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Research Article

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BJRI Mesta-3: A newly released improved variety of *Hibiscus sabdariffa* L.

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ABSTRACT
Bangladesh Jute Research Institute (BJRI) has recently evolved a high-yielding, prickles free and wide adaptable smooth mesta (*Hibiscus sabdariffa* L.) variety released by National Seed Board (NSB) in the year 2017 namely, BJRI Mesta-3. It was previously isolated from the farmers' field of Khankhanapur, Rajbari in 1993 and was developed through pure line selection as a promising line SAMU'93. The line was evaluated for smoothness, fiber yield, and other morphological attributes. Advanced Yield Trial (AYT) was conducted for two years (2009 and 2010) along with Zonal Yield Trial (ZYT) for three consecutive years (2011 to 2013) at Manikganj, Faridpur, Rangpur, Chandina, Kishoreganj and Monirampur stations. Besides, Multi-location Trial (MLT) was conducted for three consecutive years (2014 to 2016) at different farmers' fields in different agro-ecological zones. It was observed to be suitable for a wide range of sowing time (March to June) and fit for existing cropping pattern in Bangladesh. The variety is time-bound or time-based means that whenever it is sown give flowers from November to December. Its stem is fully green and smooth, petiole green and leaf pubescence absent. It can withstand vagaries of growing conditions, as drought or increased rains, infested with weeds, or similar adversities, much more than either jute or kenaf. It is moderately tolerant to stem rot disease, mealybug, mite, and root-knot nematode. It also possesses superior quality fiber than the check variety Hs-24, popularly known as 'Tani Mesta-1'. However, the average yield was observed at 2.8 t ha^{-1} which was around 5% higher than the check variety Hs-24.
Keywords: Mesta, wide adaptable, high yielding.

INTRODUCTION

Hibiscus sabdariffa L. comprises two distinct botanical varieties: the edible var. *sabdariffa* and the fiber producing var. *altissima* (Sobhan, 1993). The edible variety is a short bushy plant (1 - 2 m) bearing profuse smooth fruits having large fleshy calyx and epicalyx. This type is grown for culinary purposes and is popularly known as roselle or rosella (Dempsey, 1975). Its fleshy calyx and epicalyx are used for jelly making and dried form is processed into other confections like cordial drinks, jams, sauces, liqueurs, wines, and food preserves (Zaman, *et al*., 2017). The fiber-producing variety is a tall (2 - 4 m), erect, unbranched plant with smaller inedible hairy fruits. It is a tropical and subtropical crop. The major altissima-producing countries are India, Thailand, Bangladesh, Indonesia, Vietnam, and Myanmar (Dempsey, 1963).

Mesta is known for its adaptability to poor soils and exhibits a fair tolerance to drought. Traditionally, it is grown in Bangladesh on relatively less fertile marginal uplands where jute or other major field crops cannot be grown profitably in the Kharif season (Monsoon). Farmers usually grow mesta in weed infested plots because this is a weed-smothering crop. Due to the increasing cropping intensity from cereal crops, jute (the main cash crop of Bangladesh) is being pushed to marginal lands. Under this changing situation, mesta offers a better crop than jute (Sobhan, 1993). Mesta fiber is bright, silky, and shiny and is as good as medium-grade jute but is sold at a lower price than jute. It is used for making sacks, cordage, rope, and generally for all purposes for which jute is used. It is also used in combination with other synthetic fibres or natural fibers like jute (Maiti, 1997). In terms of environmental impact, kenaf as well as mesta can absorb CO_2 and NO_2 3-5 times faster than forest trees. Their deep roots can improve soil fertility and clean the environment efficiently (Lam, 2000).

