Studies on Character Association and Genetic Divergence in White Jute (*Corchorus capsularis* L.)

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ABSTRACT

Background: In white jute, very limited success has been reported by researchers to break yield plateau due to the narrow genetic base of the genetic material available with the breeders. Evaluation of agronomic traits and information about genetic variance in the breeding population is essential for selection and in planning crosses to enhance the productivity and diversity in cultivars. Yield character components are inherited and each one accounts for variations in yield, hence interrelated with each other. The current investigation was done to measure the genetic variability and genetic diversity of white jute genotypes for characters and interrelationship that contribute to yield and fibre quality.

Methods: In the present study, fifty-two white jute (*C. capsularis* L.) genotypes were assessed during the *Pre-Kharif* season of 2017 at the Teaching Farm of Bidhan Chandra Krishi Viswavidyalaya, Mandouri, Nadia, West Bengal. Plants were raised in randomized block design with three replications. Statistical analysis was done for the estimation of ANOVA variability, correlation and path analysis and genetic divergence.

Result: Plant height and bark thickness with high heritability and high genetic advance were identified as important selection parameters. Plant height, bark thickness and green weight per plant had a significantly high positive correlation with dry fibre weight per plant both at genotypic and phenotypic levels. Plant height had the highest contribution toward the dry fibre weight followed by bark thickness. Genotypes were grouped into 13 clusters and cluster I had the highest number of 23 genotypes. The inter-cluster distance was found maximum between cluster I and cluster VI. Cluster XI recorded the highest mean for the plant height. Ten genotypes identified from different clusters in this study can be incorporated as donors in hybridization to combine both yield and improved fibre quality.

Key words: Correlation analysis, Genetic diversity, Genetic variability, Heritability, Path coefficient analysis, White jute.

INTRODUCTION

Jute belongs to the second most important textile fibre next to cotton. It is a natural fibre with golden and silky shine hence called "The Golden Fibre". Jute of commerce is obtained from the bast or bark of the plant's stem of two cultivated species of the genus *Corchorus* namely *C. capsularis* L. (White jute/Desi jute) and *C. olitorius* (Tossa jute). The fibre of *Corchorus capsularis* is ordinarily whitish. White jute (*Corchorus capsularis* L.) can be grown both in low and high land and has better adaptability than the other cultivated species. In general, *C. capsularis* shows flexibility in relation to drought and flood conditions. Assessment of genetic variability among the genotypes of jute (*Corchorus sp.*) for quality improvement has been attempted by several workers at different places and times. Still, very limited success has been reported by researchers to break yield plateau in this crop due to the narrow genetic base of the genetic material available with the breeders. In this circumstance, success can be achieved if the available gene pool can be broadened by the collection of variable genotypes from diverse regions. Evaluation of agronomic traits and information about genetic variance in the breeding population is essential for selection and in planning crosses to enhance the productivity and diversity in cultivars. Yield character components are inherited and each one accounts for variations in yield, hence interrelated with each other. Heritability estimates, genetic gain, correlation and path analysis were used to assess the variability and relative importance of yield component traits. The path coefficient analysis (Wright, 1921) allows specific parameters to perform an important test to create a specific correlation and divides the amount of relationship into direct and indirect effects. The concept of D^2 statistics by Mahalanobis,1928 which is one of the potent techniques for measuring forces of differentiation at inter and intra-cluster levels determines the relative contribution of each component trait to total divergence. Considering this in view, the current investigation was done to measure the genetic variability and genetic diversity

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of white jute genotypes for characters and interrelationship that contribute to yield and quality to identify appropriate breeding methods and parents of choice in this species.

