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GENETIC VARIABILITY ASSESSMENT FOR MESTA (*Hibiscus sabdariffa* L.) GERMPLASM BY MORPHOTYPIC CHARACTERS

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ABSTRACT

Thirty-five accessions with one variety of mesta germplasm were collected from Gene Bank of BJRI and conducted at Jute Agriculture Experimental Station (JAES), Manikganj during kharif season in 2016. The accessions were characterized for twenty morpho-agronomic traits as per *Hibiscus* descriptor in order to select superior genotypes for the genetic improvement of mesta. Considerable ranges of variability were observed in stem colour, petiole colour, stipule colour, plant technical height, base diameter, dry fiber weight and dry stick weight. Considering the major yield contributing characters accessions 3851, 4081, 3592 and 1993, performed better in most of the cases than the check variety (HS-24).

Key words: Mesta, genetic variability, morphotypic characters.

Introduction

Hibiscus L. is the type genus of the tribe Hibisceae of the family Malvaceae (BarssumWaalkes, 1966). The genus contains about 300 species that grow in tropical and subtropical regions throughout the world (Anderson and Pharis, 2003). It includes both annual and perennial herbaceous plants. Some of the species are economically important as a source of food, beverage, fiber, medicines and other species such as ornamentals (Wilson and Menzel, 1964; Bolade *et al*., 2009). One species of Hibiscus, known as mesta (*Hibiscus sabdariffa*) which is originated in Africa (David and Adam, 1988) and widely cultivated in West Africa as vegetable plant. Mesta also known as sorrel, roselle, karkade and popular plant in Middle Eastern countries (Morton, 1987; AbuTarboush *et al*., 1997). It is also found in almost all tropical countries including Malaysia, South East Asia, Indonesia, and Thailand (Rao, 1996). Mesta is currently an important cash crop grown in the river banks and char areas of Bangladesh. There is one variety currently available for growers to cultivate in Bangladesh. It is grown mainly for its red acid succulent calyces that can be made into a drink or to make jams or jellies. The red coloring makes it a popular ingredient of commercial herbal teas. In some places its leaves are also used as a vegetable and its stem has a fiber that is sometimes used for domestic purposes. The seeds contain oil, which is good as a lubricant fuel, and used for making soap. The Gene Bank of Bangladesh Jute Research Institute (BJRI) has been conserved about 6012 germplasm of jute, kenaf, mesta and allied fiber of both indigenous and exotic origin. Out of these 476 germplasm of *Hibiscus sabdariffa*, about 324 germplasm are characterized as per *Hibiscus* Descriptor. The rest of germplasm need to characterize and find out superior germplasm for varietal development programme. To fulfill the above desire the present study was carried out at Jute Agriculture Experimental Station (JAES), Manikganj during kharif season in 2016.

Materials and Methods

The experiment was conducted at Jute Agriculture Experimental Station (JAES), Manikganj sowing seeds on 9 April, 2016. Thirty entries along with the check variety HS-24 were taken in to this study. Each accession was sown in 5 rows of 3 m length; spacing was 30 cm between rows, 5-6 cm between plants and 1 m between plots. Standard cultural and inter-cultural practices were followed. Pigmentation data on stem colour, leaf colour, vein colour, petiole colour, stipule colour, bud colour, and fruit colour were collected at

60 days after sowing and pre-bud stage. Plants were harvested at 140 days after sowing and post-harvest data were collected as per *Hibiscus* Descriptor. Data were analyzed following standard statistical procedures.

