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Effect of time of sowing, stage of harvest and plant population on fibre yield and quality of mesta (*Hibiscus sabdariffa*) under dryland condition

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ABSTRACT

A field experiment was conducted at Regional Agricultural Research Station, Bijapur (Karnataka), in medium black soil during 1998 and 1999. The experiment comprised 24 treatments, consisting of 4 dates of sowing (first fortnight of July, second fortnight of July, first fortnight of August and second fortnight of August), 2 stages of harvest (at 50% flowering and at maturity) and 3 plant populations (0.22, 0.33 and 0.66 million plants/ha). The experiment was laid out in split-split plot design with 3 replications. Pooled results of 2 years showed that, fibre yield, green matter, green stalk, dry stalk yields and fibre recovery were significantly higher with early planting during first fortnight of July compared to later sowing dates of second fortnight of July, first fortnight of August and second fortnight of August. Fibre quality with respect to fineness increased, while strength decreased significantly with delay in sowing time from first fortnight of July to secod fortnight of August. Stage of harvesting did not cause significant differences in green stalk, dry stalk and fibre yields, while green matter yield was significantly higher when the corp was harvested at 50% flowering compared to maturity. Fibre fineness was greater at maturity compared to 50% flowering. Fibre strength did not vary significantly due to stage of harvesting. Fibre yield increased significantly with increase in plant population from 0.22 million/ha (484 kg/ha) to 0.33 million/ha (559 (kg/ha) and with further increase in plant population to 0.66 million/ha (604 kg/ha) no significant increase was noticed. Dry-stalk yield followed similar tend. However, green matter and green stalk yields increased significantly with successive increase in plant population from 0.22 to 0.66 million/ha.

Key words: Mesta, Sowing time, Harvest stage, Plant population, Fibre yield, Fibre quality

Mesta (*Hibiscus* sp.) is one of the important annual fibre crops next to jute and has long been recognized as a source of cordage fibre that can be used in making rope, twine, carpet backing and burlap. In India, presently mesta plays an important role in supplementing the short supply of jute in jute industry to manufacture various jute goods. The productivity of this crop is high in jute belt of north-eastern states compared to non-traditional areas. The major constraints in productivity of mesta appear to be non-availability of improved varieties and lack of suitable crop-management practices. Though the crop is well suited and adopted to north-eastern part of the country, on account of its hardiness and less exacting nature in the adaphic requirements unlike jute, it is capable of growing under a much wider range of soil and climatic conditions. Hence there is a scope to extent its cultivation commercially in the non-traditional areas having much drier climatic conditions. The productive efficiency of a crop though depends on its genetic potential, its yield could be improved to a perceptible magnitude through suitable agronomic practices. Hence present study was undertaken to find out optimum time of sowing, stage of harvest and plant population on fibre yield and quality under dryland condition.

MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Bijapur (Karnataka), during 1998 and 1999 in medium black soil. There were 24 treatments consisting of 4 dates of sowing (first fortnight of July, second fortnight of July, first fortnight of August and second fortnight of August), 2 stages of harvest (at 50% flowering and at maturity) and 3 plant populations (0.22, 0.33 and 0.66 million plants/ha). The experiment was laid out in split split-plot design with dates of sowing as main plots, stages of harvest as subplots and plant populations as sub-subplots and the treatments were replicated thrice. The gross and net plot size was 4.2 m × 3.6 m and 3.6 m × 2.4 m respectively. 'AS 73-CP 560' mesta (*Hibiscus sabdariffa* L.) was used as a test variety and it was planted

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Table 1. Effect of date of sowing, stage of harvest and plant population on growth and yield attributes of mesta (mean data of 1998 and 1999)