MATERIALS AND METHODS

The present experiment was conducted during the *Pre-Kharif* season of 2017 at Bidhan Chandra Krishi Vishwa Vidyalaya, Mandauri, Nadia, West Bengal with 52 diverse genotypes of white jute (*C. capsularis* L.) and two check varieties (JRC-517, JRC-698) (Table 1). Plants were raised in randomized block design with three replications. The gross plot was divided into three blocks and a spacing of 0.5m width was left between the blocks. The blocks were considered as replications and each block, in turn, was divided into 52 equal plots. Each plot was of the size of 1.5 m × 0.9 m at a spacing of 30 cm between the rows for each genotype. Five randomly selected plants were considered per replication per individual genotype for recording data. Observations were made on eight characters *viz.* Plant height(cm) (PH), number of nodes/plant (NPP), basal diameter (mm) (BD), mid diameter(mm) (MD), top diameter(mm) (TD), bark thickness(mm) (BT), green weight/plant(mm) (GWP), dry fibre weight/plant (DFP). Statistical analysis was done for the estimation of ANOVA by Panse and Sukhatme (1989); Variability (Singh and Chaudhary, 1985); Correlation and path analysis (Dewey and Lu, 1959); and Genetic divergence by Mahalanobis D^2 statistics (Rao 1952).

RESULTS AND DISCUSSION

Significant differences were observed among genotypes for all the eight characters studied in the present investigation indicating sufficient scope for further selection (Table 2).

Studies on variability

The genotype CIN-107 reported the maximum variability for plant height (247.00 cm) and basal diameter (12.46 mm). The no of node per plant was found maximum in CIN-115 while the maximum dry fibre weight was reported in the genotype CIN-92 (Table 3). The phenotypic coefficient of variation (PCV) was approximately close to the genotypic coefficient of variation (GCV) for plant height, the number of nodes per plant, basal diameter and mid diameter, indicating less influence of environment on the expression of these characters. While for the characters like top diameter, bark thickness, green weight and dry fibre weight the PCV value was higher than GCV indicating the role of the environment in the expression of these characters. These are in accordance with findings reported by Ali (2003) and Senapati *et al.* (2006). Heritability estimates and the genetic advance were maximum for plant height (88.00% and 65.54) followed by basal diameter (82.60% and 52.08) respectively. It may, therefore, be suggested that the characters' plant height and bark thickness can be considered for effective direct selection. Earlier studies indicate that high heritability coupled with high genetic advance will be more useful for selection, as reported by Johnson *et al*., 1985 and Das and Kumar (2016). Knowledge of variability and heritability (h^2) is essential to identify the characters amenable to genetic improvement through selection. High heritability and high GA for plant height and bark thickness suggest the simple phenotypic selection for the traits.

Studies on character association

Correlation studies in the present experiment indicated the different degrees of association between characters both at genotypic and phenotypic levels. The correlation values at the genotypic level were slightly higher in magnitude than the phenotypic correlations indicating the inherent association between the characters (Table 4). The present findings are in conformity with Prakash *et al.* (2003) wherein, plant height, bark thickness and green weight per plant had a significantly positive correlation with dry fibre weight per plant at genotypic as well as at phenotypic levels, by Islam *et al*. (2002). The highest positive significant correlation was observed between plant height and green weight per plant at the genotypic level followed by plant height and number of nodes per plant. At the phenotypic level, the highest positive significant correlation was found between plant height and the number of nodes per plant closely followed by plant height and green wt. per plant and the lowest between dry fibre weight per plant and node number per plant. A similar relationship was also reported by Islam *et al*. (2001) and Das and Kumar (2016). The character also had a significant and positive correlation with dry fibre weight and dry stick weight.

Studies on path coefficient

The direct effects of plant height on dry fibre weight per plant were positive and maximum followed by basal diameter (Table 5). Similar findings were observed by Senapati *et al.* (2006). Hence these two traits should be considered as

Table 1: List of 52 White Jute genotypes used in the present experiment.

