International Journal of Agricultural and Applied Sciences, June 2022, 3(1):29-36
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2022.315

Research Article

OPEN ACCESS

Cluster analysis of *Corchorus capsularis* jute based on agro-morphological characters to isolate high-yielding genotypes for breeding purposes

Sadia Afrin Jui, M. M. Mukul*, Iffat Jahan Nur and Ranjit Kumar Ghosh
Breeding Division, Bangladesh Jute Research Institute, Ministry of Agriculture, Dhaka-1207, Bangladesh.
Corresponding author e-mail: mukulbjribreeding@gmail.com
(**Received:** 04/12/2021; **Revised:** 21/03/2022; **Accepted:** 20/04/2022)

ABSTRACT
White jute (*Corchorus capsularis*) is an important bast fiber producing cash crop. Its narrow genetic base due to its self-pollination nature as well as genetic incompatibility in respect of interspecific hybridization cause low morphological variability. The searching for good genotypes and their use in intraspecific hybridization is the best option to increase the yield potentiality of this crop. In this research experiment, 95 white jute genotypes including 93 accessions and two pre-released varieties (CVL-1 and BJRI Deshi Pat 9) were investigated for higher fibre yield. The experiment was laid out in an augmented design at Jute Agricultural Experiment Station, Manikgonj during 2019. Plants were harvested at 120 days age and morphological data like plant height (m), base diameter (mm), green weight with leaves (g plant^{-1}), fiber yield (g plant^{-1}) and stick yield (g plant^{-1}) were recorded carefully. From the descriptive analyses of the recorded data, good fibre yields were found in A-725 (20 g plant^{-1}) and A-2232 (16.60 g plant^{-1}) followed by A-2224, A-248, A-07, A-675, A-2264, A-1292, A-247, A-469, A-2226, A-674, A-02, A-232, A-10, A-684 than the control varieties BJRI Deshi Pat-9 (10.80 g plant^{-1}) and CVL-1 (9.20 g plant^{-1}). From the hierarchical cluster analysis, the average inter-cluster distances were found higher than the average intra-cluster distances, which shows the presence of wide genetic diversity among the genotypes of different clusters than those of the same cluster. These higher fibre yielding accessions with wide genetic diversity would be used as breeding materials for varietal improvement through hybridization and selection approaches.
Keywords: Bast fibre; Cluster analysis; White jute; Gene Bank; Genotype.

INTRODUCTION
Jute is second only to cotton in world's production of textile fibers, among all of the important fibrous plant (Islam et al., 2013; Jui et al., 2021). The fiber of Jute crop is obtained from the bark of the two commercially important species, that is *C. capsularis* L. (White jute) and *C. olitorius* L. (Tossa jute). The centre of origin of White jute is said to be Indo-Burma including South China, and Africa for Tossa (Kundu, 1951). It is a self-pollinated crop with little genetic diversity (La Farge et al., 1997; Mukul et al., 2021a). According to Kar et al. (2009) and Mukul et al. (2021b), the breeding of jute crop is problematic due to its narrow genetics base; jute is a self-pollinating crop having the possibility of natural out-crossing in *C. olitorius* (8–12%) than in *C. capsularis* (3–4%). Although both cultivated jute species are largely self-fertilized (Basu et al., 2016), natural outcrossing occurs up to 15% in *C. olitorius* and 5% in *C. capsularis* (Basak and Chaudhuri, 1966). Jute is grown for commercial purposes in many south Asian countries (Alam and Rahman, 2000; Rahman et al., 2021), mostly in India and Bangladesh (Ghosh et al., 2015). It is a traditional cash crop in Bangladesh (Islam and Ali, 2017; Mukul et al., 2020a). Jute *(Corchorus spp.)* is grown in our country as a fiber crop in Kharif-1 season and plays an important role in our national economy. Jute contributes about 4% GDP to the national economy and earns about 5% of the foreign exchange as well in Bangladesh (Islam and Ali, 2017). After the country's independence, more than 80% of total foreign currency in Bangladesh was earned from jute and jute related goods. But after 80's, the earning rate of foreign currency from jute industry has gradually declined. About 90% of jute products produced in Bangladesh is exported (CPD, 2011). Entire life-cycle of jute from cultivation to usage disposal, it is friendly to the environment and produces no toxic material (Sarkar, 2008). More than 7 lakh hectare area is under jute cultivation both white and tossa jute. Around 25-30 million people are directly or indirectly dependent on this crop. Among the statistics for Jute and allied fiber crop cultivation in Bangladesh, 80% are Tossa Jute and 10% are White jute and the rest 10% are Kenaf and Mesta (Al-Mamun et al., 2017; Mostofa et al., 2020a; Mukul et al., 2021c). The yield performance of existing white Jute varieties is good but not up to the mark. Moreover, our cultivable land area is declining day by day due to increasing population. For overcoming future