Results and Discussion

The mean performance of the major yield contributing characters and co-efficient of variation are presented in Table 1. Pigmentation data on stem colour, leaf colour, vein colour, petiole colour, stipule colour, bud colour, and fruit colour are presented in Table 2. The plant technical height at harvest (120 days) ranged from 1.78-3.85m. The highest score was observed in accession 3851 (3.85 m/plant) followed by accessions 4081 (3.75 m/plant), 3592 (3.74 m/plant) and 2993 (3.68 m/plant). Dry fiber weight ranged from 8.28-16.74 g/plant. The highest dry fiber weight was observed accessions 3851 (16.75 g/plant), followed by 4081 (15.85 g/plant), accession 3592 (15.68 g/plant) and 2993 (15.35 g/plant). Dry stick weight ranged from 23.52-47.55 g/plant. The highest score was recorded in accessions no. 3851 (47.55 g/plant) followed by accession 4081 (45.11 g/plant), accession 3592 (45.05 g/plant) and 2993 (44.98 g/plant). Similar result was reported in Annual Research Report (2016) BJRI for different accession. Among the accessions characterized, four accessions viz. 3851, 4081, 3592 and 2993 performed better in most of the cases than that of check variety HS-24. The analysis of variance (ANOVA) for fiber yield and yield cotibuting components like plant height, base diameter, core diameter, dry stick weight etc. in mesta germplasm, is described in Table 3. The ANOVA revealed significant difference as the source of variation, for the traits plant height (m), base diameter (cm), fiber weight (g/plant) and stick weight (g/plant). All parameters are significantly different at 1% level of significance. The finding of this present study is similar to the findings of Roy *et al.* (2018).

The phenotypic coefficient of variation (PCV) was found to be greater than the genotypic coefficient of variation (GCV) in case of all the characters (Table 4). The percentage (%) of PCV of plant height 15.40, base diameter 15.35, dry fiber weight 17.64 and dry stick weight 18.48 and the percentage (%) of GCV of plant height 14.57, base diameter 15.07, dry fiber weight 17.28 and dry stick weight 18.24 were found in this study. The GCV and PCV were found to differ significantly for all the fiber yield components. This is in agreement with the findings of Sawarkar *et. al*. (2014). The percentage (%) of heritability of plant height 89.53, base diameter 96.38, dry fiber weight 95.97 and dry stick weight 97.43 and the percentage (%) of genetic advance (GA) of plant height 28.41, base diameter 30.48, dry fiber weight 34.88 and dry stick weight 37.10 were found in this study. The heritability and genetic advance (% of mean) were also found to be high for all the traits and this is similar to the findings of Roy *et al*. (2015) who reported that higher heritability and genetic advance for fiber yield components of mesta.

All genotypes were distributed in distinct divergent clusters. The distribution of the mesta germplasm accessions exhibiting higher fiber yield along with the different morpho agronomic factors in the five groups of divergent clusters are presented in Table 5. In the first group of divergent clusters consisting of cluster-I, five genotypes having higher average rank namely serial no. of Ac 01, Ac 05, Ac 10, Ac 13 and Ac 34 belonged to cluster-I. In the second group of divergent clusters consisting of cluster-II, eleven genotypes namely serial no. of Ac 02, Ac 03, Ac 07, Ac 14, Ac 19, Ac 22, Ac 25, Ac 30, Ac 31, Ac 33 and Ac 35 belonged to cluster-II. In the third group of divergent clusters consisting of cluster-III, ten genotypes namely serial no. of Ac 04, Ac 06, Ac 08, Ac 12, Ac 16, Ac 20, Ac 23, Ac 27, Ac 28 and Ac 29 belonged to cluster-III. In the fourth group of divergent clusters consisting of cluster-IV, six genotypes namely serial no. of Ac 09, Ac 11, Ac 17, Ac 18, Ac 26 and Ac 36 belonged to cluster-IV. In the fifth group of divergent clusters consisting of cluster-V, four genotypes namely serial no. of Ac 15, Ac 21, Ac 24 and Ac 32 belonged to cluster-V. These findings are in agreement with Das *et al*. (2016). The diversity in the present materials was also supported by the appreciable amount of variation among cluster means for different characters (table 6). Cluster V showed highest mean for plant height (3.76 m), base diameter (23.80 mm), dry stick weight (45.67 g) and dry fiber weight (15.91 g). Similar result was found by Das *et al*. (2016).