Genotype	Sl. No.	Genotype	Sl. No.	Genotype
CIN-84	19	CIN-102	37	CIN-122
CIN-85	20	CIN-103	38	CIN-123
CIN-86	21	CIN-104	39	CIN-124
CIN-87	22	CIN-105	40	CIN-125
CIN-88	23	CIN-106	41	CIN-126
CIN-89	24	CIN-107	42	CIN-127
CIN-90	25	CIN-108	43	CIN-128
CIN-91	26	CIN-110	44	CIN-129
CIN-92	27	CIN-111	45	CIN-130
CIN-93	28	CIN-112	46	CIN-131
CIN-94	29	CIN-113	47	CIN-132
CIN-95	30	CIN-114	48	CIN-133
CIN-96	31	CIN-115	49	CIN-134
CIN-97	32	CIN-116	50	CIN-135
CIN-98	33	CIN-117	51	JRC-517
CIN-99	34	CIN-119	52	JRC-698
CIN-100	35	CIN-120		
CIN-101	36	CIN-121		

important criteria for improving yield. The negative direct effect on dry fibre weight per plant was obtained by the characters like node number per plant, mid diameter and green weight at the genotypic level. The number of nodes per plant had direct negative effects on dry fibre weight per plant. The number of nodes per plant has the lowest positive effect on dry fibre yield per plant followed by mid diameter and top diameter. Thus, there was an indirect negative effect of the number of nodes per plant via other characters like plant height, basal diameter mid diameter and top diameter. This clearly shows the negative role of no. of node plant towards fibre yield. Pervin and Haque (2012) observed that there is a negative correlation between green weight and fibre yield.

Studies on genetic diversity

The dry fibre weight contributed the maximum (62.59%) towards the degree of divergence followed by plant height (7.99%), bark thickness (6.63%). It is interesting to note that the other characters like the number of nodes per plant, basal diameter, mid diameter and top diameter had very little contribution to the degree of divergence. The grouping pattern of the genotypes observed due to geographical diversity and genetic divergence was unrelated. Based on

Table 2: Analysis of variance in 52 genotypes of white jute (*C. capsularis* L.).

		Mean sum of square							
Source of variance	df	Plant height (cm)	No. of node /plant	Basal diameter (mm)	Mid diameter (mm)	Top diameter (mm)	Bark thickness (mm)	Green-weight (g)	Dry fibre weight (g)
Replication	2	414.75	33.83	1.71	0.75	0.15	0.0041	511.62	0.039
Genotype	51	3608.55**	136.14**	6.87**	1.85**	1.39**	0.09**	2556.38**	8.97**
Error	102	156.95	6.28	0.45	0.20	0.19	0.0052	127.28	0.225

Table 3: Genotypic variability parameters of 52 genotypes of white jute (*C. capsularis* L.).

Traits	Range		GCV%	PCV%	H^2 (BS)	GA	GA % of mean
	Max	Min					
Plant height (cm)	CIN-107(247.00)	CIN-96(116.33)	20.48	21.83	88.00	65.54	39.57
No. of node/plant	CIN-115(43.78)	CIN-117(18.67)	20.01	22.48	79.23	11.49	36.69
Basal diameter (mm)	CIN-107(12.46)	CIN-88(5.77)	15.16	16.68	82.60	2.74	28.39
Mid diameter (mm)	CIN-92(6.99)	CIN-96(4.32)	13.23	15.47	73.10	1.31	23.35
Top diameter (mm)	CIN-92(5.68)	CIN-129(2.87)	14.93	18.21	67.20	1.07	25.22
Bark thickness (mm)	CIN-133(1.08)	CIN-98(0.43)	22.98	25.01	78.90	52.08	36.21
Green weight (g)	CIN-115(227.33)	CIN-130(110.67)	21.24	25.01	72.12	0.27	37.16
Dry fibre weight (g)	CIN-92(10.74)	CIN-112(3.99)	21.12	24	77.44	3.00	38.29

Table 4: Genotypic (G) and phenotypic (P) correlation among eight characters of white jute (*C.capsularis* L.).