challenges we need more high yielding variety of white Jute. Bangladesh Jute Research Institute (BJRI) has established a gene bank in 1982 now having world's largest collection of about 6060 accession of jute and allied fiber (JAF) germplasm from home and abroad (Haque et al., 2007; Miah et al., 2020; Mukul et al., 2021b). Fortunately, there are 2404 germplasms of white Jute of both indigenous and exotic origin, which have wider gene pool of different types. Of which, very few numbers of germplasm were screened for higher yield. Therefore, it is needed to study the morphological traits and yield of existing germplasm for getting variability with desirable traits that can be used as a parent for different varietal improvement program.

MATERIALS AND METHODS

Ninety-five accessions of white jute were used in this screening program. The accessions were collected from Gene Bank of BJRI. The experiment was laid out at JAES, Manikgonj in 2019 following augmented design with four blocks. No replication was maintained for a large population of the genotypes. Each block consisted of 25 accessions including two popular varieties (CVL-1 and BJRI Deshi Pat 9) as check. Every single accession was grown in single line of 3.0 meter long with spacing 30 cm between line and 1.0 m between blocks. Light irrigation was supplied after seed sowing, and then irrigation was given as and when necessary at seedling to vegetative growth stages. Thinning and rouging were done at 50-60 DAS (1.5-2.0 ft.). Weeding was carried out at 20, 45, 90 days after sowing (Nur et al., 2021). Fertilization was done on the basis of requirement. After 120 days of seed sowing, data were recorded on plant population, plant height, base diameter, green weight with leaves, fiber yield and stick yield. Some healthy plants were used for stem (60-80 cm top) cutting at 100 days old to produce good seed materials. These seed materials would be used for research purposes in later (Mostofa et al., 2020b).

Data analysis

Morphological data of the jute plants were collected carefully. Data were compiled and the descriptive analyses were done using MS Excel program (2016). Mean performance for the respective character of the genotypes were estimated along with ranges and statistical parameter like co-efficient of variation (CV %). No analyses of variances (ANOVA) were estimated due to the experimental augmented design having no replication for the respective traits of the jute genotypes.

RESULTS AND DISCUSSION

Morphological observations

The mean performance, range and coefficient of variation among the major yield contributing character are presented in the Table 1. It was observed from the table that jute genotypes used in this experiment varied to a great extent regarding the studied traits. Therefore, there is ample scope to select suitable genotypes for further breeding program. Significant differences in morphological features of jute plants were previously described (Ngomuo et al., 2017; Jatothu et al., 2018; Mukul et al., 2020d).

Plant height (m)

Plant height at harvest time ranged from 2.02-3.27m with a mean 2.80 m. Plant height is the most efficient morphological characteristic that is directly associated to higher fibre yield. Similar results were also obtained by (Pervin et al., 2012). The maximum plant height was found in Acc.2224 (3.27 m) followed by Acc.725.

Base diameter (mm)

Plant base diameter ranged from 10.60-22.30 mm with a mean 16.21 mm. The highest base diameter was observed in Acc.2224 (22.30 mm) followed by Acc. 2232 (20.58 mm). The minimum plant base diameter was recorded in Acc. 461 (10.60 mm). Jute fiber is a secondary phloem fiber or bast fiber obtained from the bark of the stem (Mukul, 2020b). Fibrous plant material with a large stem base diameter contributes to fibre yield and could be utilized as hybridization breeding material (Zhang et al., 2019). The Acc. 725, Acc. 2232, Acc. 2224 in the experiment showed higher fibre yield; and these genotypes would be selected as pure line or would be used as parent materials in hybridization pattern to develop high yielding white jute variety.

Green weight (g plant^{-1})

Jute's green weight, also known as fresh weight, refers to the total weight of the plant, including green leaves. Jute fiber yield is proportional to jute plant green weight, according to Maity et al. (2012). Here, green weight ranged from 61.00-357.80 g plant^{-1} with a mean 147.93 g plant^{-1}. Maximum green weight obtained from Acc. 2224 (357.8 g plant-1) followed by Acc. 2237 (300 g plant^{-1}).