Treatment	Fibre yield (kg/ha)	Fibre weight/ plant (g)	Fibre recovery (%)		Green matter yield (Mg/ha)	Green stalk yield (Mg/ha)	Dry stalk yield (Mg/ha)	Plant height (cm)	Stem diameter (cm)
			On green-weight basis	On dry-weight basis					
Date of sowing (D)									
I F.N. of July (D_1)	954	3.72	4.98	16.17	20.46	14.48	5.98	187.0	0.77
II F.N. of July (D_2)	647	2.50	4.38	16.18	14.79	10.46	4.29	167.3	0.71
I F.N. of August (D_3)	442	1.70	3.87	14.72	11.54	7.87	3.30	134.8	0.63
II F.N. of August (D_4)	153	0.63	3.14	14.29	4.91	3.26	1.42	83.9	0.43
CD (P=0.05)	81	0.48	0.37	0.99	1.84	1.29	0.51	11.1	0.06
Stage of harvest (H)									
At 50% flowering (H_1)	545	2.13	4.03	15.20	13.61	9.22	3.79	139.5	0.60
At maturity (H_2)	553	2.14	4.16	15.48	12.23	8.82	3.70	147.1	0.67
CD (P=0.05)	NS	NS	NS	NS	0.68	NS	NS	3.8	0.02
Plant population (P)									
0.22 million/ha (P_1)	484	2.71	4.28	15.90	11.78	8.02	3.50	151.4	0.70
0.33 million/ha (P_2)	559	2.07	4.11	15.34	12.93	9.01	3.78	143.7	0.64
0.66 million/ha (P_3)	604	1.63	3.88	14.79	14.06	10.02	3.96	134.7	0.58
CD (P=0.05)	48	0.27	0.20	0.56	0.84	0.61	0.28	4.8	0.03

F.N., Fortnight

at 30 cm row spacing with 15, 10 and 5 cm spacing between the plants within the row to get the required plant population as per treatments. A fertilizer dose of 40, 20 and 20 kg N, P and K/ha was applied to the crop at the time of planting. The soil was low in available N (160 kg/ha) and P_2O_5 (16 kg/ha), medium in available K_2O (308 kg/ha) and high in calcium content (20%) with organic carbon 0.24% and pH 8.1. A total rainfall of 964.1 and 404.3 mm was received in 48 and 32 rainy days during the cropping period (June to December) in 1998 and 1999, respectively, as compared with the normal rainfall of 552.9 mm received in 44 rainy days. Rainfall distribution during 1999 was favourable for crop growth, though it was lower. In 1998, excess rains received during August, September and October caused waterlogging conditions and affected the crop growth adversely. As a result, lower yields were recorded during 1998 compared to 1999. The crop was harvested by cutting at ground level and left in the field for drying. Sun-dried sticks were used for retting and fibre extraction. Fibre-quality assessment was done at the National Institute of Research on Jute and Allied Fibres Technology, Kolkata.

RESULTS AND DISCUSSION

Time of sowing

Pooled data of 2 years indicated that, fibre yield of mesta was significantly higher with early planting during first fortnight of July (954 kg/ha) compared to later sowing dates (Table 1). The fibre yield decreased to an extent of 32.2, 53.7 and 84.9% due to late sowing during the second fortnight of July, first fortnight of August and second fortnight of August, respectively, over that of first fortnight of July. Lakshmi *et al.* (1995) noticed 20.0 to 32.5% enhanced fibre yield due to early planting in the third week of June. Variation in fibre yield due to sowing dates may be attributed to the variation in green matter and dry stalk yields. Signifiantly higher green matter yield (20.46 Mg/ha) was obtained with early sowing during first fortnight of July compared to 14.79, 11.52 and 4.91 Mg/ha obtained due to sowing during second fortnight of July, first fortnight and second fortnight of August, respectively, and the later sowing dates in furn differed significantly with each other. Similarly, dry stalk yield decreased from 5.98 to 1.42 Mg/ha with delay in sowing from first fortnight of July to second fortnight of August (Table 1).

Fibre yield is the manifestation of yield-contributing characters, viz. fibre weight/plant and fibre recovery. In the present study, fibre weight/plant and fibre recovery decreased significantly with delay in planting from first fortnight of July to second fortnight of August (Table 1). Therefore, higher fibre weight/plant coupled with greater fibre recovery with early sowing might have contributed towards higher fibre yield/ha with early planting (first fortnight of July).

Fibre-quality parameters, viz. fineness and strength (tenacity) differed significantly due to sowing time. Fibre of early-planted crop in first fortnight of July) was more coarser and the fineness increased, as there was delay in planting up to second fortnight of August (Table 2). Increased fineness with delay in planting may be attributed to more number of weaker and immature fibre. On the

Table 2. Fibre quality of mesta as influenced by date of sowing, stage of harvest and their interactive effect (mean data of 1998 and 1999)

Treatment	Fibre fineness (tex)			Fibre strength (g/tex)		
	H_1	H_2	Mean	H_1	H_2	Mean
Date of sowing (D)						
I F.N. of July (D_1)	4.17	4.10	4.13	27.98	28.77	28.38
II F.N. of July (D_2)	3.92	3.10	3.51	29.57	25.07	27.32
I F.N. of August (D_3)	3.40	3.32	3.36	25.10	26.88	25.99
II F.N. of August (D_4)	2.50	2.05	2.28	18.68	19.70	19.19
Mean	3.50	3.14		25.33	24.10	
For comparing the means of						
CD (P=0.05) for date of sowing		0.37			2.17	
CD (P=0.05) for stage of harvest (H)		0.19			N.S.	
CD (P=0.05) for Interaction (D×H)		0.38			2.24	

F.N., Fortnight

H_1, Harvesting at 50% flowering; H_2, harvesting at maturity

other hand, fibre strength was greater (28.38 g/tex) with early planting (first fortnight of July) and it decreased gradually when the planting was delayed up to second fortnight of August (19.19 g/tex). Greater fibre strength of the early-planted crop may be attributed that, the crop planted early during first fortnight of July takes more number of days for its growth and development compared to late-planted crop. Lower strength and increased fibre fineness of the delayed-planted crop (second fortnight of August) may also be attributed to reduced growth resources, viz. light, temperature and moisture for the growth of crop.

Stage of harvesting

Fibre yield did not vary significantly due to the stage of harvesting (Table 1). The results corroborate the findings of Pathak *et al.* (1989). Fibre yield is the manifestation of yield-contributing characters, viz. green stalk and dry stalk yield/ha. In the present study, both the parameters did not differ significantly due to harvesting of crop either at 50% flowering or at maturity (Table 1). While the green matter yield was significantly surperior when the crop was harvested at 50% flowering (13.61 Mg/ha) compared to that of maturity (12.23 mg/ha). Similar results were reported by Naidu *et al.* (1996). Higher green matter yield at 50% flowering did not bring significant improvement in fibre yield/ha. It might be attributed to greater amount of foliage and moisture content (58.59%) in the plant material compared to the crop harvested at maturity (58.05%) and this resulted in greater loss in weight after stripping (removal of foliage) and drying when it was harvested at 50% flowering. Fibre yield is also related to fibre recovery and fibre weight/plant and these characters were not significantly influenced by stage of harvesting (Table 1). This might be the reason for non-significant differences in fibre yield/ha observed between the 2 stages of harvesting.

Fibre quality with respect to fineness was greatly influenced by the stage of harvgesting. Crop harvested at maturity recorded significantly superior fine fibres (3.14 tex) compared to 50% flowering (3.50 tex). However, fibre strength was similar at both stages of harvesting indicating that, crop can be harvested even at 50% flowering for best quality fibre.

Plant population

Fibre yield increased significantly with an increase in plant population from 0.22 to 0.33 million/ha (484 to 559 kg/ha) and with further increase in plant population to 0.66 million/ha, no significant improvement was observed (604 kg/ha). Medium and higher plant populations recorded 15.5. and 24.8% higher fibre yield compared to that of lower plant population. The results corroborate the findings of Huang *et al.* (1994).

Fibre yield is mainly related to the production of green matter and dry stalk yields/ha at harvest. Green matter yield was significantly higher with higher plant population (14.06 Mg/ha) compared to medium plant population (12.93 Mg/ha) which in turn was superior to lower plant population (11.78 Mg/ha). However, dry stalk yield increased significantly with increase in plant population from 0.22 to 0.33 million/ha (3.50 to 3.78 Mg/ha) and with further increase in plant population to 0.66 million/ha, no significant increase (3.96 Mg/ha) was noticed. In the present study, fibre yield was in similar trend as that of dry stalk yield. Though green matter yield increased significantly with increase in plant population from 0.33 to 0.66 million/ha, it did not bring significant improvement in fibre yield. This might be due to greater weight loss during the process of drying and due to shedding of higher amount of leafy material from the total biomass. The results are in conformity with the findings of Bhangoo *et al.* (1986).

Table 3. Plant height, stem diameter and dry stalk yield of mesta as influenced by the interactive effect of date of sowing, stage of harvest and plant population (mean data of 1998 and 1999)

Treatment	Date of sowing											
	Plant height (cm)				Stem diameter (cm)				Dry stalk yield (Mg/ha)			
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
Stage of harvest												
50% flowering	180.3	164.14	131.7	81.4	0.72	0.69	0.61	0.38	6.24	4.38	3.40	1.15
Maturity	193.8	170.1	137.8	86.6	0.82	0.73	0.64	0.48	5.96	4.19	3.21	1.69
CD (P=00.5)		NS				0.04				0.45		
Plant population												
0.22 million/ha	20.2.0	176.8	144.6	82.2	0.84	0.77	0.71	0.46	5.69	4.08	3.02	1.21
0.33 million/ha	185.4	167.4	134.5	87.4	0.76	0.73	0.63	0.44	6.29	4.47	2.99	1.36
0.66 million/ha	173.7	157.3	125.3	82.4	071	0.64	0.55	0.40	5.94	4.32	3.90	1.71
CD (P=0.05)		9.5				NS				0.56		

D_1, I fortnight of July; D_2, II fortnight of July; D_3, I fortnight of August, D_4, II fortnight of August

Fibre weight/plant decreased significantly with successive increase in plant population from 0.22 to 0.66 million/ha (2.71 to 1.63 g/plant). Higher fibre weight/ plant at lower plant population (0.22 million/ha) did not compenstate the loss in plant population, resulting in lower fibre yield/ha compared to higher plant population (0.33 and 0.66 million/ha). At higher plant population, the loss in fibre weight/ plant might have been compensated by increased number of plants per unit area, resulting in significantly higher fibre yield/ha.

Fibre recovery differed significantly due to variation in plant population. Significantly higher fibre recovery of 4.28 and 15.90% on green- and dry-weight basis, respectively, was noticed at lower plant population (0.22 million/ha) compared to higher plant population (0.66 million/ha), but was on a par with medium plant population. Higher fibre recovery at lower plant populations (0.22 and 0.33 million/ha) could be attributed to greater plant height and stem diameter (Table 1) which might have facilitated easy fibre extraction without any loss of fibre.

Interaction effects

Time of sowing and stage of harvest : Significantly higher dry stalk yield (6.24 Mg/ha) was obtained with early planting (first fortnight of July) and when the crop was harvested at 50% flowering over other treatments but was on par with the crop harvested at maturity (5.96 Mg/ha). Higher dry stalk yield with early planting could be attributed to greater plant height and stem diameter of the crop (Table 3) due to longer period of growth and better availability of growth resources.

Fibre quality with respect to fineness at both the stages of harvesting increased significantly with delay in planting from first fortnight of July to second fortnight of August. Fibre was more coarser with early planting (first fortnight of July) and the coarseness decreased with delay in planting time. While fibre strength was greater with early planting and it decreased significantly with successive delay in planting at both the stages of harvesting (Table 2). Lower fibre strength and increased fibre fineness due to delayed planting at both the stages is attributed to greater number

Table 4. Fibre weight and fibre recovery of mesta as influenced by the interactive effect of date of sowing, stage of harvest and plant population (mean data of 1998 and 1999)

Treatment	Date of sowing							
	Fibre weight (g/plant)				Fibre recovery on green weight basis (%)			
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
Plant population								
0.22 million/ha	4.73	3.32	2.10	0.69	5.17	4.56	3.89	3.50
0.33 million/ha	3.47	2.39	1.77	0.67	53.09	4.36	3.97	3.02
0.66 million/ha	2.98	1.79	1.24	0.52	4.64	4.24	3.76	2.89
CD (P=0.05)		0.53				NS		
Stage of harvest								
50% flowering	3.84	2.45	1.66	0.60	4.80	4.21	3.84	3.26
Maturity	3.61	255	1.75	0.66	5.15	4.56	3.90	3.01
CD (P=00.5)		NS				0.36		

D_1, I fortnight of July; D_2, II fortnight of July; D_3, I fortnight of August, D_4, II fortnight of August

of immature fibre due to reduced duration of the crop and decreased growth resources.

Time of sowing and plant population: Fibre weight/plant was significantly higher when the crop was planted early (first fortnight of July) at lower plant population of 0.22 million/ha (4.73 g/plant) compared to other treatments (Table 4). The crop sown during second fortnight of August and at higher plant population of 0.66 million/ha produced significantly lower fibre weight (0.52 g/plant). Higher fibre weight/plant with early planting at lower plant population is attributed to greater plant height, stem diameter and fibre recovery due to longer duration of the crop and reduced competition between the plants for growth resources (Tables 3, 4).

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