Table 1. Range, Mean and co-efficient of variation (CV %) of twelve characters of thirty *Hibiscus sabdariffa* germplasm along with check variety HS-24

Acc. No.	TH (m)	LA (dg)	LL (cm)	LW (cm)	PL (cm)	Node no.	BD (mm)	MD (mm)	TD (mm)	CD (mm)	DFW (g)	DSW (g)
2595	3.05	56	18.62	18.65	9.85	89	20.55	11.86	4.65	18.58	13.89	36.84
2635	2.63	63	16.52	15.73	8.95	77	15.78	9.57	4.05	13.75	11.64	32.51
2659	2.87	62	17.56	15.32	9.78	82	17.34	9.65	4.12	14.46	11.82	29.87
2698	3.23	52	20.85	20.94	10.63	89	21.27	12.12	4.56	18.17	14.56	38.69
2719	3.15	55	19.27	18.48	9.66	98	20.78	12.27	4.51	17.79	14.36	40.57
2721	3.54	51	21.02	20.35	11.14	101	22.47	12.79	4.96	18.89	14.85	39.88
2739	2.85	57	15.67	17.42	8.87	79	19.45	9.38	4.61	16.44	11.74	29.62
2803	3.25	52	20.22	20.91	9.85	96	21.25	12.26	4.75	18.85	14.55	41.75
2933	2.22	60	11.18	14.54	7.95	75	15.11	8.97	3.65	11.45	9.14	25.45
2935	3.02	53	19.28	19.38	9.48	98	20.24	11.98	4.43	18.15	13.95	37.59
2936	2.52	64	13.95	13.65	8.55	79	15.25	8.98	3.69	11.71	9.25	26.35
2938	3.46	51	18.35	20.62	10.85	99	22.05	12.53	4.74	18.67	14.68	41.02
2952	3.25	52	15.51	19.31	9.98	89	20.75	12.03	4.69	18.21	14.54	40.55
2958	2.95	62	16.35	15.15	8.85	83	18.47	11.49	4.87	16.36	13.26	38.85
2993	3.68	50	23.28	22.98	11.62	107	23.45	13.35	5.45	19.35	15.35	44.98
2994	3.55	51	22.52	21.74	9.84	102	21.89	12.76	5.21	18.89	14.98	41.53
3010	2.68	60	14.54	14.85	9.25	82	16.24	9.66	3.89	12.85	9.58	26.84
3296	2.66	63	12.58	14.65	8.78	79	15.56	10.85	3.96	12.66	9.89	26.29
3358	2.86	62	13.26	15.79	9.12	95	18.55	10.22	4.11	15.59	10.58	29.59
3482	3.25	49	22.45	18.35	10.23	98	21.89	12.58	4.35	18.67	13.98	37.75
3592	3.74	48	24.02	22.85	11.82	110	23.65	13.65	5.56	19.46	15.68	45.05
3613	2.85	55	17.26	15.66	8.48	89	18.45	9.55	5.05	15.57	11.56	31.74
HS-24	3.63	47	23.35	21.86	11.21	107	21.86	12.87	4.21	18.68	15.11	44.75
3851	3.85	45	24.51	23.25	12.55	115	24.35	14.35	5.84	20.47	16.74	47.55
3941	2.95	60	18.55	17.28	9.45	80	18.05	11.44	4.14	16.34	11.27	32.24
4036	1.78	65	10.56	13.36	7.25	70	14.75	8.44	3.32	10.15	8.28	23.52
4038	3.38	48	22.12	21.05	10.87	98	22.45	12.51	4.78	18.54	14.64	39.89
4039	3.25	48	21.85	20.55	10.45	86	22.58	12.46	4.65	17.95	14.55	41.55
4040	3.02	49	19.69	20.25	10.54	98	21.25	12.25	4.56	17.52	14.22	40.36
4065	2.98	55	17.58	18.74	8.94	85	17.25	10.28	4.36	16.35	11.58	32.82
4068	2.75	57	16.59	16.54	9.52	82	16.55	9.55	4.12	15.68	10.57	29.56
4081	3.75	48	23.78	22.65	11.95	112	23.75	13.89	5.69	19.87	15.85	45.11
4676	2.87	62	17.52	18.32	10.63	85	15.85	9.68	4.45	12.35	12.15	35.54
4678	3.05	59	19.26	20.65	11.21	95	19.52	12.54	4.87	17.66	14.53	41.52
4680	2.68	60	16.62	16.25	9.35	85	15.25	9.15	4.25	12.36	11.24	32.21
4819	2.35	62	15.36	15.58	9.14	81	16.23	9.63	3.92	13.54	10.32	29.32
Range	1.78 -3.85	45-65	10.56-24.51	13.36-23.25	7.25-12.55	70-115	14.75-24.35	8.44-14.35	3.32-5.84	10.15-20.47	8.28-16.74	23.52-47.55
Mean	3.04	55.30	17.95	18.43	9.90	92.9	19.40	1.32	4.51	16.44	12.91	36.09
CV%	17.25	12.97	13.59	14.55	12.92	11.6	15.71	11.52	10.9	15.28	19.55	21.45