Despite the importance of mesta in Bangladesh, many constraints still limit its production. One of the major constrain to increase mesta productivity is the non-availability of modern varieties. The only existing fiber type variety (Hs-24) is characterized by a slow growth rate, requiring a long vegetative period of 7-8 months for flowering when sown during the optimum time of April. Moreover, the variety has some undesirable characters. The stem, petiole, flower stalk, epicalyx and calyx have staff hairs that may cause skin irritation. Due to long vegetative period and also the presence of pubescence on stems and bristles on calyx, the growers show little

interest in mesta cultivation. Hence, early maturing and quick growing smooth mesta varieties are of great need to cope with this problem. With these views kept in mind, the present piece of study has been undertaken. Therefore, the objective of the study was to develop and release new mesta variety with a higher yield, adaptability, smoothness, and good fiber quality.

MATERIALS AND METHODS

An advanced line SAMU'93 was derived from pure line selection. It possesses high yielding, prickle or bristle-free, and quick growing characteristics. The existing variety Hs-24 was used as a check to evaluate the advanced line for fibre yield, quality, adaptability, and overall suitability at farmers' field in different regions of Bangladesh as well as on-stations. Different yield trials (AYT, ZYT, and MLT) were conducted under different topography at different Jute Research Regional Stations. Agronomic trials were also conducted in different locations. The varietal status was also assessed regarding diseases and pest incidence conducting experiments under field conditions without using any fungicide and pesticide. Advanced yield trial was conducted for two years (2009 and 2010) at Manikganj, Faridpur, Rangpur, Chandina, Kishoreganj, and Monirampur stations. Zonal yield trial was also conducted for three years (2011 to 2013) along with a multi-location trial for assessing yield productions for three consecutive years (2014 to 2016) at different farmers' fields in different agro-ecological zones. Quality parameters of the produced fibre were tested in the Fibre Quality Improvement Division and Technology Wing of BJRI.

The trials were conducted in RCB design with four replications in the 12 m^2 effective area of each plot. The existing variety Hs-24 was used as control in all trials. In MLT, a plot of 10 decimal lands was divided into two halves, each portion having 5 decimals. One portion was used for advanced line SAMU'93 and the other for check variety Hs-24. The seeds of both entries were sown from mid-March to mid-April during the tested years. Intercultural operations and agronomic practices were done in time simultaneously for whole plots as per recommendation. The crop was harvested at 120 days after sowing and necessary records were kept. Data were recorded on plant population, plant height, base diameter, and green weight at harvesting time; fiber weight and stick weight were taken after retting, washing, and drying in different experimentation.

RESULTS AND DISCUSSION

BJRI evolved a new variety of mesta which is high yielding and wide adaptable in Bangladesh. It is released by the National Seed Board (NSB) of Bangladesh in the year 2017. The variety is quick growing and early maturing nature having high biomass. Its stem is fully green and smooth, leaf pubescence absent. It can be grown in a varied range from March to June. Time of flowering 7-8 months after sowing but the variety can be harvested at any time after 120 days of sowing and may gain excellent fiber yield. Ali *et al*. (2017) reported a range of 2.9 – 3.1 t ha^{-1} fiber yield of BJRI Mesta-3 at Kishoreganj and Manikganj stations when harvested at 120 DAS using a combined dose of NPK and S @ 100-10-60-20 kg ha^{-1}. The Fibre color of the new variety is bright, silky, and shiny. It is moderately tolerant to root-knot nematode (Islam, 2019a; Islam, 2019b).

Plot view of SAMU'93

Plot view of Hs-24


Comparison between SAMU'93 & Hs-24

Data on yield and yield contributing traits of the advanced line SAMU'93 (BJRI Mesta-3) and check variety Hs-24 at six BJRI stations namely Manikganj, Faridpur, Rangpur, Chandana, Kishoreganj, and Monirampur, as well as 18 sites of farmers' field of those locations, are shown in Table 1-3. The maximum fiber yield was obtained at Monirampur (3.23 t ha^{-1}) followed by Chandina (3.09 t ha^{-1}) in 2010. The pooled mean value of fiber yield of the tested line was 4.56 % higher than the control Hs-24 (Table 1).