Dry fiber and stick yield (g plant^{-1})

Fiber production is the most desirable feature of the jute plant (Kumar et al., 2016). Fiber yield ranged from 3.80-20.00 g plant^{-1} with a mean 10.09 g plant^{-1}, where the highest fiber yield was observed in Acc. 725 (20.00 g plant^{-1}) followed by Acc. 2232 (16.60 g plant^{-1}) and Acc. 2224 (14.00 g plant^{-1}). Stick yield ranged from 8.60-55.80 g plant^{-1} with a mean 24.12 g plant^{-1}. The highest stick yield was found in Acc. 725 (55.80 g plant^{-1}) followed by Acc. 2232 (39.00 g plant^{-1}) and Acc. 2224 (35.24 g plant^{-1}). Considering fiber yield, Acc. 725, Acc. 2232 and Acc. 07 performed better than all other genotypes.

Table 1: Performance of white jute genotypes for yield and yield attributing characters

SL. No. of genotypes	Accession No.	Plant height (m)	Base diameter (mm)	Green weight (g plant^{-1})	Fibre yield (g plant^{-1})	Stick yield (g plant^{-1})
1	A-02	2.79	16.88	158.80	12.60	27.40
2	A-04	2.60	17.84	156.00	10.40	25.60
3	A-05	2.81	19.08	152.20	10.80	27.00
4	A-07	2.90	20.56	290.00	14.40	33.00
5	A-08	2.70	17.42	147.80	10.00	24.60
6	A-10	2.82	20.16	170.20	12.20	30.00
7	A-231	2.78	18.92	162.00	12.00	26.40
8	A-232	2.75	18.48	172.60	12.40	28.80
9	A-233	2.82	17.24	157.80	10.60	25.40
10	A-234	2.53	16.60	129.40	10.00	22.00
11	A-235	2.65	18.12	142.60	9.20	26.40
12	A-236	2.85	16.50	155.00	11.80	25.80
13	A-237	2.78	18.36	137.20	10.40	23.20
14	A-238	2.74	17.84	141.60	9.80	24.00
15	A-239	2.79	16.08	134.80	10.00	24.00
16	A-240	2.92	18.44	162.00	10.20	29.00
17	A-241	2.77	17.00	130.00	9.60	22.00
18	A-242	2.80	16.76	137.80	6.80	20.40
19	A-243	2.79	18.16	123.20	8.80	20.80
20	A-244	2.80	17.20	152.80	11.40	26.00
21	A-245	2.74	16.84	129.00	10.00	21.40
22	A-246	2.90	17.24	150.40	10.20	26.00
23	A-247	2.88	16.68	141.80	13.20	32.60
24	A-248	2.90	20.12	196.00	14.40	34.20
25	CVL-1	2.78	16.88	122.80	9.20	22.00
26	BJRI Deshi pat 9	2.79	17.88	171.20	10.80	27.00
27	A-249	2.73	12.02	130.80	7.80	20.60
28	A-250	3.08	13.64	184.60	8.40	23.60
29	A-461	2.79	10.60	99.00	7.00	15.40
30	A-462	3.07	14.64	173.20	10.40	26.40
31	A-463	2.96	11.80	150.60	10.40	24.00
32	A-464	2.92	13.40	130.80	9.00	21.40
33	A-465	2.95	15.96	170.00	10.60	26.60
34	A-466	2.98	14.08	135.60	10.40	21.20
35	A-467	2.81	13.90	125.00	9.40	22.00
36	A-468	2.88	16.00	148.80	10.60	24.00
37	A-469	3.05	17.08	192.20	13.20	27.80
38	A-470	2.79	15.14	115.80	8.80	19.20
39	A-671	2.76	15.60	141.60	10.80	23.00
40	A-672	2.86	15.46	141.80	9.20	22.40
41	A-673	2.80	15.22	141.00	8.20	18.60
42	A-674	2.90	15.88	171.40	12.80	27.80