* Check Variety

Technical height (TH), leaf angle (LA), leaf length (LL), leaf width (LW), petiole length (PL), base diameter (BD), middle diameter (MD), top diameter (TD), core diameter (CD), dry fiber weight (DFW), dry stick weight (DSW)

Table 2. Pigmentation of *Hibiscus sabdariffa* germplasm along with check variety HS-24

Acc. No.	Stem color	Leaf color	Vein color	Petiole color	Stipule	Stipule color	Bud color	Fruit color
2595	G/R	G/R	G	G/R	+	G	R	B
2635	G/R	G/R	G	G/R	+	G	R	B
2659	G/R	G/R	G	G/R	+	G	R	B
2698	G/R	G/R	G	G/R	+	G	R	B
2719	G/R	G/R	G	G/R	+	G	R	B
2721	G/R	G/R	G	G/R	+	G	R	B
2739	G/R	G/R	G	G/R	+	G	R	B
2803	G/R	G/R	G	G/R	+	G	R	B
2933	G/R	G/R	G	G/R	+	G	R	B
2935	G/R	G/R	G	G/R	+	G	R	B
2936	G/R	G/R	G	G/R	+	G	R	B
2938	G/R	G/R	G	G/R	+	G	R	B
2952	G/R	G/R	G	G/R	+	G	R	B
2958	G/R	G/R	G	G/R	+	G	R	B
2993	G/R	G/R	G	G/R	+	G	R	B
2994	G/R	G/R	G	G/R	+	G	R	B
3010	G/R	G/R	G	G/R	+	G	R	B
3296	G/R	G/R	G	G/R	+	G	R	B
3358	G/R	G/R	G	G/R	+	G	R	B
3482	G/R	G/R	G	G/R	+	G	R	B
3592	G/R	G/R	G	G/R	+	G	R	B
3613	G/R	G/R	G	G/R	+	G	R	B
HS-24	G/R	G/R	G	G/R	+	G	R	B
3851	G/R	G/R	G	G/R	+	G	R	B
3941	G/R	G/R	G	G/R	+	G	R	B
4036	G/R	G/R	G	G/R	+	G/R	R	B
4038	G/R	G/R	G	G/R	+	G	R	B
4039	G/R	G/R	G	G/R	+	G/R	R	B
4040	G	G	G	G	+	G	R	B
4065	R	G/R	G/R	G/R	+	G/R	R	B
4068	R	G/R	G	G/R	+	G/R	R	B
4081	G/R	G/R	G	G/R	+	G	R	B
4676	G/R	G/R	G	G/R	+	G/R	R	B
4678	G/R	G/R	G	G/R	+	G/R	R	B
4680	G/R	G/R	G	G/R	+	G	R	B
4819	G/R	G/R	G/R	G/R	+	G/R	R	B

G= Green, R= Red, LR= Light Red, B=Brown, "+"= Present, * Check variety

Table 3. Analysis of variance (mean square)

SOV	df	TL (m)	LA (dg)	LL (cm)	LW (cm)	PL (cm)	Node No.	BD (mm)	MD (mm)	TD (mm)	CD (mm)	DFW (g)	DSW (g)
Rep.	2	0.034	21.77	0.028	0.121	0.122	0.694	0.028	0.353	0.027	0.007	0.384	0.247
Acc.	35	0.613 **	103.7 **	40.86 **	25.57 **	4.200 **	384.0 **	26.10 **	7.975 **	0.988 **	23.33 **	15.16 **	131.2 **
Error	70	0.023	10.97	0.428	0.431	0.087	14.20	0.323	0.263	0.016	0.246	0.209	1.143

