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Full Length Research Paper

Dry matter accumulation studies at different stages of crop growth in mesta (*Hibiscus cannabinus*)

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In crop like mesta, stem is the main source of fibre and therefore, fibre yield depends greatly on fresh biomass yield as well as on dry stalk yields of a particular variety at the time of harvesting. At 30 DAS (days after sowing), dry matter accumulation in stem varied significantly with respect to different plant spacing, varieties and nutrient sources. Between the varieties, variety HS-108 had recorded significantly higher dry matter accumulation in stem (0.46 g/plant) than variety AMV-4 (0.29 g/plant). Significantly higher dry matter accumulation in stem was achieved under 45 cm × 10 cm spacing (0.42 g/plant) than 30 cm × 10 cm (0.34 g/plant). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer induced higher dry matter accumulation in stem (0.44 g/plant) compared to 100% N equivalent through FYM (0.32 g/plant). The interaction effects between varieties, plant spacing and nutrient sources were found to be significant. Significantly higher dry matter accumulation in stem (0.71 g/plant) was obtained with variety HS-108 planted at 45 cm × 10 cm compared to variety AMV-4 planted at 30 cm × 10 cm (0.36 g/plant). Significantly highest dry matter accumulation in stem (0.75 g/plant) was observed in the variety HS-108 supplied with 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer than 100% N equivalent through FYM alone in the variety AMV-4 (0.31 g/plant). Application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered higher dry matter accumulation in stem (0.69 g/plant) compared to 100% N equivalent through FYM (0.37 g/plant).

Key words: Mesta, uptake, nutrient, fibre, biomass, India.

INTRODUCTION

Mesta (*Hibiscus sabdariffa)* is being successfully grown as a commercial crop in many tropical and subtropical countries of the world including India. FAO (2007) estimates shows that the total annual production of jute and jute like fibres including mesta is 3.68 million tonnes with developing countries accounting for production that is six times more than developed countries. World production of *H. sabdariffa var. altissima* far exceeds its other related species (Krishna Murthy et.al.,1992). In India, both *H. sabdariffa var. altissima* and *H. cannabinus* are grown. However, *H. sabdariffa var. altissima* accounts for more than 75% of the area under mesta in India (Krishna Murthy et al., 1992). The importance of varieties with high yield potential combined with its wider adoptability for boosting up production of mesta fibre need hardly be emphasized. A variety found superior in a particular locality may not exhibit similar performance under certain other environmental conditions. It is therefore, essential to evaluate the varieties in different agro-climatic conditions of a region to assess their performance and selecting the best one's to exploit their yield potentiality through various agro-techniques.

MATERIALS AND METHODS

The experiments were conducted in 19E block at field unit Gandi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences, Bangalore which is located at latitude of 12°58' north, longitude of

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77°3' east and at an altitude of 930 m above mean sea level in Eastern dry zone (zone 5) of Karnataka, India. The soil of the experimental site was Red Sandy Loam. The soil was near neutral in pH (5.8) with low organic carbon content. The soil was also found to be medium in available nitrogen (273.18 kg/ha), available phosphorus (39.00kg/ha), and available potassium content (231.80 kg/ha).

The experiment conducted in 2007 and 2008 comprised 16 treatment combinations consisting of two varieties AMV-4 and HS-108, two spacing trails 30 × 10 cm and 45 × 10 cm and four nutrient treatments, that is, 40:20:20 kg NPK/ha, 40:20:20 kg NPK/ha + 5 t/ha FYM, 30:20:20 kg NPK/ha + 7.5 t/ha FYM and 100% N equivalent through FYM. The experiment was laid out in Split-Split plot design.

Five plants were uprooted at random from the adjacent net plot rows excluding border rows at 30, 60, 90, 120 DAS and at harvest (135-140DAS). The root portion of the plant was discarded. The above ground portion of the plant samples were separated into leaves, stem and reproductive parts. The separated plant parts were air dried and kept it in hot air oven at 65°C to get a constant weight. After thorough drying, the weight was recorded for all the parts separately and expressed in grams. The mean of five plants was taken as the dry matter produced per plant. The mean dry weight of all the plant parts was added and taken as total dry matter accumulation per plant.