43	A-675	2.95	17.24	184.40	14.20	30.40
44	A-676	2.83	14.44	120.00	10.80	25.60
45	A-677	2.86	14.56	117.20	9.00	22.00
46	A-678	2.84	18.56	149.00	9.00	22.60
47	A-679	2.85	16.64	158.80	8.40	21.00
48	A-680	2.89	18.22	165.00	10.60	25.00
49	A-681	2.93	18.20	162.20	12.00	26.40
50	A-682	2.94	19.58	188.00	11.00	29.20
51	A-683	2.82	17.02	176.00	10.20	25.00
52	A-684	2.85	15.72	161.20	12.20	34.20
53	A-718	2.37	13.60	104.00	5.80	17.20
54	A-719	2.30	10.80	61.00	7.00	15.40
55	A-720	2.53	14.92	121.00	8.40	19.60
56	A-721	2.85	16.46	165.00	10.60	20.40
57	A-722	2.49	14.20	100.80	5.60	14.00
58	A-723	2.80	15.98	132.20	9.60	24.00
59	A-724	2.83	15.56	141.00	9.60	20.40
60	A-725	3.12	19.14	190.60	20.00	55.80
61	A-726	2.36	12.80	63.20	5.60	13.80
62	A-727	2.02	11.76	70.20	5.20	13.00
63	A-800	2.08	14.15	83.40	4.20	10.60
64	A-801	2.35	16.16	91.60	4.60	12.00
65	A-802	2.33	12.50	75.00	5.80	14.60
66	A-803	2.30	12.24	93.00	3.80	8.60
67	A-804	2.33	13.36	88.20	9.80	22.00
68	A-1288	3.10	14.40	132.40	10.80	20.60
69	A-1292	2.82	14.06	110.00	13.40	30.20
70	A-1297	3.12	13.82	130.00	10.00	24.40
71	A-1301	2.73	13.30	126.00	8.00	21.60
72	A-1302	3.09	14.98	130.00	10.00	24.00
73	A-2222	2.86	14.64	128.20	8.80	21.40
74	A-2223	2.85	16.02	146.00	9.80	24.00
75	A-2224	3.27	22.30	357.80	14.40	35.40
76	A-2226	2.94	15.76	141.20	13.20	31.20
77	A-2227	2.92	18.34	154.00	11.20	32.00
78	A-2230	2.75	15.80	141.80	6.00	14.40
79	A-2231	2.76	13.40	81.60	10.00	25.00
80	A-2232	3.11	20.58	250.00	16.60	39.00
81	A-2233	2.87	18.38	150.00	11.00	25.00
82	A-2235	2.77	16.70	160.00	9.00	28.00
83	A-2236	2.81	16.04	125.00	10.80	26.00
84	A-2237	2.98	18.56	300.00	9.20	20.20
85	A-2245	2.97	17.32	161.80	11.20	25.00
86	A-2264	2.82	18.14	220.00	13.80	29.20
87	A-2265	2.78	15.92	107.00	9.00	24.00
88	A-2318	3.00	17.84	181.60	11.20	26.00

89	A-2319	2. 83	15.32	122.00	9.00	18.00
90	A-2333	3.04	18.10	182.00	10.80	27.00
91	A-2389	2.99	15.02	141.60	10.00	25.00
92	A-2390	2.77	16.22	136.00	10.40	20.00
93	A-2440	2.86	15.60	134.00	11.20	26.00
94	A-2526	2.99	19.14	230.00	10.40	25.00
95	A-4683	2.95	16.30	134.60	8.00	21.60
	Mean	2.80	16.21	147.93	10.09	24.12
	Range	2.02-3.27	10.60-22.30	61.00-357.80	3.80-20.00	8.60-55.80
	CV (%)	7.85	14.00	30.00	25.00	26.24

Cluster analysis

Using all morphological traits to show the current genetic divergence across all white jute accessions, the cluster analysis grouped the experimental 95 white jute accessions into five cluster groups (Table-2), that is showed in the Dendrogram (Figure-1). Jute genotypes with similar physical features were grouped together into same cluster in Dendrogram (Mukul et al., 2020c). Cluster I consist of 54 accessions. It is the largest cluster among five. Cluster II consists of 3 accessions, which is the smallest one among the five. Cluster III consists of 14 accessions, which is the 2nd largest one after Cluster I. Cluster IV consists of 11 accessions and Cluster IV consists of 13 accessions.