SOV = Source of variation, Rep. = Replication, Acc. = Accessions
** = Significant at 1% level of probability

Table 4. Variability, heritability (h2b), genetic advance (GA) and GA in percent of mean for twelve yield and its related characters of *H. sabdariffa*

Charac-ters	Min.	Max.	Mean	Genotypic variance	Phenotypic variance	GCV (%)	PCV (%)	Heritability (h^2b)	GA	GA (%)
TH	1.78	3.85	3.04	0.20	0.22	14.57	15.40	89.53	0.86	28.41
LA	45.00	65.00	55.36	30.921	41.90	10.04	11.69	73.80	9.84	17.78
LL	10.56	24.51	18.38	13.476	13.904	19.98	20.29	96.92	7.44	40.51
LW	13.36	23.25	18.43	8.38	8.81	15.70	16.10	95.11	5.82	31.55
PL	7.25	12.55	9.91	1.37	1.46	11.82	12.19	94.03	2.34	23.61
Node	70.0	115.0	90.97	123.234	137.443	12.20	12.89	89.66	21.65	23.80
BD	14.75	24.35	19.45	8.592	8.915	15.07	15.35	96.38	5.93	30.48
MD	8.44	14.35	11.32	2.571	2.834	14.16	14.87	90.72	3.15	27.79
TD	3.32	5.84	4.53	0.324	0.340	12.57	12.88	95.29	1.14	25.28
CD	10.15	20.47	16.44	7.694	7.940	16.87	17.14	96.90	5.62	34.21
DFW	8.28	16.74	12.91	4.982	5.191	17.28	17.64	95.97	4.50	34.88
DSW	23.52	47.55	36.09	43.353	44.496	18.24	18.48	97.43	13.39	37.10

Technical height (TH), leaf angle (LA), leaf length (LL), leaf width (LW), petiole length (PL), base diameter (BD), middle diameter (MD), top diameter (TD), core diameter (CD), dry fiber weight (DFW), dry stick weight (DSW)

Table 5. Number, percent and name of genotypes in different cluster

Cluster number	Number of varieties	Percent (%)	Name of Accessions
I	5	13.89	Ac 01, Ac 05, Ac 10, Ac 13 and Ac 34
II	11	30.56	Ac 02, Ac 03, Ac 07, Ac 14, Ac 19, Ac 22, Ac 25, Ac 30, Ac 31, Ac 33 and Ac 35
III	10	27.78	Ac 04, Ac 06, Ac 08, Ac 12, Ac 16, Ac 20, Ac 23, Ac 27, Ac 28 and Ac 29
IV	6	16.67	Ac 09, Ac 11, Ac 17, Ac 18, Ac 26 and Ac 36
V	4	11.11	Ac 15, Ac 21, Ac 24 and Ac 32

Table 6. Cluster mean for twelve yield and yield characters of *H. sabdariffa*

Characters	I	II	III	IV	V
TH	3.10	2.84	3.36	2.37	3.76
LA	55.00	59.55	49.80	62.33	47.75
LL	18.39	16.68	21.24	13.03	23.90
LW	19.29	16.56	20.66	14.44	22.93
PL	10.04	9.27	10.56	8.49	11.99
Node	93.80	83.82	97.40	77.67	111.00
BD	20.37	17.36	21.90	15.52	23.80
MD	12.14	10.00	12.51	9.42	13.81
TD	4.63	4.38	4.68	3.74	5.64
CD	18.08	15.02	18.48	12.06	19.79
DFW	14.25	11.58	14.61	9.41	15.91
DSW	39.41	32.23	40.72	26.30	45.67

Technical height (TH), leaf angle (LA), leaf length (LL), leaf width (LW), petiole length (PL), base diameter (BD), middle diameter (MD), top diameter (TD), core diameter (CD), dry fiber weight (DFW), dry stick weight (DSW)