The mean results over years of ZYT showed that BJRI Mesta-3 gave maximum fiber yield at Monirampur station (3.39 t ha^{-1}) followed by Chandina (3.02 t ha^{-1}) and Faridpur (2.89 t ha^{-1}) (Table 2). The highest plant height was observed at Monirampur station (3.38 m) followed by Manikganj (3.35 m) and Faridpur (3.13 m). Mean performance over stations showed that BJRI Mesta-3 gave 4.96 % higher fiber yield than check variety Hs-24 (Table 2).

Table 1. Fibre yield (t ha^{-1}) of the advanced line SAMU'93 (BJRI Mesta-3) and check variety Hs-24 at different stations of BJRI during 2009-2010

Varieties	Manikganj		Faridpur		Rangpur		Chandina		Kishoreganj		Monirampur		Pooled mean	Yield increased (%)
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010		
BJRI Mesta-3	2.57	2.75	2.54	2.57	2.53	2.99	2.95	3.09	2.55	2.69	2.54	3.23	2.75	4.56
Hs-24	2.46	2.66	2.45	2.48	2.46	2.88	2.86	2.90	2.42	2.51	2.45	3.04	2.63	

Table 2. Yield performance of the advanced line SAMU'93 (BJRI Mesta-3) and Hs-24 at different stations of BJRI during 2011-2013

Locations	Characters	2011		2012		2013		Mean over years	
		BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24
Manikganj	Plant height (m)	3.67	3.11	3.56	3.10	2.82	2.72	3.35	2.98
	Fiber yield (tha^{-1})	2.65	2.56	2.95	2.80	2.88	2.75	2.83	2.70
Faridpur	Plant height (m)	3.12	3.07	3.08	3.18	3.18	3.10	3.13	3.12
	Fiber yield (tha^{-1})	2.78	2.42	2.95	2.88	2.95	2.81	2.89	2.70
Rangpur	Plant height (m)	2.99	2.95	2.90	2.88	2.92	2.90	2.94	2.91
	Fiber yield (tha^{-1})	2.98	2.88	2.50	2.40	2.84	2.72	2.77	2.67
Chandina	Plant height (m)	3.15	3.11	3.00	2.98	2.99	2.96	3.05	3.02
	Fiber yield (tha^{-1})	3.40	3.22	2.45	2.30	3.22	3.09	3.02	2.87
Kishoreganj	Plant height (m)	2.89	2.76	2.88	2.73	2.80	2.75	2.86	2.75
	Fiber yield (tha^{-1})	2.99	2.88	2.75	2.65	2.78	2.70	2.84	2.74
Monirampur	Plant height (m)	3.45	3.52	3.58	3.53	3.12	3.02	3.38	3.36
	Fiber yield (tha^{-1})	3.62	3.50	3.59	3.43	2.96	2.82	3.39	3.25
Mean over stations	Plant height (m)	3.21	3.09	3.17	3.07	2.97	2.91	3.12	3.02
	Fiber yield (tha^{-1})	3.07	2.91	2.87	2.74	2.94	2.82	2.96	2.82
					Yield increased (%)			4.96	

Table 3. Yield performance of the advanced line SAMU'93 (BJRI Mesta-3) and Hs-24 at farmers' fields in different agro-ecological zones during 2014-2016

Locations	Characters	2014		2015		2016		Mean over years	
		BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24	BJRI Mesta-3	Hs-24
Manikganj	Plant height (m)	2.62	2.43	2.77	2.71	2.82	2.48	2.74	2.54
	Fiber yield (t ha^{-1})	2.75	2.72	2.76	2.72	2.56	2.25	2.69	2.56
Faridpur	Plant height (m)	2.73	2.64	2.74	2.73	2.51	2.32	2.66	2.56
	Fiber yield (t ha^{-1})	2.79	2.77	2.75	2.73	2.28	2.11	2.61	2.54
Rangpur	Plant height (m)	2.77	2.72	2.92	2.80	2.71	2.41	2.80	2.64
	Fiber yield (t ha^{-1})	2.74	2.73	2.76	2.72	2.46	2.19	2.65	2.55
Chandina	Plant height (m)	3.08	2.50	2.90	2.89	2.95	2.58	2.98	2.66
	Fiber yield (t ha^{-1})	2.60	2.53	2.77	2.75	2.68	2.35	2.68	2.54
Kishoreganj	Plant height (m)	2.95	2.82	2.77	2.76	2.47	2.21	2.73	2.60
	Fiber yield (t ha^{-1})	2.55	2.53	2.74	2.70	2.24	2.01	2.51	2.41
Monirampur	Plant height (m)	2.70	2.53	2.88	2.82	2.56	2.34	2.71	2.56
	Fiber yield (tha^{-1})	2.70	2.65	2.76	2.72	2.33	2.13	2.60	2.50
Mean over locations	Plant height (m)	2.81	2.61	2.83	2.79	2.67	2.39	2.77	2.60
	Fiber yield (tha^{-1})	2.69	2.66	2.76	2.72	2.43	2.17	2.63	2.52
					Yield increased (%)			4.37	

MLT mean results over years at different farmers' fields in different agro-ecological zones showed that the advanced line SAMU'93 (BJRI Mesta-3) gave maximum fiber yield at Manikganj location (2.69 tha^{-1}) followed by Chandina (2.68 tha^{-1}) and Rangpur (2.65 tha^{-1}). The highest plant height was observed at Chandina location (2.98 m) followed by Rangpur (2.80 m) and Manikganj (2.74 m). Mean performance over locations showed that BJRI Mesta-3 gave a 4.37% higher fiber yield than the check variety Hs-24 (Table 3).

Agronomic trials on time sowing (30 March, 15 April, 30 April, and 15 May) conducted in 2016 (Anonymous, 2016) showed that the advanced line SAMU'93 (BJRI Mesta-3) gave higher fiber yield at all locations on 15 April sowing date (Table 4). The results were in agreement with Sobhan (1977). He studied the effect of time of sowing on growth, development, and yield of the mesta variety Hs-24 sown from 14th February to 1st June at intervals of 15 days. Better growth and yield were recorded in plants sown from mid-March to mid-April, with the highest yield of 36.68 g of fiber per plant being in the lot sown on 1st April.

Table 4. Effect of date of sowing of the advanced line SAMU'93 (BJRI Mesta-3) on fiber yield and yield attributes at different locations in 2016

Stations	Treatments	Plant population (m^{-2})	Plant height (m)	Fiber yield (t ha^{-1})
Manikganj	30 March	20.80	2.16	2.13
	15 April	27.53	2.71	2.79
	30 April	25.37	2.54	2.51
	15 May	23.68	2.30	2.20
Kishoreganj	30 March	22.80	2.22	2.23
	15 April	25.97	2.69	3.14
	30 April	24.64	2.46	2.63
	15 May	23.79	2.32	2.43
Pakhimara (Patuakhali)	30 March	22.66	2.28	2.13
	15 April	25.83	2.75	3.09
	30 April	24.50	2.52	2.57
	15 May	23.65	2.38	2.45

Disease incidence studies at Rangpur, Faridpur, Kishoreganj, and Chandina stations revealed that there were no infestations in 2016 at all stations on the advanced line SAMU'93 (BJRI Mesta-3). But at Rangpur and Kishoreganj, some infestations were observed in 2015. The level of infestation was lower on the advanced line SAMU'93 (BJRI Mesta-3) compares to the control variety Hs-24 (Table 5). Varieties' responses to disease organisms varied differently in different environmental conditions (Kabir *et al*., 1968). Results regarding pest infestation at different locations indicated that the attack of mealybug and yellow mite on advanced line SAMU'93 (BJRI Mesta-3) was comparatively less than the check variety Hs-24 (Table 6). Infestation depends on the climatic conditions and varies from location to location (Anonymous, 2015).