RESULTS

Dry matter accumulation in stem

Averages values on dry matter accumulation in stem of mesta varieties as influenced by the plant spacing and nutrient sources at different stages of crop growth are presented in Table 1. At 30 DAS, dry matter accumulation in stem varied significantly with respect to different plant spacing, varieties and nutrient sources. Between the varieties, variety HS-108 achieved significantly higher dry matter accumulation in stem (0.46 g/plant) than variety AMV-4 (0.29 g/plant).

Significantly higher dry matter accumulation in stem was recorded under 45 cm × 10 cm spacing (0.42 g/plant) than 30 cm × 10 cm (0.34 g/plant). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer recorded higher dry matter accumulation in stem (0.44 g/plant) compared to 100% N equivalent through FYM (0.32 g/plant).

The interaction effects between varieties, plant spacing and nutrient sources were found to be significant but the interaction effects between varieties, plant spacing and nutrient sources were found to be significant.

Dry matter accumulation in leaves

Pooled data on dry matter accumulation in leaves of mesta varieties as influenced by the plant spacing and nutrient sources at different stages of crop growth are presented in Table 2. At 30 DAS, dry matter accumulation in leaves varied significantly with respect to different plant spacing, varieties and nutrient sources. Between the varieties, variety AMV-4 recorded significantly higher dry matter accumulation in leaves (0.18 g/plant) than variety HS-108 (0.12 g/plant). Significantly higher dry matter accumulation in leaves was recorded under 45 cm × 10 cm spacing (0.15 g/plant) than 30 cm × 10 cm (0.14 g/plant). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha of fertilizer induced higher dry matter accumulation in leaves (0.20 g/plant) compared to 100% N equivalent through FYM (0.09 g/plant).

Among the interactions, dry matter accumulation in leaves was found to be significant between varieties and plant spacing as well as varieties with nutrient.

Total dry matter accumulation

Average data on total dry matter accumulation of mesta varieties as influenced by the plant spacing and nutrient sources at different stages of crop growth are presented in Table 3. Total dry matter accumulation differed significantly due to different plant spacing, varieties and nutrient sources at all the stages of crop growth. At 30 DAS, significantly largest total dry matter accumulation was noticed in variety HS-108 (0.58 g/plant) than, variety AMV-4 (0.47 g/plant). Significantly higher total dry matter accumulation was recorded under 45 cm × 10 cm spacing (0.58 g/plant) than 30 cm × 10 cm (0.47 g/plant). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer recorded higher total dry matter accumulation (0.62 g/plant) compared to 100% N equivalent through FYM (0.41 g/plant).

The interaction effects between varieties, plant spacing and nutrient sources were found to be significant.

DISCUSSION

Dry matter accumulation in stem

In mesta, stem is the main source of fibre and therefore, fibre yield depends greatly on fresh biomass yield as well as dry stalk yields of a particular variety at the time of harvesting. Dry stalk yield is the ultimate factor which decides the final fibre yield. While in fresh biomass yield, stalk portion constitutes nearly 70% and remaining 30% is constituted by leaf, petiole and reproductive parts (Krishna Murthy et.al.,1992). Bhattacharjee et al. (1987) observed higher fibre yield in variety which was superior in total green biomass. Results of the present investigations are in conformity with the findings of Naidu et al. (1996b). In the present study also, HS-108 belonging to 'roselle' showed superiority over AMV- 4 in biomass production. Higher biomass production with 'roselle' could be due to its superior genetic potential (Naidu et al., 1996a). Similar results were also reported by Lakshminarayana et al. (1980).

Varietal differences in total fresh biomass and dry stalk

Table 1. Dry matter accumulation in stem (g) of mesta varieties as influenced by plant spacing and nutrient sources at different stages of crop growth.

Treatments	30 DAS			60 DAS			90 DAS			120 DAS			At Harvest		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Variety (V)															
AMV-4 (V_1)	0.28	0.29	0.29	0.63	0.66	0.65	10.07	10.36	10.21	14.69	15.18	14.94	16.53	17.12	16.83
HS-108 (V_2)	0.45	0.47	0.46	0.97	0.99	0.98	14.26	14.65	14.46	18.67	18.86	18.76	19.47	19.64	19.56
S.Em ±	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.04	0.04	0.03	0.01	0.02	0.21	0.01	0.12
C.D. (0.05)	0.03	0.03	0.03	0.02	0.06	0.04	0.12	0.10	0.11	0.09	0.03	0.06	0.48	0.03	0.28
Plant spacing (S)															
30 cm × 10 cm (S_1)	0.33	0.35	0.34	0.74	0.76	0.75	11.27	11.45	11.36	16.22	16.33	16.28	17.29	17.59	17.44
45 cm × 10 cm (S_2)	0.40	0.43	0.42	0.85	0.90	0.88	13.06	13.56	13.31	17.15	17.72	17.42	18.72	19.17	18.95
S.Em ±	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.02	0.02	0.02	0.22	0.02	0.12
C.D. (0.05)	0.02	0.05	0.04	0.06	0.09	0.08	0.12	0.13	0.10	0.06	0.04	0.06	0.56	0.06	0.32
Nutrient source (N)															
40:20:20 kg/ha (N_1)	0.40	0.39	0.40	0.84	0.86	0.85	12.54	12.87	12.71	17.19	17.21	17.20	18.69	18.45	18.57
40:20:20 kg/ha + 5 t FYM/ha (N_2)	0.43	0.45	0.44	0.88	0.90	0.89	13.09	13.19	13.14	17.59	17.76	17.68	18.42	19.11	18.76
30:20:20 kg/ha + 7.5 t FYM/ha (N_3)	0.35	0.37	0.36	0.79	0.81	0.80	12.13	12.44	12.29	16.67	16.76	16.72	17.97	18.19	18.08
100% N equivalent through FYM (N_4)	0.29	0.34	0.32	0.68	0.76	0.72	10.90	11.51	11.21	15.28	16.37	15.82	16.95	17.77	17.36
S.Em ±	0.02	0.02	0.02	0.02	0.01	0.01	0.06	0.07	0.07	0.03	0.02	0.03	0.29	0.01	0.15
C.D.(0.05)	0.05	0.06	0.06	0.04	0.03	0.03	0.18	0.20	0.21	0.09	0.06	0.09	0.64	0.03	0.40
Interactions															
V×S															
S.Em ±	0.02	0.01	0.02	0.01	0.01	0.01	0.12	0.13	0.14	0.04	0.03	0.04	0.60	0.05	0.32
C.D.(0.05)	0.04	0.03	0.04	NS	NS	0.09	0.33	0.35	0.38	0.12	0.09	0.11	NS	0.13	0.84
V×N															
S.Em ±	0.02	0.02	0.03	0.02	0.03	0.02	0.17	0.19	0.18	0.06	0.05	0.04	0.83	0.04	0.42
C.D.(0.05)	NS	NS	0.06	0.05	0.09	0.06	0.38	0.40	0.36	0.18	0.15	0.14	NS	0.12	NS
S×N															
S.Em ±	0.02	0.03	0.03	0.03	0.04	0.04	0.16	0.18	0.18	0.08	0.05	0.06	0.84	0.05	0.42
C.D.(0.05)	0.04	NS	0.09	0.06	NS	0.10	0.34	0.39	0.42	0.21	0.13	0.16	1.78	0.12	0.99
V×S×N															
S.Em ±	0.01	0.02	0.02	0.01	0.02	0.02	0.08	0.09	0.09	0.04	0.03	0.03	0.41	0.01	0.23
C.D.(0.05)	0.03	NS	NS	0.03	NS	NS	0.23	0.26	0.28	0.12	0.09	0.09	NS	0.03	NS

DAS, Days after sowing; FYM, farm yard manure; NS, non-significant.

Table 2. Dry matter accumulation in leaves (g) of mesta varieties as influenced by plant spacings and nutrient source at different stages of crop growth.

Treatments	30 DAS			60 DAS			90 DAS			120 DAS			At Harvest		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Variety (V)															
AMV-4 (V_1)	0.17	0.19	0.18	1.14	1.28	1.21	2.26	2.34	2.30	3.70	3.74	3.77	0.10	0.14	0.12
HS-108 (V_2)	0.10	0.13	0.12	0.84	0.85	0.85	1.72	1.78	1.75	2.87	2.84	2.80	0.04	0.06	0.05
S.Em ±	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.05	0.03	0.08	0.03	0.06	0.01	0.01	0.01
C.D. (0.05)	0.03	0.02	0.03	0.06	0.03	0.05	0.03	0.12	0.09	0.20	0.09	0.14	0.03	0.03	0.03
Plant spacing (S)															
30 cm x 10 cm (S_1)	0.13	0.15	0.14	0.90	0.95	0.93	1.95	2.07	2.01	3.27	3.25	3.22	0.06	0.09	0.08
45 cm x 10 cm (S_2)	0.14	0.17	0.15	1.08	1.18	1.13	2.02	2.05	2.04	3.29	3.32	3.35	0.08	0.11	0.10
S.Em ±	0.02	0.01	0.02	0.03	0.02	0.03	0.02	0.05	0.04	0.08	0.04	0.06	0.02	0.01	0.02
C.D. (0.05)	0.04	0.03	0.04	0.09	0.06	0.09	0.06	NS	0.10	NS	0.12	0.14	0.05	0.03	0.04
Nutrient source (N)															
40:20:20 kg/ha (N_1)	0.15	0.17	0.16	1.08	1.19	1.14	2.08	2.16	2.12	3.34	3.37	3.39	0.07	0.12	0.09
40:20:20 kg/ha + 5 t FYM/ha (N_2)	0.17	0.22	0.20	1.20	1.26	1.23	2.19	2.34	2.27	3.52	3.51	3.52	0.11	0.14	0.12
30:20:20 kg/ha + 7.5 t FYM/ha (N_3)	0.14	0.15	0.15	0.98	1.03	1.01	2.02	2.04	2.03	3.41	3.38	3.40	0.07	0.09	0.08
100 per cent N equivalent through FYM (N_4)	0.08	0.10	0.09	0.70	0.78	0.74	1.66	1.71	1.69	2.85	2.88	2.91	0.04	0.05	0.05
S.Em ±	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.06	0.04	0.07	0.03	0.05	0.02	0.01	0.02
C.D.(0.05)	0.03	0.03	0.03	0.02	0.06	0.06	0.02	0.14	0.08	0.14	0.09	0.15	0.04	0.03	0.06
Interactions															
V×S															
S.Em ±	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.13	0.06	0.23	0.03	0.12	0.02	0.02	0.02
C.D.(0.05)	NS	NS	NS	0.05	0.05	0.05	0.02	NS	NS	NS	0.09	0.08	0.05	0.04	0.04
V×N															
S.Em ±	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.18	0.12	0.24	0.05	0.15	0.03	0.02	0.03
C.D.(0.05)	NS	NS	NS	0.06	0.05	0.06	0.05	0.40	0.23	NS	0.14	0.14	0.06	0.06	0.08
S×N															
S.Em ±	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.18	0.10	0.23	0.04	0.13	0.02	0.02	0.03
C.D.(0.05)	NS	NS	NS	0.05	0.06	0.06	0.04	NS	0.05	NS	0.12	0.10	NS	NS	NS
V×S×N															
S.Em ±	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.09	0.06	0.10	0.02	0.06	0.01	0.01	0.01
C.D.(0.05)	NS	NS	NS	0.03	0.06	0.04	0.03	NS	NS	NS	NS	NS	NS	NS	NS

DAS, Days after sowing; FYM, farm yard manure; NS, non-significant.

Table 3. Total dry matter accumulation (g) of mesta varieties as influenced by plant spacings and nutrient source at different stages of crop growth.

Treatments	30 DAS			60 DAS			90 DAS			120 DAS			At Harvest		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Variety (V)															
AMV-4 (V_1)	0.45	0.48	0.47	1.77	1.94	1.86	12.33	12.70	12.51	19.48	20.04	19.77	22.79	23.47	23.14
HS-108 (V_2)	0.55	0.60	0.58	1.81	1.84	1.83	15.98	16.43	16.21	22.10	22.82	22.46	24.88	25.12	25.01
S.Em ±	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.02
C.D. (0.05)	0.02	0.03	0.03	0.03	0.05	0.02	0.04	0.03	0.04	0.05	0.08	0.08	0.04	0.05	0.05
Plant spacing (S)															
30 cm × 10 cm (S_1)	0.46	0.47	0.47	1.65	1.71	1.68	13.18	13.46	13.33	20.24	20.46	20.35	23.09	23.47	23.28
45 cm × 10 cm (S_2)	0.54	0.65	0.58	1.93	2.08	2.00	15.18	15.58	15.38	21.22	22.45	21.84	24.38	25.12	24.75
S.Em ±	0.01	0.04	0.03	0.01	0.05	0.03	0.01	0.03	0.02	0.01	0.05	0.03	0.01	0.02	0.01
C.D. (0.05)	0.03	0.12	0.07	0.03	0.14	0.09	0.02	0.07	0.06	0.02	0.15	0.09	0.03	0.05	0.03
Nutrient source (N)															
40:20:20 kg/ha (N_1)	0.54	0.57	0.55	1.91	2.05	1.98	14.62	15.02	14.82	21.32	21.80	21.58	24.14	24.45	24.30
40:20:20 kg/ha + 5 t FYM/ha (N_2)	0.58	0.65	0.62	2.08	2.16	2.12	15.28	15.47	15.38	21.91	22.41	22.20	24.43	25.25	24.84
30:20:20 kg/ha + 7.5 t FYM/ha (N_3)	0.50	0.52	0.51	1.76	1.83	1.80	14.26	14.41	14.33	20.83	19.09	19.96	23.82	24.13	23.98
100 per cent N equivalent through FYM (N_4)	0.37	0.43	0.41	1.38	1.54	1.46	12.56	13.18	12.87	18.86	17.80	18.33	22.55	23.34	22.95
S.Em ±	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.03	0.02	0.02	0.10	0.06	0.01	0.02	0.02
C.D.(0.05)	0.03	0.04	0.04	0.03	0.04	0.04	0.03	0.06	0.05	0.04	0.28	0.19	0.03	0.04	0.04
Interactions															
VxS															
S.Em ±	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.05	0.04	0.03	0.11	0.07	0.02	0.03	0.03
C.D.(0.05)	0.06	0.03	0.04	0.05	0.03	0.04	0.04	0.15	0.10	0.07	0.30	0.18	0.06	0.10	0.08
V×N															
S.Em ±	0.03	0.04	0.04	0.02	0.03	0.03	0.03	0.08	0.05	0.05	0.24	0.15	0.03	0.06	0.05
C.D.(0.05)	0.08	NS	0.08	0.06	0.06	0.06	0.06	0.16	0.10	0.10	0.50	0.30	0.6	0.13	0.10
S×N															
S.Em ±	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.09	0.06	0.04	0.26	0.15	0.03	0.06	0.05
C.D.(0.05)	NS	NS	0.06	0.06	0.07	0.07	0.06	0.19	0.13	0.09	0.55	0.32	0.07	0.13	0.10
V×S×N															
S.Em ±	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.04	0.03	0.02	0.14	0.08	0.02	0.03	0.03
C.D.(0.05)	NS	NS	NS	0.03	0.06	0.05	0.06	0.12	0.09	0.06	NS	NS	0.06	0.09	0.08

DAS, Days after sowing; FYM, Farm yard manure; NS, Non-significant.

production might be attributed to their variability in total dry matter production and its accumulation in different plant parts and stem in particular. During the initial period (at 60 DAS), total dry matter production (pooled) was significantly superior with AMV- 4 compared to HS-108 but in later stages (90 DAS, 120 DAS and harvest stage) total dry matter production (pooled) of variety HS-108 was significantly superior to AMV-4. Dry matter accumulation in stem of variety HS-108 was significantly superior over AMV- 4 at all the growth stages (pooled) (Table 1). Higher dry matter accumulation in stem of HS-108 variety had favourable influence on production of significantly higher fresh biomass as well as dry stalk yields which in turn resulted in significantly higher fibre yield per hectare.

Dry matter accumulation in leaves

Total dry matter production and its greater partitioning into stem depends upon photosynthetic capacity of the plant during its vegetative period (up to 130 to 140 DAS) and translocation of photosynthates from source (leaf and petiole) to ultimate sink (stem). Photosynthetic ability of a plant at any stage depends upon dry weight of leaf, leaf area index and photosynthetic efficiency of leaves (Donald, 1963). Dry weight of leaves in variety AMV- 4 was significantly higher than variety HS-108 at all the growth stages. At harvest, AMV- 4 variety recorded significantly higher dry weight of leaf per plant (Table 2). Variety AMV- 4 showed lower translocation of photosynthates from leaf to stem resulting in poor dry matter accumulation in stem.

Higher dry matter accumulation in leaf of variety AMV-4 could be attributed to production of more number of leaves per plant at all the stages of crop growth. Leaf area, leaf area index and leaf area duration also followed similar trend at all the growth stages (Pushpa, 2009).

Total dry matter production

Higher total dry matter production and its partitioning into stem may be attributed to higher rate of dry matter production and crop growth rate. From 60 to 90 DAS, rate of dry matter production in variety HS-108 was 0.48 g per plant per day as against 0.36 g per plant per day in AMV-4 variety. Similarly, crop growth rate (pooled) in AMV- 4 variety during the same period was 1.60 g per m^2 per day when compared to 1.18 g per m^2 per day of HS-108 variety. In both the varieties, the rate of dry matter production and growth rate declined towards maturity (120 to 160 DAS) as compared to 60 to 120 DAS. But the decline was more in AMV- 4 variety when compared to HS-108 variety which indicates that dry matter accumulation and its diversion to different plant parts in AMV- 4 variety takes place for a shorter period when compared to HS-108 resulting in lower dry matter accumulation in stem. Higher dry matter accumulation in reproductive parts, depends on photosynthetic capacity of the plant during capsule developing period (after flowering to maturity) and translocation of assimilates from other plant parts to developing capsules (Krishna Murthy et al.,1992)

Photosynthetic ability of a plant in turn depends on photosynthetic efficiency of leaves. In the present study, dry weight of leaves during the capsule development period (120 DAS to harvest) was significantly higher with AMV-4 (3.77 g/plant and 0.12 g/plant, respectively) compared to HS-108 variety (2.80 and 0.05 g/plant, respectively). Leaf area, leaf area index and leaf area duration also followed similar trend, this might have resulted in increased rate of dry matter production and accumulation in reproductive parts compared to HS-108 variety. In variety HS-108, lower rate of dry matter production and crop growth rate was observed during the capsule formation period (100 to 120 DAS). This might be due to infestation of crop by top shoot borer which had restricted the growth of plants preventing formation of capsules and further dry matter accumulation. Premature shedding and drying of capsules was also noticed. This might have reduced the number of capsules and dry matter accumulation in capsules as a consequence; lower number of seeds per capsules was observed which in turn resulted in lower seed yield per hectare.

Effect of plant spacing

Plant spacing adjustment is an important agronomic manipulation for attaining higher yields. Maintenance of optimum plant population helps to utilize available moisture, nutrients, solar radiation efficiently and enable the crop to produce higher yields.

Dry matter accumulation in leaves and reproductive parts also decreased significantly with increase in plant population from 0.25 million per ha to 0.38 million per ha. Higher dry matter accumulation in leaf at 45 cm × 10 cm plant spacing might have helped in increased total dry matter production per plant and its greater accumulation in stem due to increased photosynthesis and greater translocation of assimilates from source to sink on account of higher leaf area per plant and greater availability of growth resources, have been reported by Bhangoo et al. (1986), Krishnamurthy et al. (1992), Sarma and Bordoloi (1995) and Guggari (2002).

Total fresh biomass production per hectare increased from 16.26 to 17.99 t per ha with increase in inter row spacing from 30 to 45 cm and it may depends upon photosynthetic activity of a crop. There was a significant difference in total fresh biomass production between 30 and 45 cm row spacing (16.26 and 17.99 t/ha, respectively). This may be attributed to significant difference in leaf area per plant and crop growth rate between the plant populations at different plant spacing.

Higher total dry mater production per plant and its distribution in stem, leaf, and reproductive parts under 45 ×10 cm plant spacing might be attributed to higher rate of dry matter production, relative growth rate, crop growth rate and net assimilation rate and they decreased with increase in plant population. This might be due to mutual shading of leaves and increased respiratory losses, resulting in decreased net photosynthesis per unit leaf area as the inter row spacing decreased.

Effect of nutrient sources

The production efficiency of a crop though depends on its genetic potential, its yield could be improved to a perceptible magnitude through proper nutrient management, and further the nutrient requirement of a crop varies with the variety. Therefore, study was conducted to find out the optimum requirement of the nutrients for higher yields.

Total dry matter production per plant and its greater accumulation in stem is vital for higher fibre yield. At harvest, significantly higher average dry matter accumulation (pooled) was observed with the application of 5 t FYM per ha along with 40:20:20 kg NPK per ha (24.43 g/plant) when compared to application of 40:20:20 kg NPK per ha alone (24.30 g/plant), application of 7.5 t FYM along with 30:20:20 kg NPK per ha (23.98 g/plant) and application of 100% N equivalent through FYM alone (22.95 g/plant). Similar trend was observed in respect of dry matter accumulation in stem (Table 3). This increased total dry matter production per plant and its accumulation in stem at higher levels of nitrogen was attributed to increased plant height coupled with higher stem diameter (Krishnamurthy et al., 1992).

Dry matter accumulation in leaves and reproductive parts increased significantly with the combined application of both organic and inorganic sources at all the growth stages (pooled). Dry matter accumulation in leaves per plant was maximum at 120 DAS and there after it declined drastically towards maturity. At 120 DAS (pooled), application of 5 t FYM per ha along with 40:20:20 kg NPK per ha accumulated significantly higher dry matter in leaves (3.52 g/plant) compared to application of 100% N equivalent through FYM alone (2.91 g/plant). At 30, 60, 90 DAS and at harvest a similar trend was noticed. Dry matter accumulation in reproductive parts also followed similar trend. This increased dry matter accumulation in leaves and reproductive parts with combined application of N might be the reason for higher total dry matter production per plant and its accumulation in stem. Higher dry matter accumulation in leaf at combined application of N may be due to higher number of leaves and increased leaf area per plant.

Higher total dry matter production per plant and its distribution in different plant parts with increasing rate of nitrogen with the combined application of both organic and inorganic source of N might be due to higher leaf area, leaf area index, leaf area duration, rate of dry matter production, crop growth rate and net assimilation rate at all the growth stages. Krishanmurthy et al. (1992) opined that increased biomass / dry matter yield due to increased N application was attributed to higher leaf area index. Higher biomass production with the application of 5 t FYM per ha along with 40:20:20 kg NPK per ha may be attributed to increased crop growth rate at all the growth stages.

REFERENCES

Bhangoo MS, Tehrani HS, Henderson J (1986). Effect of planting date, nitrogen levels, row spacing and plant population on Kenaf performance in the San Joaquin Valley, California. Agron. J. 78:600-604.

Bhattacharjee AK, Mukerjee N, Datta AN, Goswami KK (1987). Suitability of rainfedkenaf*(Hibiscus cannabinus* L.) as the source of raw materials for newsprints. Jute Dev. J. 2:27-29.

Donald CM (1963). Competition among crop and pasture plants. Adv. Agron., 10: 435-473.

FAO (2007). Statistics:9-10

Guggari AK (2002) Studies on production technologies for mesta in medium black soils of northern dry zone of Karnataka. Ph.D. Thesis, University of Agricultural Sciences, Dharwad.

Krishna murthy N, Hunsagi G, Singlachar MA, Rudraradhya M (1992). Influence of plant density and nitrogen levels on mesta: Growth components, dry matter and biomass yields. