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Anatomical and morphological characteristics of nine jute genotypes

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ABSTRACT

In the present investigation eight genotypes of C. olitorious L. (OMU-09, OMU-42, OMU-43 OEX-16, OIM-45, JRO-204, JRO-524, JRO-8432), *and one genotype of C. capsularis L. (Fanduk) were included to evaluate their morphological and anatomical characteristics. Mean performance of six different morphological and nine different anatomical characters at 30, 60, 90 and 120 DAS of the crop revealed plant height, basal diameter and inter-node length increased sharply between 30 and 60 days age and slowly between the latter two growth stages; mid-diameter and top diameter reduced between 30 and 60 days and increased between the latter two growth stages; number of nodes increased steadily all along. Fibre anatomical characters revealed that total bark diameter and difference between fibre wedge tip and outer bark layer increase sharply between 30 and 60 days; average length and width of fibre cell wedge, number of fibre cell block at base and at middle increased linearly all along up to 120 days age of the crop. Number of fibre cell in each block increased sharply between 30 and 60 days and slowly between the latter two stages. All the plant morphological and fibre anatomical characters exhibited high variation at different growth stages. The anatomical characters may be considered as an easy and effective method for screening genotypes without destructive sampling within a short period.*

***Keyword*:** Bark diameters, fibre cell block, length of fibre and weight of fibre

Jute is a long, soft, shiny natural fibre that can be spun into coarse, strong threads. The crop belongs to the genus *Corchorus*, family *Tiliaceae*, with chromosome number 2n = 14. The fibre quality of jute is dependent upon several anatomical characters (Kundu *et al*., 1959; Maiti, 1977; Chen, 1991 and Satya *et al*., 2011). To study fibre anatomy, a plant is needed to be harvested prior to its maturity *i.e.* destructive sampling is required to be done prior to seed production. Thus, a plant that is used to study fibre quality cannot be a seed yielder. The knowledge of correlation between fibre quality and fibre anatomical character is helpful in selection of suitable parents. Genetic analysis based on morphological character is very crucial in jute breeding. Bast fibres are part of vegetative biomass as they are formed in the secondary phloem region in jute stem. Since whole plant is to be harvested and retted for direct estimation of fibre yield, the plant does not reach to the reproductive stage.

Karmakar *et al.* (2007) studied correlation and genetic variation in different characters of jute at harvesting stage. However, a few attempts have been made to link anatomical characters with fibre yield and such results are genotype specific and have not been validated on a larger number of genotypes (Maiti and Satya, 2009).

In a breeding population, jute breeder thus rely more on indirect estimation of fibre yield by using component characters such as plant height and diameter of base, middle or top. The heritability and correlation of these characters have been found to be variable depending on environmental conditions, retting methods and management practices (Chaudhury, 1988). Therefore, in the present experiment an attempt has been made to study the morpho-anatomical characteristics at various crop growth stages and to examine fiber development patterns through nondestructive sampling so that the same plant may reach maturity to produce fibres.

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MATERIALS AND METHODS

In the present study eight genotypes of *C. olitorious* L. (OMU-09, OMU-42, OMU-43, OEX-16 OIM-45, JRO-204, JRO-524 and JRO-8432) and one genotype of *C.capsularis* (Fanduk) were considered. All the genotypes were collected from Central Research Institute of Jute and Allied Fibers, Barrackpore, Kolkata, West Bengal. They were grown in Randomized Block design with three replications at the Instructional Farm, BCKV, Mohanpur, Nadia during summer *(Kharif)* season in 2011 following recommended agronomic practices. There were three rows of 3m length for each genotype grown at distances of 30cm between rows and 10cm between plants.

Five competitive plants were selected randomly per plot from the middle row of each genotype for anatomical as well as morphological studies from the

same plants. For anatomical study, a rapid and non-destructive method was adopted. At four different ages, *viz.*, 30, 60, 90 and 120 days after sowing (DAS), the bark from each selected plant measuring 1-2cm length and 1-2mm width at a height of 0.5cm from the base was excised out with the help of sharp blade. The cut sections were immediately preserved in formalin: acetic acid: alcohol (5:15:80) solution, labeled properly and stored for further anatomical studies. Hand-free cross-sections were made using sharp blade and the sections after rinsing with water to remove additional mucilage were stained with 1% safranin (aqueous) solution. Stained sections were mounted with a drop of water on clear glass slide with a cover slip. Observations were recorded on nine fiber anatomical characteristics as per the following fig.-1. Data on the characteristics were obtained through microscopic study.

Data with respect to morphological characters like plant height (m), basal diameter (cm), middle diameter, top diameter, number of nodes, internodal length, biomass yield, green fiber weight, stick weight and dry fibre weight were recorded from the same plants at harvest. The data were computed following two factor factorial analysis in the SPSS software.

RESULTS AND DISCUSSION

The mean performance of nine genotypes for six morphological characteristics at different growth stages revealed that there was significant difference in growth rate as observed during different observation dates. The rate of increase in plant height was more between 60 and 90 days age of the crop while in case of base diameter it was between 90 and 120 days (Table 1). Interestingly, the mid diameter and top diameter reduced with the increase in age from 30 to 60 days but it increased rapidly between the ages from 60 to 90 days. Thus there was substantial increase in mean values for base diameter and mid diameter during the ages between 60 and 90 days and also between 90 and 120 days. But in case of top diameter such rapid increase could not be noticed. Ghosh *et al.* (2013) observed plant height to be highly associated with basal diameter, internode length, green weight and fibre yield. The number nodes increased linearly with the increase in age of the crop. The increase in mean between 30 and 60 days was 13.18; between 60 and 90 days 14.20 and between 90 and 120 days it was 15.89. Interestingly in case of internodes length the mean value increased substantially between 30 and 60 days and it reduced slightly between 60 and 90 days and again it increased slightly between 90 and 120 days.

The mean values of different fibre anatomical characters and the pattern of fibre development in nine genotypes of jute are presented in table-2 and represented through fig.-2, 3 4 and 5. Considering the total bark diameter it was observed that the main bark development takes place between 30 and 60 days age

Table 1: Mean performance of morphological characters in jute genotypes at different growth stages

Growth stages	PH	BD	MD	TD	NN	IL
30	0.18	0.27	0.26	0.23	6.40	0.37
60	1.02	0.35	0.24	0.19	19.58	5.75
90	2.15	0.64	0.59	0.48	33.78	5.18
120	2.69	1.02	0.86	0.52	49.47	5.45
Mean	**1.51**	**0.57**	**0.49**	**0.36**	**27.31**	**4.19**
LSD(0.05)	**0.08**	**0.04**	**0.09**	**0.22**	**2.05**	**0.35**

PH=Plant height (m), BD=Basal diameter (cm), MD=Middle diameter (cm), TD=Top diameter (cm), NN=No. of nodes (no), IL= Internodal length (cm).

Table 2: Mean performance of fibre anatomical characters in jute genotypes

Growth stages	A	B	C	D	F	G	H1	H2	I
30	0.45	0.16	0.21	0.20	0.22	0.24	3.48	3.89	10.37
60	0.92	0.25	0.57	0.31	0.25	0.27	4.52	3.92	18.51
90	1.08	0.26	0.77	0.42	0.31	0.36	6.00	3.96	22.50
120	1.11	0.27	0.89	0.50	0.37	0.37	6.11	3.97	24.52
Mean	**0.89**	**0.23**	**0.61**	**0.36**	**0.29**	**0.31**	**5.03**	**3.94**	**18.97**
LSD(0.05)	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.32**	**0.26**	**0.73**

of the crop. However, the rate of bark development declined sharply with the increase in age of the crop. This was revealed from the difference in mean value for the character that reduced from 0.49 mm as observed between 30 and 60 days age of the crop to 0.16 mm between 60 and 90 days age and it further reduced to 0.03 mm with increase in age from 90 to 120 days. Similar relation could be noticed in case of the difference between fibre wedge tip and outer bark layer. In this character the increase of mean was highest between the ages of 30 and 60 days while the difference for the same between 60 and 90 days and also between 90 and 120 days declined sharply from 0.09 mm in case of the former to 0.01 mm in case of the latter two periods. Interestingly, the mean value for the character average length of fibre cell wedge, increased more or less steadily with the age of the crop. Similar steady development of the average width of fiber wedge with the increase of age could be noticed. However, the mean for average width of fiber wedge at top increased at higher rate at older stage *i.e.* the difference in mean between the ages 30 and 60 days was 0.03 mm which increased to 0.06 mm between 60 and 90 days and also between 90 and 120 days. Interestingly, the average width of fibre wedge at the middle increased at a lower rate between 30 and 60 days age, sharply between 60 and 90 days and again declined sharply between 90 and 120 days age of the crop. Similar relation could be discerned in case of number of fiber cell blocks at the base where the amount of increase in mean was 1.04 between 30 and 60 days and it was high between 60 and 90 days (1.48) and again declined to 0.11 between 90 and 120 days. Considering the number of fibre cell blocks in the middle it was revealed that the rate of increase in mean values was comparable between 30 and 60 days and between 60 and 90 days but between 90 and 120 days the increase of mean reduced. In case of number of fibre cell blocks also the mean values increased with age of the crop but the rate of increment declined gradually from 8.14 between 30 and 60 days to 3.99 between 60 and 90 days to 2.02 between 90 and 120 days. This revealed that the rate of increase reduced by 50 % in each stage of growth. According to Mandal and Datta (2014) stem anatomy of the mutant jute shows significant enhancement in fibre zone, number of fibre pyramids and fibre bundles per pyramid, and diameter of fibre cell in relation to control. Moreover, tensile strength of mutant fibre is significantly higher than control fibre and the trait is inversely related to fibre diameter.

Maiti (1997) first proposed possibility of prediction of fibre quality from anatomical studies. In the present experiment the mean performance of individual genotype with respect to different anatomical characters (Table 3) at the age of 30 days reveals that only two genotypes, JRO-204 and JRO-8432 had significantly higher mean for total bark diameter while none for difference between fiber wedge tip and outer bark layer, average length of fiber cell wedge, average width of fiber wedge at base, average width of fiber wedge at middle and number of fibre cell blocks at middle could do so. Inter-varietal differences with respect to fibre wedge characteristics have earlier been reported by Majumdar (2002). However, average width of fiber wedge at top was significantly higher in case of OMU-09 and JRO-204. Number of fibre cell blocks at base was significantly higher in case of OMU-42, JRO-204 and JRO-8432, and for number of fiber cells in each block significantly higher mean could be recorded in case of OMU-42, JRO-524 and JRO-8432.

Considering mean performance of different genotypes at the age of 120 days (Table 4), two genotypes *viz*. OMU-42 and OEX-16 produced significantly higher mean for Base diameter while three different genotypes *viz.* JRO-204, JRO-524 and FANDUK produced significantly higher mid diameter and these three genotypes along with OIM-45 produced significantly higher mean top diameter. In case of number of nodes and inter node length, OIM-45, OMU-43 and the former along with 0EX-16, JRO-204 and FANDUK produced significantly higher mean. In case of fibre yield, only three genotypes *viz.* OIM-45, JRO-204 and JRO-524 produced significantly higher mean. Among these genotypes JRO-204 and JRO-524 produced significantly higher mean for different anatomical characters also.

Analysis of variance for fibre anatomical characteristics revealed that there was highly significant variability for all the characters with respect to both plant growth habit and genotypes except in case of difference between fibre wedge tip and outer bark layer (Table 5). However, genotypic variation for difference between fibre wedge tip and outer bark layer was non-significant. In case of variation due to growth stages x genotype interaction also there was highly significant variation for the entire characteristic. This indicated that there is enough scope for selection of genotypes on the basis of these characteristics and such study will facilitate selection without destructive sampling.

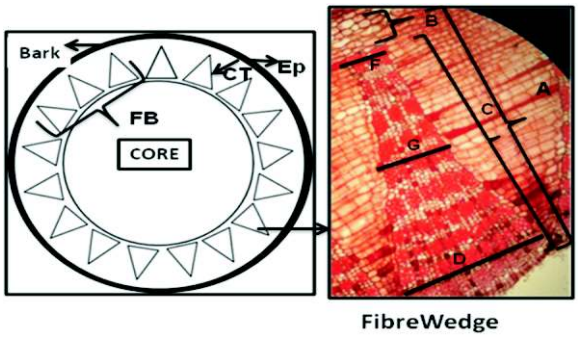

Fig. 1: Exhibits the pattern of distribution of cells in cross section of jute fibre

FB *= Fiber Bundle* ***Ep*** *= Epidermis* ***CT****= Cortex* ***A*** *= Total bark diameter* ***B*** *= Difference between fiber wedge tip* ***C*** *= Average length of fiber cell wedge* ***D*** *=Average width of fiber wedge at base* ***F*** *=Average width of fiber wedge at top* ***G*** *=Average width of fiber wedge at middle*

Distribution of fibre cells in cross section of different genotypes

Stage-1(30 Days)	Stage-2(60 Days)	Stage-3(90 Days)	Stage-4(120 Days)

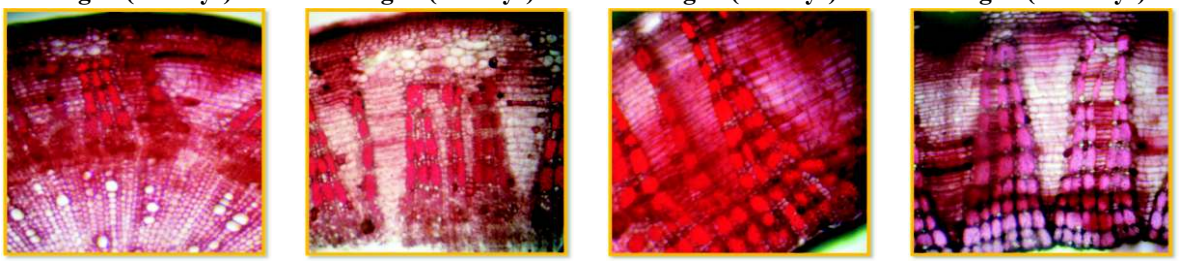

Fig.2: JRO 204

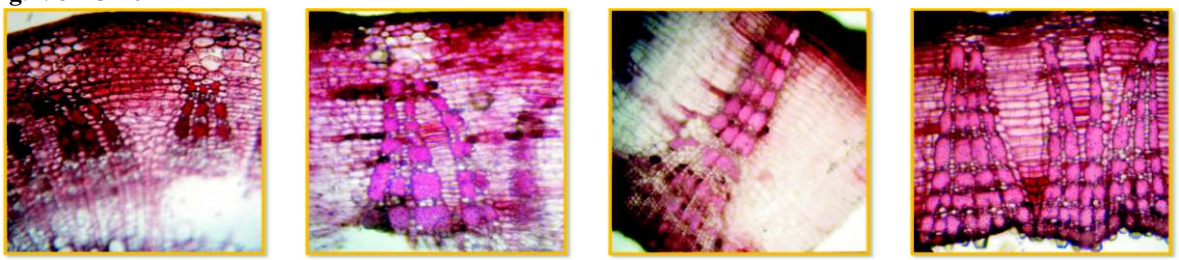

Fig.3: JRO 524

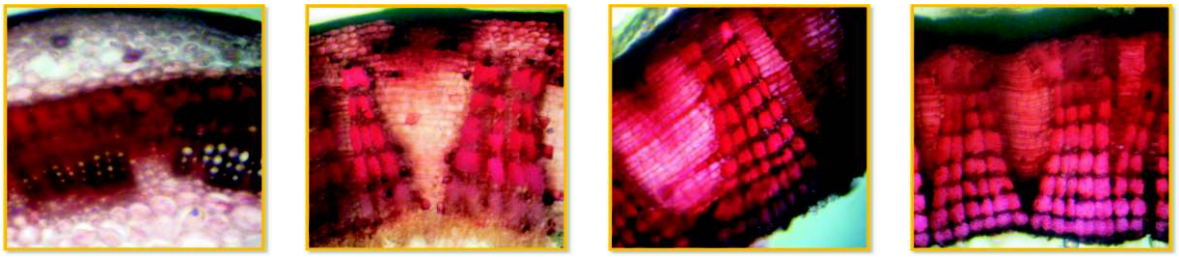

Fig.4: JRO 8432

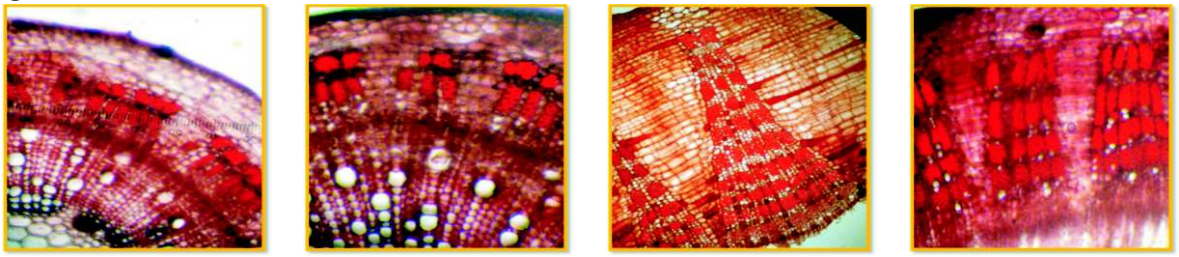

Fig.5: OMU 09

Table 3: Mean performance of individual genotypes for various fibre anatomical characters at 30 days