Characters		No. of node /plant	Basal diameter (mm)	Mid diameter (mm)	Top diameter (mm)	Bark thickness (mm)	Green-weight (g)	Dry fibre weight (g)
Plant height	G	0.852**	0.658**	0.430**	0.551**	0.408**	0.913**	0.744**
	P	0.846**	0.649**	0.369**	0.442**	0.398**	0.838**	0.701**
No. of node/plant	G		-0.263	0.195	0.188	0.475**	0.848**	0.240
	P		-0.259	0.155	0.178	0.438**	0.813**	0.224
Basal diameter	G			0.435**	0.381**	0.409**	0.315**	0.385**
	P			0.425**	0.341**	0.428**	0.347**	0.258*
Mid diameter	G				6.33*	0.033	0.346**	0.390**
	P				0.558**	0.023	0.321**	0.253**
Top diameter	G					0.081	0.453**	0.344**
	P					0.074	0.364**	0.291*
Bark thickness	G						0.336**	0.719**
	P						0.288*	0.703**
Green weight	G							0.657**
	P							0.614**

the Tocher value, fifty-two genotypes of white jute were grouped into 13 clusters of which cluster I had the highest number of 23 genotypes and all most all the remaining clusters accommodated 2 genotypes except cluster XI and XII had 3 and 6 genotypes respectively (Table 6). The results obtained with intra and inter-cluster divergence indicate variations for the parameters. When the clusters were compared for divergence, the inter-cluster distance was found maximum between cluster I and cluster VI indicating greater diversity between the genotypes falling under these clusters (Table 7). Among all the clusters the cluster XI recorded the highest mean for the character like plant height closely followed by cluster X for the same character. The number of nodes per plant, basal diameter and green weight recorded maximum means in cluster XI (Table 8). The mid and top diameter had a maximum mean in cluster V followed by cluster XI. All the characters studied contributed the maximum divergence which indicates the utility of

Table 5: Path coefficient at genotypic level of 52 genotypes in white jute (*C. capsularis* L.).

Character	Plant height (cm)	No. of Node /plant	Basal diameter (mm)	Mid diameter (mm)	Top diameter (mm)	Bark thickness (mm)	Green weight (g)	Dry fibre weight (g)
Plant height	0.84	-0.203	0.022	-0.039	0.024	0.224	-0.124	0.744**
No.of node/plant	0.306	-0.213	0.014	-0.035	0.021	0.261	-0.114	0.240**
Basal diameter	0.392	-0.032	0.095	-0.038	0.006	0.005	-0.043	0.385**
Mid diameter	0.361	-0.084	0.041	-0.09	0.028	0.181	-0.047	0.390**
Top diameter	0.463	-0.102	0.013	-0.057	0.044	0.044	-0.062	0.343**
Bark thickness	0.343	-0.101	-0.001	-0.03	0.004	0.55	-0.046	0.719**
Green weight	0.767	-0.178	0.03	-0.031	0.02	0.185	-0.136	0.657**

Table 6: Grouping of 52 genotypes of white jute (*C. capsularis* L.).

Cluster	No. of genotypes	Genotype
I	23	CIN-84, CIN-85, CIN-86, CIN-87, CIN-88, CIN-89, CIN-90, CIN-91, CIN-92, CIN-93, CIN-94, CIN-95, CIN-96, CIN97, CIN-98, CIN-99, CIN-100, CIN-101, CIN-102, CIN-103, CIN-104, CIN-105, CIN-106
II	2	CIN-112, CIN-124
III	2	CIN-123, CIN-128
IV	2	CIN-113, CIN-128
V	2	CIN-116, CIN-124
VI	2	CIN-119, CIN-120
VII	2	CIN-122, CIN-125
VIII	2	CIN-132, CIN-135
IX	2	CIN-1 10, CIN-111
X	2	CIN-108, JRC-698
XI	3	CIN-107, CIN-1 16, JRC-517
XII	6	CIN-129, CIN-130, CIN-126, CIN-121, CIN-1 17, CIN-1 14
XIII	2	CIN- 133, CIN-131

Table 7: Inter and intra cluster distance of 54 white jute genotypes.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	8.746	11.908	9.1	8.606	7.7758	87.005	10.413	10.182	7.785	10.296	11.123	10.964	10.383
II		2.882	6.778	10.266	12.37	12.693	6.076	17.489	10.899	15.684	13.487	8.393	17.361
III			2.989	6.971	9.516	8.694	7.732	13.332	5.858	12.167	11.467	7.312	13.739
IV				3.313	9.371	6.944	7.844	9.914	6.893	10.118	12.219	8.591	10.61
V					3.422	6.421	11.153	8.482	7.966	10.266	11.234	11.262	8.01
VI						3.422	6.421	11.153	7.21	5.869	8.16	11.026	10.681
VII							3.787	10.429	15.31	14.31	12.889	8.291	15.218
VIII								3.86	4.06	7.795	13.308	14.831	4.765
IX									4.172	9.94	11.061	9.57	10.386
X										5.149	8.905	13.812	9.23
XI											7.66	12.738	13.449
XII												9.666	14.839
XIII													6.969

Table 8: Cluster mean of 52 white jute (*C. capsularis* L.) genotypes.

Cluster	Plant height (cm)	Node no/plant	Basal diameter (mm)	Mid diameter (mm)	Top diameter (mm)	Bark thickness (mm)	Green-weight (g)	Dry fibre weight (g)
I	169.13	32.678	9.334	5.633	4.318	0.738	140.971	7.44
II	131	22.538	9.768	5.037	3.593	0.498	122.833	4.185
III	127.833	21.79	9.41	4.87	4.213	0.532	117.833	6.202
IV	141	26.562	10.428	5.042	3.543	0.88	126.833	7.335
V	158.167	30.428	7.708	6.457	5.375	0.768	135.833	6.907
VI	175.167	34.667	9.217	5.023	4.385	0.825	136.667	8.07
VII	149.333	30.165	11.663	5.688	4.043	0.677	134.5	5.477
VIII	169.833	33.528	8.058	5.483	3.958	I .007	152	9.183
IX	138.333	26.553	9.127	5.115	3.835	0.538	124.833	7.56
X	220	40.168	10.257	4.932	4.01	0.943	203.5	9.84
XI	242.444	43.509	12.05	6.428	4.714	0.678	218.333	9.316
XII	138.722	24.332	10.585	5.788	4.172	0.642	128.056	6.247
XIII	170.167	33.832	8.122	6.412	4.095	0.982	151.5	8.942

multivariate analysis in identifying potential parents combining high yield and other desirable characters. The genotypes from the cluster II and VI could be selected for hybridization program to produce highly heterotic or diverse genotypes due to higher inter-cluster distance. Cluster analysis for quantitative traits will be of direct use to breeders in planning crosses between diverse genotypes to create new variability. The clustering pattern revealed a meager amount of genetic diversity among the jute genotypes considered in the present study which indicates the presence of common ancestry and hence warrants for the collection of diverse genotypes to broaden the genetic base and an intensive hybridization programme among new diverse genotypes. This result corroborated with the finding of Kar *et al*. (2009).

CONCLUSION

Based on the present study, the hybridization program could be initiated by crossing among the genotypes CIN-84, CIN-85, CIN-86, CIN-88, CIN-119 and CIN-120to create a new genetic base. The genotypes CIN-92, CIN-107, CIN-115 and CIN-132 were identified as promising for fibre production. The traits plant height, bark thickness, green weight per plant had a highly significant positive correlation with dry fibre weight per plant both at the genotypic and phenotypic levels. Plant height and bark thickness have significantly contributed to dry fibre yield and can be considered in the selection of superior genotypes of jute.

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