Table 5. Comparative disease incidence (stem rot and leaf mosaic) of the advanced line SAMU'93 (BJRI Mesta-3) and the variety Hs-24 at different stations during 2015-16

	Station wise affected plants (%)							
Line /variety	Rangpur		Faridpur		Kishoreganj		Chandina	
	2015	2016	2015	2016	2015	2016	2015	2016
BJRI Mesta-3	3.67	Nil	Nil	Nil	5.00	Nil	Nil	Nil
Hs-24	15.11	9.00	1.92	2.00	7.72	Nil	Nil	Nil

The quality of fiber is dependent on some chemical and physical properties. Among them cellulose and lignin content, whiteness (color), brightness, fineness, and bundle strength are major. Cutting per cent and retting period are also quality parameters. Considering fiber quality parameters, the advanced line SAMU'93 (BJRI Mesta-3) requires less time for retting (15 days) with less cutting percentage (5 %) compare to the control variety (17 days for retting and cutting 9 %). Moreover, the advanced line SAMU'93 (BJRI Mesta-3) produced desirable silky and shiny (golden) fiber color with higher bundle strength (8.18 1bs/mg), brightness (37.89 %), and fineness (36.90 µ) compare to check variety Hs-24 (fiber color lightly golden, bundle strength 7.98 1bs/mg, brightness 35.95 % and fineness 36.50 µ) (Table 7).

Table 6. Comparative pest infestation (mealybug and mite) records of advanced line SAMU'93 (BJRI Mesta-3) and check variety Hs-24 at different locations in 2015

Line/variety	Mealy bug-infested (%)			Mite infested (%)			
	Manikganj	Kishoreganj	Faridpur	Monirampur	Faridpur	Chandina	Monirampur
BJRI Mesta-3	3.57	1.03	2.89	3.88	Nil	0.13	Nil
Hs-24	17.99	2.01	3.84	4.78	1.16	0.26	0.27

Table 7. Fibre quality characters of the advanced line SAMU'93 (BJRI Mesta-3) and the check variety Hs-24 over stations

Line/variety	Cutting (%)	Retting period (days)	Bundle strength (1bs/mg)	Fineness (µ)	Brightness (%)	Fiber color	Apparent quality
BJRI Mesta-3	5	15	8.18	36.90	37.89	Golden	++
Hs-24	9	17	7.98	36.50	35.95	Light golden	+

Yield is a complex character in any crop which is governed by several factors. The smoothness and early maturing characters are of great importance in mesta breeding as to fit this crop with a suitable cropping pattern. The development of high yielding mesta variety is essential for migrating the total production of mesta and also for its cultivation in marginal land of Bangladesh. In this study the advanced promising line SAMU'93 (BJRI mesta-3) produced 4.37 % higher fibre yield than the check variety Hs-24 at farmers' field in

different agro-ecological zones suggested that the line is better than the check variety in respect of fiber yield. Moreover, it is well recognized that plant height is one of the important parameters for fiber yield. The line SAMU'93 (BJRI Mesta-3) had produced a higher plant height than the check variety Hs-24 in all stations as well as farmers' fields. The finding suggested that the advanced line SAMU'93 (BJRI Mesta-3) is the potential for getting higher fiber yield. A similar finding was found by Khatun *et al*. (2007) in kenaf (*Hibiscus cannabinus* L.).

CONCLUSION

In view of the results and discussion, it could be safely concluded that the newly released variety BJRI Mesta-3 performed better in all stations as well as farmers' fields of different regions of Bangladesh. The variety not only gave higher fiber yield but also possesses superior quality fiber than the check variety. It has extra merit over the control such as smoothness and quick growing characters. Moreover, the new variety can be harvested only 120 days after sowing with negligible yield loss. This would benefit the farmers fitting it easily into the existing three cropping pattern in Bangladesh. Therefore, the variety BJRI Mesta-3 is recommended for commercial cultivation in the farmers' fields around the country.

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