Mean value of these five cluster groups for different morphological traits of 95 White jute accessions are revealed in Table-3. Plant height, base diameter, green weight and fiber output were all higher in cluster II. The lowest mean value are observed in Cluster V. Higher means were found in the genotypes of clusters (I, II, I, IV) than their respective grand centroids. So, it would be considered nearly as good genotypes compared to the genotypes of cluster (V) having lower means (Table 3). The common inter and intra cluster distances amongst all jute genotypes have been assessed (Table 4). The higher inter-cluster distance (6.66) was recorded between cluster IV and V; on the other hand, the minimum distance (1.14) was found between cluster II and III. The genotypes of a cluster group showed more or less similarities for the respective characters.

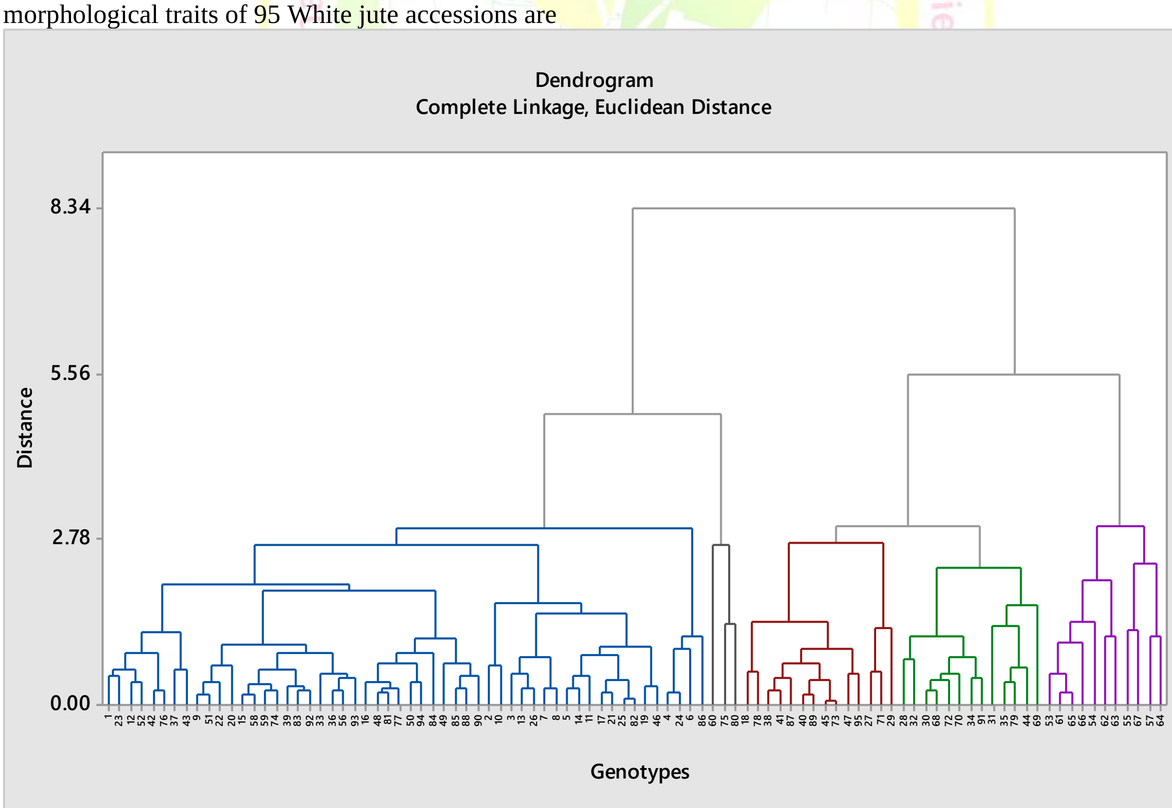

Fig. 1. Dendogram sowing the relationships among 95 tossa jute genotypes

Table 2: Grouping of genotypes into different cluster

Clusters	Serial number of genotypes	Total number of genotypes	Percentage of genotypes
I	1, 23, 12, 52, 42, 76, 37, 43, 9, 51, 22, 20, 15, 58, 59, 74, 39, 83, 92, 33, 36, 56, 93, 16, 48, 81, 77, 50, 94, 84, 49, 85, 88, 90, 2, 10, 3, 13, 26, 7, 8, 5, 14, 11, 17, 21, 25, 82, 19, 46, 4, 24, 6, 86	54	56.84
II	60, 75, 80	3	3.16
III	18, 78, 38, 41, 87, 40, 89, 45, 73, 47, 95, 27, 71, 29	14	14.74
IV	28, 32, 30, 68, 72, 70, 34, 91, 31, 35, 79, 44, 69	13	13.68
V	53, 61, 65, 66, 54, 62, 63, 55, 67, 57, 64	11	11.58