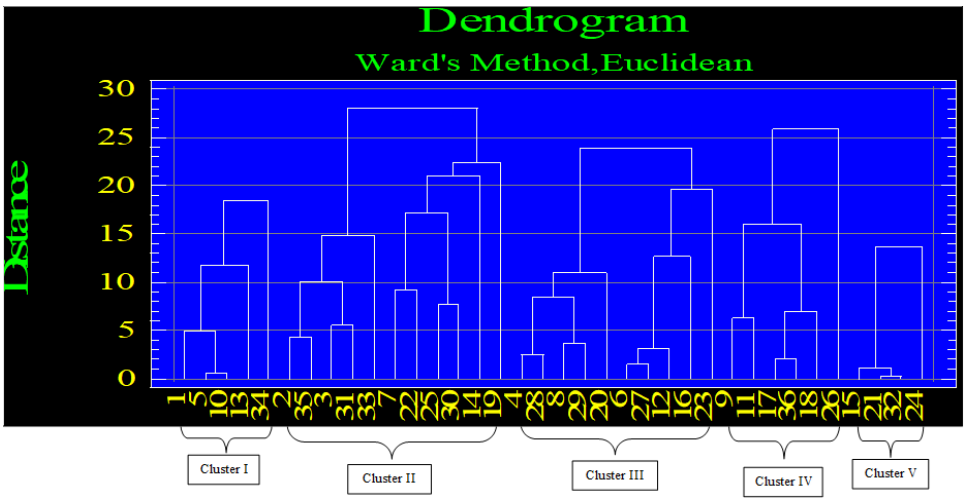

Fig. 1. Dendrogram of 36 mesta genotypes

Conclusion

The present study on morphotypic characters of mesta clearly explores the state of genetic variability. The differences between some accessions in the same species were not sufficient. Knowledge from this study could be used for taxonomic classification and the development of economic variety of mesta for char areas of Bangladesh.

References

Annual Research Report. 2016. Bangladesh Jute Research Institute. Manik Mia Avenue, Dhaka-1207.

Abu-Tarboush, H. M., Ahmed, S. A. B. and Kahtani, H. A. 1997. Some nutritional properties of karkade (*Hibiscus sabdarifa*) seed products. *Cereal Chem*., 74:352-355.

Anderson, N. and Pharis, J. 2003. Kenaf fiber-A new basket liner. *Minnesota Commercial Flower Growers Bull*., 52(3):7-9.

BarssumWaalkes, J. Van. 1966. MalesianMalvacea revised. *Blumea*, 14:1-251.

Bolade, M. K., Oluwalana, I. B. and Ojo, O. 2009. Commercial Practice of Roselle (*Hibiscus sabdariffa* L.) Beverage Production: Optimization of Hot Water Extraction and Sweetness Level. *World J. Agric. Sci*. 5:126- 131.

Das, A. and Kumar, D. 2016. Genetic Divergence and Character Association for Yield and Quality Attributing Characters in Jute Cultivars (*Corchorus* spp.). *Elect. J. Plant Breed.* ,7(3): 529-537.

David, G. and Adam, P. 1988. Crops of the drier regions of the Tropics. ELBS Edt. Longman Publishing Co., Wisconsin, Madison, USA.

Morton, J. 1987. Roselle. In Morton, J. F. (Ed). Fruits of Warm Climates, Creative Resource Systems Inc., USA.

Rao, P. U. 1996. Nutrient composition and biological evaluation of mesta (*Hibiscus sabdariffa*) seeds. *Plant Foods Human Nutr*., 49:27-34.

Roy, S. K., Chakraborty, Hijam, H. M., Mondal, H. A., Surje, D. T., Roy, A., Mondal, A., Pal, S., Kundu, A., Das, S., Sarkar, P., Kheroar, S., Chakraborty, G. and Mitra, S. 2018. Studies on genetic variability and screening for fiber yield components and biotic stress factors in tossa jute (*Corchorusolitorius* L.) germplasm under Terai region of West Bengal. *Electr. J. Plant Breed.*, 9 (2) : 409-423

Wilson, F. D. and M. Y. Menzel. 1964. Kenaf (*Hibiscus cannabinus*), Roselle (*Hibiscus sabdariffa*). *Econ. Bot.*, 18:80-91.