 and Akter *et al*., 2002. All the characters have high heritability indicating that improvement of these characters would be effective through selection.

Genetic advance expressed as percentage of mean was highest for plant height followed by fibre strength and basal diameter. Like heritability almost all the characters except fibre % have high genetic advance. Relationship of heritability and genetic advance also give an idea about the type of gene action. It was found that all the characters were under the influence of mainly additive gene action which suggests that simple selection methods will be effective for jute breeding programme. The preponderance of additive type of gene action in tossa jute in the inheritance of all these characters was also reported by Saha *et al*. (1996).

Genetic divergence: On the basis of relative magnitude of D^2 values these 18 tossa jute genotypes could be classified into 5 clusters, on the assumption that germplasm within the cluster have similar D^2 values among themselves rather than those from groups belonging to two different clusters (Table 3 and Fig. 1). Eight genotypes were accordingly placed in cluster I. Cluster II consisted of 5 genotypes and cluster IV comprised of 3 genotypes. However, cluster III and V included one strain in each cluster. The clustering pattern of the genotypes revealed that varieties developed by selection from exotic collections (Sudan Green and Tanganyka I) were placed into cluster I but also with one indigenous collection (Chinsura Green) and varieties developed through selection from local strains (JRO 620 and JRO 632). The other varieties present in cluster I have either Sudan Green or Tanganyka I or both as one of the parent in their pedigree. The clustering pattern of the strains revealed that there was no close correspondence between geographical distribution and genetic divergence as estimated by the D^2 statistics. This result refutes the claim of Joshi and Dhawan (Joshi and Dhawan, 1966). Genetic drift and selection in different environments could cause greater genetic diversity than geographical distance (Murty and Arunachalam, 1966). Similar results were obtained from the studies on other crops (Malhotra, *et al*., 1974; Asthana and Pandey, 1980; Bhandari and Gupta, 1993; Rana *et al*., 2005). Three varieties (JRO 524, JRO 7835 and JRO 878) and JRO 36 E evolved from Sudan Green or Tanganyka 1 respectively placed in to different cluster from their parent. JRO 2345 was selected from a Kenyan germplasm placed in to cluster III. Two varieties under cluster IV (TJ 40 and Bidhan Rupali) were developed from mutant of JRO 632. A variety, KOM 62 present in cluster V originated from gamma ray treated JRO 878 which was placed in cluster II. It is thus clear that, in general the varieties of tossa jute originating from related crosses, where at least one parent is common in their pedigree tended to fall into same cluster. However, varieties differed in cluster position from their parent. The clustering pattern revealed meager amount of genetic diversity between the genotypes studied in tossa jute due to hybridization and selection from a few common ancestor. This deduction corroborated with the finding of Kar *et al*. (2009).

Cluster grouping: The inter-cluster distance (Table 4) was maximum between I and IV (8.58) followed by that between cluster II and V (7.94) and between cluster II and IV (7.76) which could be expected to produce high heterotic effects when crossed. The least distance was observed between cluster III and V (5.42). The intra-cluster divergence ranged from 0 to 4.10. Cluster III and V had the least intra-cluster distance. Cluster II had the highest intra-cluster D^2 value.

Cluster means: The diversity in the present materials was also supported by the appreciable amount of variation among cluster means for different characters (Table 5). Cluster II showed highest mean for plant height (420.47 cm), fibre strength (27.43 g/tex), fibre % (34.39) and fibre weight (13.33 g). Cluster II also showed highest mean values for fibre fineness (3.09 tex) i.e. produced less finer fibre. Cluster IV showed highest mean value for B.D. (1.79 cm), node number (65.67) and stick weight (25.82). Fibre fineness, fibre %, stick weight and basal diameter were the potent characters that influence the genetic diversity among the 18 varieties of tossa jute.

Interrelationship analysis: Interrelationships of the characters and their association with fibre weight in tossa jute were examined through the study of genotypic and phenotypic coefficient. Such study would also help to know the suitability of various characters for indirect selection because selection of one or more character results in correlated response in several other traits. The study of correlations (Table 6) showed that all the correlation coefficients at genotypic level were greater than the corresponding phenotypic ones. The higher values of genotypic than those of phenotypic correlations suggested that the genotypic effects were more important than the environmental factors. In the present investigation fibre weight was positively correlated with plant height, node number, basal diameter, stick weight, fibre fineness and fibre percentage at both phenotypic and genotypic level. Similar relationship was also reported by Khatun *et al*., 1998 and Islam *et al*., 2001. Only character fibre strength exhibited negative correlation with fibre weight. Thus, in order to obtain fibre of good strength, yield has to be sacrificed. When interrelationships among different characters were considered, significant positive correlations were observed between plant height and basal diameter, basal diameter and node number, basal diameter and stick weight, node number and stick weight. It therefore follows that selection for any of these four characters is likely to generate a correlated response over the remaining three characters. Such correlation may arise due to linkage or pleiotropy. But in this investigation it is not possible to conclude the cause of correlation. Significant but negative correlation was observed between stick weight and fibre percentage.

Estimates of correlation do not alone provide comprehensive pictures of the direct and indirect influences of each of the characters to the fibre weight as this trait is the resultant product of combined effect of various factors complementing and counter acting. So the path coefficient analysis of fibre weight was carried out to assess the extent of phenotypic as well as genotypic relationship of fibre weight and its attributes, and establish the impact of the individual component on fibre yield of tossa jute. In the present material, direct positive effects of plant height and node number were observed on fibre weight at both phenotypic and genotypic level (Table 7). These direct effects of plant height and node number were mostly positive through other characters. This result corroborated with the finding of Sardana *et al*., 1990 and Islam *et al*., 2001. Basal diameter and fibre fineness exhibited direct positive effect on fibre weight at genotypic level only while fibre strength and fibre % revealed direct positive effect on fibre weight at phenotypic level only. However, significant positive correlation was obtained with plant height, basal diameter and node number with fibre weight. Stick weight produced negative direct effect with fibre weight at both phenotypic and genotypic level. Thus plant height, node number, basal diameter, fibre fineness, fibre strength and fibre % appeared to be most important fibre yield attributing characters.

It may be concluded from this study that genetic diversity is more important for selecting parents for hybridization than eco-geographical isolation. Better recombinants might yield when varieties from cluster I will be crossed with varieties from cluster IV. Beside fibre weight, plant height, node number and basal diameter were found important characters for selecting better fibre yielding genotypes. It, therefore appears from the present investigation that there is scope of improvement for fibre yield in tossa jute if plant type is proposed for more plant height and node number and less stick weight.

References

Ahmed, S.S., Muttalib, M.A. and Ahmed, A. 1994. Correlation between fibre yield and its components in tossa jute (*Corchorus olitorius* L.). *Bangladesh J. Plant Breed. Genet.* **7**(1): 13-16.

Akter, N. 2001. Morphological attribute and stem histology in relation to fibre yield and biomass of high land jute (*Corchorus* spp.). M.Sc. thesis. Dept. Genet. Plant Breed. BSMRAU. Salna, Gazipur-1703, Bangladesh.

Asthana, A.N. and Pandey, V.K. 1980. Genetic divergence in linseed. *Indian J. Genet.,* **40**(2): 247-250.

Bhandari, M.M. and Gupta, A. 1993. Genetic divergence in coriander. *Indian J. Genet.,* **53**(1): 71-75.

Chaudhury, S.K., Sinha, M.K. and Singh, D.P. 1981. Path analysis in tossa jute. *Indian J. Agric. Sci.,* **51**(3): 772-775.

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components on crested wheat grass and seed production. *Agron. J.,* **1**(1): 510-518.

Gosh Dastidar, K.K., Agarwalla, K.K. and Roychowdhury, P. 1993. Genetic variability and association of component characters for seed yield in *olitorus* jute. *Indian J. Genet.,* **53**(2): 157-160.

Islam, M.R., Islam, M.M., Akter, N. and Ghosh, R.K. 2002. Genetic variability and performance of tossa jute. *Pakistan J. Biol. Sci.,* **5**(7): 744-745.

Islam, M.S., Uddin, M.N., Haque, M.M. and Islam, M.N. 2001. Path coefficient analysis for some fibre yield related traits in white jute (*Corchorus capsularis* L.). *Pakistan J. Biol. Sci.,* **4**(1): 47-49.

Johanson, H.W., Robinson, H.R. and Comstock, R.F. 1955. Estimation of genetic and environmental variability in soybean. *Agron J.,* **47**(2): 314-318.