Table 3: Average values of different clusters for morphological characters

Characters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Grand centroid
Plant height (m)	2.84	3.17	2.81	2.96	2.31	2.81
Base diameter (mm)	17.43	20.67	14.83	13.97	13.32	16.04
Green Weight (g)	161.72	266.13	128.70	134.26	86.49	155.46
Dry Fibre weight (g)	10.94	17.00	8.14	10.23	5.98	10.45
Dry Stick weight (g)	25.94	43.40	20.04	24.11	14.62	25.62

Table 4: Distance among the clusters

Cluster No.	No. of observation	I	II	III	IV	V	Distances Between Cluster Centroids	
							Average	Maximum
I	54	0.00					0.84	1.93
II	3	1.60	0.00				0.75	1.92
III	14	1.65	1.14	0.00			0.74	1.41
IV	13	3.60	2.53	3.43	0.00		1.03	1.55
V	11	3.12	4.61	4.07	6.66	0.00	1.00	1.37

CONCLUSION

Jute is a self-pollinated crop having narrow genetic base with low chance of genetic improvement without artificial hybridization. The wild genotypes or other germplasms having good morphological traits like higher plant height, girth of stem, fibre yield can contribute in the breeding program. The Acc. 725, Acc. 2232, Acc. 2224 of cluster II in the experiment showed higher fibre yield; and these genotypes would be selected as pure line or would be used as parent materials in hybridization pattern to develop high yielding white jute variety in Bangladesh.

ACKNOWLEDGEMENTS

The authors were very much thankful to the Bangladesh Jute Research Institute for giving the opportunity to carry out the investigation. They were grateful to the head of the Breeding Division, BJRI for availing the field and laboratory facilities; and all the colleagues, laboratory assistants for their cordial assistances during the experiment.

AUTHOR'S CONTRIBUTION

In this investigation, RK Ghosh has designed, initiated and guided the research activities. MM Mukul has compiled and analyzed the data using statistical program, and he has prepared the analyses results, Dendrogram followed by correction, preparation, submission and corresponding the article. SA Jui has executed the work and collected data carefully; she has reported, primarily prepared and then corrected some parts of the article for publication. IJ Nur and SSU Ahmed had helped during data collection and reporting.

CONFLICT OF INTERESTS

The authors have no conflict of interests to declare.

REFERENCES

Alam SS, Rahman ANMRB, 2000. Karyotype analysis of three *Corchorus* species. *Cytologia;* **65** (4): 443–446. https://www.jstage.jst.go.jp/article/cytologia1929/ 65/4/65_4_443/_pdf

Al-Mamun M, Saha CK, Mostofa MG, Miah A, Hossain MZ, 2017. Identification of suitable varieties for seed production of jute in non-traditional areas of Bangladesh. Bangladesh J. Plant Breed. Genet.; **30**(1): 33–38. https://doi.org/10.3329/bjpbg.v30i1.36531

Basak SL, Chaudhuri BB, 1966. Extent and nature of natural cross pollination in 'tossa' jute (*C. olitorius*). *Indian j. Agri. Sci*., **36**(5): 267-272.

Basu T, Satya P, Sarkar D, Kar CS, Mitra J, Karmakar PG, 2016. Organelle genetic diversity in a global collection of Jute (*Corchorus capsularis and C. olitorius, Malvaceae*). *South African J. Bot*.; **103**: 54–60.

DOI:10.1016/j.sajb.2015.09.016

CPD-Centre for Policy Dialogue, 2011. Global market opportunities in export of jute (Occasional Paper: 93). House 40/C, Road 11 (New), Dhanmondi R/A Dhaka 1209, Bangladesh. www.cpd.org.bd

Ghosh S, Meena K, Sinha MK, et al., 2017. Genetic diversity in Corchorus olitorius genotypes using jute SSRs. Proc. Natl. Acad. Sci., India, *Sect. B Biol. Sci*.; **87**(3): 917–926. DOI: 10.1007/s40011-015-0652-4

Haque S, Begum S, Sarker RH, Khan H, 2007. Determining genetic diversity of some jute varieties and accessions using RAPD markers. *Plant Tissue Cult. Biotechnol*.; **17** (2): 183-191. https://www.banglajol.info/index.php/PTCB/article/view/3239/2726