Genotypes	A	B	C	D	F	G	H1	H2	I
OEX-16	0.347	0.137	0.201	0.198	0.104	0.215	2.501	3.122	6.249
OIM-45	0.460	0.160	0.197	0.120	0.133	0.153	2.667	3.000	11.000
OMU-09	0.233	0.167	0.310	0.210	0.287	0.310	2.000	4.000	7.000
OMU-42	0.343	0.137	0.150	0.257	0.210	0.240	4.667	4.000	12.000
OMU-43	0.243	0.130	0.150	0.197	0.200	0.180	2.667	3.091	10.002
JRO-204	0.547	0.120	0.223	0.230	0.303	0.330	3.333	2.667	8.000
JRO-524	0.457	0.163	0.213	0.220	0.230	0.253	2.667	3.333	14.333
JRO-8432	0.563	0.123	0.210	0.237	0.230	0.257	3.667	4.667	11.667
FANDUK	0.357	0.123	0.193	0.210	0.180	0.253	2.600	2.334	10.311
Mean	**0.39**	**0.14**	**0.20**	**0.20**	**0.20**	**0.24**	**2.97**	**3.35**	**10.06**
LSD(0.05)	**0.10**	**0.05**	**0.06**	**0.09**	**0.03**	**0.10**	**0.08**	**1.41**	**1.45**

Note: A=Total bark diameter(mm) , B=Difference between fiber wedge tip and outer bark layer (mm),C= Average length of fiber cell wedge (mm),D= Average width of fiber wedge at base (mm),F= Average width of fiber wedge at top (mm),G= Average width of fiber wedge at middle (mm),H1= Number of fibre cell blocks at base ,H2= Number of fibre cell blocks at middle and I= Number of fiber cells in each block.

Table 4: Mean performance of morphological characters in jute genotype at 120 days age

Genotypes	PH	BD	MD	TD	NN	IL	BM	GFW	SW	DFW
OMU-42	3.08	1.37	0.79	0.44	57.60	4.74	133.13	40.25	44.73	6.91
OEX-16	2.72	1.31	0.79	0.44	37.60	5.97	133.63	41.25	41.35	3.98
JRO-8432	2.53	1.05	0.70	0.43	45.40	5.59	136.93	44.45	49.67	6.80
OIM-45	3.10	0.91	0.88	0.57	57.80	6.04	167.59	56.89	71.53	11.16
JRO-204	3.05	1.02	1.12	0.63	51.20	6.32	208.32	59.78	76.51	13.43
OMU-43	2.08	0.74	0.74	0.45	59.20	4.02	139.66	52.76	47.10	6.49
OMU-09	2.38	0.85	0.89	0.52	47.40	4.83	125.93	38.75	47.42	7.90
JRO-524	2.72	0.88	0.90	0.55	50.60	5.34	96.79	50.55	56.68	9.98
FANDUK	2.53	1.01	0.91	0.65	38.40	6.19	97.96	35.91	46.54	6.80
MEAN	**2.69**	**1.02**	**0.86**	**0.52**	**49.47**	**5.45**	**137.77**	**46.73**	**53.50**	**8.16**
LSD(0.05)	**0.08**	**0.04**	**0.04**	**0.02**	**2.05**	**0.35**	**2.84**	**5.22**	**2.95**	**1.42**

PH=Plant HeighPH= Plant height (m), BD=Basal diameter (cm), MD=Middle diameter (cm), TD=Top diameter (cm), NN=No of Nodes, IL= Intermodal length (cm), BM=Biomass (g), GFW=Green fiber weight (g), SW=Stick weight(g), DFD=Dry fiber weight(g)..

Table 5: Analysis of variances of fiber anatomical characters

Source of variation	df	A	B	C	D	F	G	H1	H2	I
Growth stage	3	2.293**	0.073**	2.515**	0.288**	0.148**	0.066**	42.923**	4.552**	433.071**
Genotype	8	0.161**	0.008	0.126**	0.011**	0.014**	0.021**	2.396**	4.104**	122.683**
Replication	2	0.001	0.000	0.000	0.003	0.002	0.005	19.194	2.194	10.620
Stage × Genotype	24	0.058**	0.007**	0.053**	0.022**	0.040**	0.040**	4.124**	2.129**	78.606**

*Abbreviations as in table 3, **= Significant at 1 % level of probability, *= Significant at 5 % level of probability*

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