Joshi, A.B. and Dhawan, N.L. 1966. Genetic improvement of yield with special reference to self fertilizing crop. *Indian J. Genet.,* **26**(A): 101-113.

Joshua, D.C. and Thakare, R.G. 1984. Inheritance of induced mutant characters in jute (*Corchorus capsularis* L.). *Current Sci.,* **53**(1): 697-700.

Kar, C.S., Kundu, A., Sarkar, D., Sinha, M.K. and Mahapatra, B.S. 2009. Genetic diversity in jute (*Corchorus* spp.) and its utilization: A review. *Indian J Agric. Sci.,* **79**(8): 578-586.

Khatun, R. and Sobhan, M.A. 1992. Genetic variability, correlation and path analysis in *olitorius* jute. *Egpt. Genet.,* **4**(1): 48-52.

Kumar, D., Agrawal, R.C. and Begum T. 2008. Analysis for identification of distinct and uniform extant jute (*Corchorus olitorius* L. and *C. capsularis* L.) varieties. *Seed Res.,* **36**(1): 121-134.

Mahalanobis, P.C. 1936. On the generalized distance in statistics. *Proc. Nat. Inst. Sci. India (B).,* **2**: 49-55.

Malhotra, V.V., Singh, S. and Singh, K.B. 1974. Relation between geographic diversity and genetic divergence and the relative role of each character towards maximizing divergence in green gram. *Indian J. Agric. Sci.,* **44**(12): 811-815.

Murty, B.R. and Arunachalam, V. 1966. The nature of genetic divergence in relation to breeding system in crop plants. *Indian J. Genet.,* **26**(A): 188-198.

Palit, P., Sasmal, B.C. and Bhattacharryya, A.C. 1996. Germplasm diversity and estimate of genetic advance of four morpho-physiological traits in a world collection of jute. *Euphytica*., **90**(1): 89-110.

Rana, J.C, Yadav, S.K., Mandal, S. and Yadav, S. 2005. Genetic divergence and interrelationship analysis in grain amaranth (*Amaranthus hypochondriacus*) germplasm. *Indian J. Genet.,* **65**(A): 99-102.

Rao, C. R. 1952. *Advanced statistical methods in biometrical research*, John Wiley & Sons, Inc, New York, pp. 357-363.

Rao, D.S.R.M., Singh, H., Singh, B., Khola, O.P.S. and Faroda, A.S. 1990. Correlation and path coefficient analysis of seed yield and its components in sesame (*Sesamum indicum* L.). *Haryana Agric. Univ. J. Res.,* **20**(4): 273-276.

Saha, A., Kumar, D. and Basak, S. L. 1996. Diallel cross analysis over years for yield and its components in jute (*Corchorus olitorius* L.). *Bangladesh J. Bot.,* **25**(1): 59-63.

Sardana, S., Sasi kumar, B. 1990. Genetic variability and path analysis in jute germplasm. *Bangladesh J. Bot.,* **19**(1): 95-97.

Singh, D.P. 1980. Jute. In: Fehr, W.R. and Hadley, H.H. (eds) *Hybridization of crop plants*, American Soc. Agron. & Crop Sci. Soc. American Publ., Madison, Wisconsin, USA. pp 407-416.

Sobhan, M.A. 1982. Genetic variability and correlation in tossa jute. *Bangladesh J. Jute Fib. Res.,***7**: 97-101.

Sobhan, M.A., Begum, H.A. and Islam, M.R. 1993. Characterization of introduced jute varieties for yield and quality of fibre. Ann. Rep. Bangladesh Jute Research Institute, pp: 30-35.

Wilks, S.S. 1932. Certain generalizations in the analysis of variance. *Biometrics.,* **24**(1): 471.

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Table 1. Passport information on the tossa jute varieties

Name	Pedigree	Year of release	Centre
***C. olitorius:* Notified varieties**			
JRO 632	Pureline selection from an indigenous germplasm	1954	CRIJAF, Barrackpore
JRO 3690	Selection from Tobacco leaf x Long inter-node	1985	CRIJAF, Barrackpore
KOM 62	JRO 878 treated with 40 Kr gamma ray	1993	JRS, OUAT, Kendrapara
TJ 40	Selection from a cross between mutants of JRO 632	1983	BARC, Trombay
JRO 66	Selection from a multiple cross	1998	CRIJAF, Barrackpore
JRO 524	Selection from Sudan Green x JRO 632	1977	CRIJAF, Barrackpore
JRO 7835	Selection from JRO 632 x Sudan Green	1971	CRIJAF, Barrackpore
JRO 878	Selection from JRO 620 x Sudan Green	1967	CRIJAF, Barrackpore
JRO 8432	Selection from IC 15901 x Tanganyika-1	1999	CRIJAF, Barrackpore
JRO 128	Selection from TJ-6 x Tanganyika-1	2002	CRIJAF, Barrackpore
S-19	Selection from(JRO 620 x Sudan Green) x Tanganyika-1	2005	CRIJAF, Barrackpore
Bidhan Rupali	X-ray induced mutant of JRO 632		BCKV, Kalyani
***C. olitorius:* Varieties of common knowledge**			
JRO 620	Selection from local type	1967	CRIJAF, Barrackpore
Chinsurah Green	Selection from a local strain in Chinsurah	1915	CRIJAF, Barrackpore
Sudan Green	Introduction from Sudan, Africa	1956	CRIJAF, Barrackpore
Tanganyika 1	Introduction from Tanganyika	1978	CRIJAF, Barrackpore
JRO 36E	Selection from Tanganyika - 1	1981	CRIJAF, Barrackpore
JRO 2345 (INGR No.04050)	Selection from KEN/SM/024C	2004	CRIJAF, Barrackpore

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Table 2. Parameters of genetic variability in tossa jute varieties

Characters	Range		Mean	F test	PCV	GCV	Heritability	Genetic Advance as % over mean
	Minimum	Maximum						
Plant height (cm)	301.00	444.33	381.81	HS	12.45	11.90	0.91	23.43
B.D. (cm)	1.33	2.27	1.72	HS	17.80	13.32	0.56	20.53
Node number	56.00	72.00	63.59	S	9.75	7.32	0.56	11.33
Stick wt (g)	16.67	36.06	23.98	NS	30.37	15.77	0.27	16.86
Fibre strength (g/tex)	16.08	30.11	24.95	HS	15.18	14.83	0.95	29.87
Fibre Fineness (tex)	2.59	3.45	2.87	HS	9.47	8.79	0.86	16.83
Fibre %	32.28	35.71	33.77	HS	5.14	1.62	0.09	1.06
Fibre weight (g)	6.67	15.77	10.69	HS	25.47	22.14	0.76	39.65

Table 3. Grouping of genotypes into different clusters

Clusters	Genotypes	Number
I	Sudan Green, Tanganyka 1, Chinsura Green, JRO 128, S 19, JRO 8432, JRO 632, JRO 620	8
II	JRO 524, JRO 7835, JRO 66, JRO 36 E, JRO 878	5
III	JRO 2345	1
IV	JRO 3690, Bidhan Rupali, TJ 40	3
V	KOM 62	1

Table 4. Intra-cluster (in bold) and inter–cluster distance (D), value based on eight yield and fibre quality attributing characters

Cluster	I	II	III	IV	V
I	**4.02**	5.53	4.67	8.58	6.22
II		**4.10**	5.67	7.76	7.94
III			**0.00**	6.72	5.42
IV				**3.99**	6.02
V					**0.00**

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Table 5. Cluster mean values for eight yield and fibre quality attributing characters in tossa jute

Sl. No.	Cluster	Plant height (cm)	B.D. (cm)	Node No.	Stick wt (g)	Fibre strength (g/tex)	Fibre Fineness (tex)	Fibre %	Fibre weight (g)
1.	I	355.50	1.76	63.04	24.22	26.55	2.78	33.45	10.98
2.	II	**420.47**	1.74	64.60	24.11	**27.43**	**3.09**	**34.39**	**13.33**
3.	III	376.67	1.50	56.00	16.67	24.63	2.59	32.40	6.67
4.	IV	412.11	**1.79**	**65.67**	**25.82**	18.30	2.82	34.21	13.00
5.	V	313.33	1.33	64.33	23.30	20.10	2.82	33.38	8.20

Table 6. Correlation coefficient at phenotypic (P) and genotypic (G) level

Characters		B.D. (cm)	Node No.	Stick weight (g)	Fibre strength (g/tex)	Fibre Fineness (tex)	Fibre %	Fibre weight (g)
Plant height (cm)	P	0.2805*	0.2076	0.2398	0.0008	0.0539	0.0480	0.7041**
	G	0.4175	0.2537	0.3095	-0.0104	0.0743	0.2734	0.7555
B.D. (cm)	P		0.3793**	0.4709**	0.0567	0.0303	0.0557	0.3003*
	G		0.3808	0.8547	0.1268	0.0700	-0.1107	0.4047
Node No.	P			0.7543**	-0.1474	0.2122	-0.1376	0.5441**
	G			0.9590	-0.1739	0.2763	-0.1546	0.7242
Stick weight (g)	P				-0.0743	0.1502	-0.4621**	0.3703**
	G				-0.1061	0.1387	-0.0141	0.6438
Fibre strength (g/tex)	P					0.1324	-0.0188	-0.0162
	G					0.1315	-0.1155	-0.0101
Fibre Fineness (tex)	P						0.2340	0.1708
	G						1.1564	0.2522
Fibre %	P							0.1389
	G							0.4557

Table 7. Path analysis at phenotypic (P) and genotypic (G) level taking dependent variable (fibre weight) and direct effects in bold

Characters		**Plant height (cm)**	**B.D. (cm)**	**Node No.**	**Stick weight (g)**	**Fibre strength (g/tex)**	**Fibre Fineness (tex)**	**Fibre %**
Plant height (cm)	**P**	**0.6200**	0.1739	0.1287	0.1487	0.0005	0.0334	0.0297
	G	**0.7909**	0.3302	0.2006	0.2448	-0.0082	0.0587	0.2162
B.D. (cm)	**P**	-0.0137	**-0.0488**	-0.0185	-0.0230	-0.0028	-0.0015	-0.0027
	G	0.1885	**0.4514**	0.1719	0.3858	0.0572	0.0316	-0.0500
Node No.	**P**	0.1075	0.1964	**0.5178**	0.3905	-0.0763	0.1099	-0.0712
	G	0.2110	0.3167	**0.8316**	0.7975	-0.1446	0.2298	-0.1286
Stick weight (g)	**P**	-0.0168	-0.0331	-0.0530	**-0.0703**	0.0052	-0.0106	0.0325
	G	-0.2972	-0.8207	-0.9209	**-0.9602**	0.1018	-0.1332	0.0135
Fibre strength (g/tex)	**P**	0.0000	0.0034	-0.0089	-0.0045	**0.0606**	0.0080	-0.0011
	G	0.0025	-0.0304	0.0416	0.0254	**-0.2394**	-0.0315	0.0277
Fibre Fineness (tex)	**P**	-0.0002	-0.0001	-0.0009	-0.0006	-0.0006	**-0.0042**	-0.0010
	G	0.0747	0.0704	0.2778	0.1395	0.1322	**1.0054**	1.1626
Fibre %	**P**	0.0073	0.0085	-0.0210	-0.0706	-0.0029	0.0357	**0.1528**
	G	-0.2148	0.0870	0.1215	0.0111	0.0908	-0.9086	**-0.7857**

Residual effect (P) = 0.5503 Residual effect (G) = 0.5813

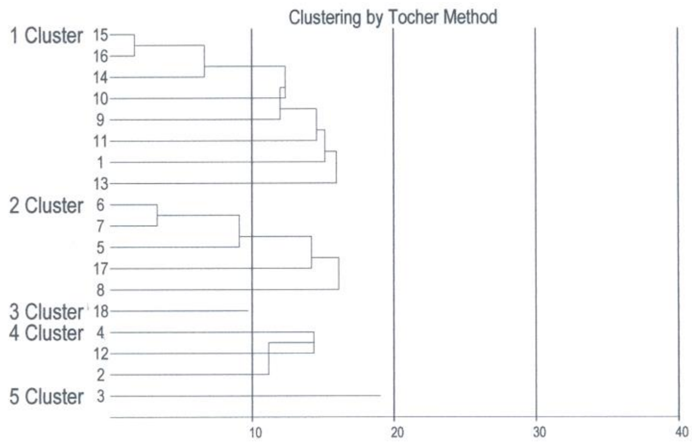

Fig. 1. Dendogram of 18 tossa jute germplasms through Tocher Method