Islam MM, Ali MS, 2017. Economic importance of jute in Bangladesh: production, research achievements and diversification. *Int. J. Econ. Theory Appl*.; **4** (6): 45-57. http://article.aascit.org/file/pdf/9180778.pdf

Islam S, Azam MS, Sazia S, Abu AS, Maksudul A, Shamim R, et al., 2013. Improved salt tolerance of jute plants expressing the kat-E gene from Escherichia coli. *Turkish journal of Biology*; 37(2): 206-211. https://doi.org/10.3906/biy-1205-52

Jatothu JL, Kumar AA, Choudhary SB, Sharma HK, Maruthi RT, Kar CS, et al., 2018. Genetic diversity analysis in Tossa jute (Corchorus olitorius L.) germplasm lines. *J. Appl. Nat. Sci*.; 10 (1): 1–3. https://doi.org/10.31018/jans.v10i1.1566

Jui SA, Mukul MM, Rashid MH, Nur IJ, Ghosh RJ, Mostofa, et al., 2021. Responses and screening of white jute (Corchorus capsularis L.) genotypes against salinity stresses. *Plant Sci. Today*; **8** (2): 416–424. https://doi.org/10.14719/pst.2021.8.2.1083

Kar C, Kundu A, Sarkar D, Sinha MK, Mahapatra BS, 2009. Genetic diversity in Jute (Corchorus spp.) and its utilization: a review. *Indian J. Agric. Sci.;* **79** (8): 575–586. https://www.cabdirect.org/cabdirect/abstract/20093254742

Kumar AD, 2016. Genetic Divergence and Character Association for Yield and Quality Attributing Characters in Tossa Jute (Corchorus olitorius L.). *Electronic J. Plant Breed*.; **7**(3): 529-537. https://www.ejplantbreeding.org/index.php/EJPB/article/ view/254

Kumar, A.A., Sharma, H.K., Choudhary, S.B., Maruthi, R.T., Jawaharlal, J., et al., 2016. Combining ability and heterosis study for fibre yield and yield attributing characters in Tossa Jute (*Corchorus olitorius* L). *Vegetos* **29**, 3.

Kundu BC, 1951. Origin of Jute. *Indian J. Genet. Plant Breed*.; **11** (1): 95-99. http://www.isgpb.org/documents/archive/vol-11-no-1-1951.pdf

La Farge T, Friedman ST, Cock CG, 1997. Improvement of fibre crops using genetics and biotechnology. In: Powell, R.M., et al. (Eds.), Paper and Composites from Agro-Based Resources. CRC Lewis Publishers, Boca Raton, pp. 39–59.

Maity S, Chowdhury S, Datta AK, 2012. Jute biology, diversity, cultivation, pest control, fibre production and genetics. Organic Fertilization *Soil Qual. Human Health*; 227–262. http://dx.doi.org/10.1007/978-94-007-4113-3_9

Miah A, Saha N, Ali M, Kamrujjaman M, Parvej M, Farabi S, 2020. Genetic divergence analysis of deshi jute (Corchorus capsularis) based on fibre yield and its attributing traits. *Progressive Agriculture*, **31**(1), 26–35. https://doi.org/10.3329/pa.v31i1.48309

Mostofa MG, Al-Mamun M, Yahiya ASM, Mukul MM, Saha CK, 2020b. Age of Cutting and Spacing Effects on Seed Yield of Tossa Jute (Corchorus olitorius L.). *American J. Agril. Sci*.; **7**(2): 25-29. http://www.aascit.org/journal/ajas

Mostofa MG, Rahman L, Yahiya ASM, Rashid MH, Mukul MM, 2020a. RAPD Analysis of Genetic Diversity and Relationships among Kenaf (Hibiscus cannabinus L.) Germplasms. *Indian J. pure and applied BioSci.;* **8**(3), 37-47; 2020. DOI: 10.18782/2582-2845.8096

Mukul MM, & Akter N, 2021a. Morpho-anatomical variability, principal component analysis and Euclidean clustering of tossa jute (*Corchorus olitorius* L.). *Heliyon*; **7**(5): 1-17; e07042. doi:10.1016/j.heliyon.2021.e07042

Mukul MM, Ahmed SSU, Akter N, Mostofa MG, Rahman MS, Talukder FU, 2021c. Responses of seed germination, seedling growth under salinity stresses and variability for phenotypic traits in Tossa Jute (*Corchorus olitorius* L.). *Plant Sci. Today*; **8**(1):166–180. https://doi.org/10.14719/pst.2021.8.1.999

Mukul MM, Akter N, Ahmed SSU, et al., 2020a. Genetic Diversity Analyses of Twelve Tossa Jute (Corchorus olitorius L.) Genotypes Based on Variability, Heritability and Genetic Advance for Yield and Yield Attributing morphological Traits. *International Journal of Plant Breeding and Genetics*, **14**: 9-16. DOI: 10.3923/ijpbg.2020.9.16

Mukul MM, Akter N, Mostofa MG, et al., 2020d. Analyses of Genetic Variability, Character Association, Heritability and Genetic Advance of Tossa Jute (Corchorus olitorius) Genotypes for Morphology & Stem Anatomy. *American Journal of BioScience;* **8**(4): 99-112. DOI: 10.11648/j.ajbio.20200804.12

Mukul MM, Akter N, Mostofa MG, Rahman MS, Hossain MA-E, Roy DC, et al., 2020c.

Analyses of variability, euclidean clustering and principal components for genetic diversity of eight Tossa Jute (Corchorus olitorius L.) genotypes. *Plant Sci. Today*; **7**(4): 564–576. https://doi.org/10.14719/pst.2020.7.4.854

Mukul MM, N Akter, MM Islam, MSH Bhuiyan, MG Mostofa, RK Ghosh, et al., 2021b. Morpho-phenetical study of high yielding tossa jute variety BJRI Tossa Pat 7 (MG-1) for bast fibre yield and qualities. *Heliyon* **7** (2021): e081292; 1-17. https://doi.org/10.1016/j.heliyon.2021.e08129

Mukul, 2020b. Elucidation of Genotypic Variability, Character Association, and Genetic Diversity for Stem Anatomy of Twelve Tossa Jute (Corchorus olitorius L.) Genotypes. Hindawi: *BioMed Research International*. Article ID 9424725: 1-16. https://doi.org/10.1155/2020/9424725

Ngomuo M, Stoilova T, Feyissa T, Ndakidemi PA, 2017. Characterization of morphological diversity of jute mallow (Corchorus spp.). *Hindawi: Int. J. Agron*., 6460498, 12 pages. https://doi.org/10.1155/2017/6460498

Nur IJ, Kundu B, Chowdhury MAH, Mukul MM, et al., 2021. Weed Management of Kenaf (Hibiscus Cannabinus) Through Intercropping Leafy Vegetables and Cultural Practices. *SAARC J. Agric.*; **19**(1): 165-176. DOI: 10.3329/sja.v19i1.54787

Pervin N, Haque GKMN, 2012. Path Coefficient Analysis for fibre Yield Related Traits in Deshi Jute (*Corchorus capsularis* L.). *International Research Journal of Applied Life Science*, 1(3): 72-77. DOI: 10.1.1.300.3480&rep=rep1&type=pdf

Rahman MS, Islam MN, Polan MS, Talukder FU, Mukul MM, 2021. Relative toxicity of some chemical pesticides against jute hairy caterpillar (*Spilosoma Obliqua* W.) in tossa jute (*Corchorus olitorius* L.). Malaysian J. Sustain. Agric.; 5 (2), 115–122. http://doi.org/10.26480/mjsa.02.2021.115.122

Sarkar S, 2008. Good practices for jute and allied fibre crops. In: Souvenir, International Symposium on jute and allied fibre Production, Utilization and Marketing, pp 1-3. Organized by Indian Fibre Society (Eastern Region). Kolkata, 9-12 January.

Zhang L, Ibrahim AK, Niyitanga S, Zhang L, Qi J, 2019. Jute (Corchorus spp.) Breeding. In: Al-Khayri J., Jain S., Johnson D. (eds.) Advances in Plant Breeding Strategies: Industrial and Food Crops. Springer, Cham, pp. 85–113. https://doi.org/10.1007/978-3-030-23265-8_4

Citation: Jui, S. A.; Mukul, M. M.; Nur, I. J. and Ghosh, R. K. 2022. Cluster analysis of *Corchorus capsularis* jute based on agro-morphological characters to isolate high-yielding genotypes for breeding purposes. *International Journal of Agricultural and Applied Sciences*, 3(1):29-36. https://doi.org/10.52804/ijaas2022.315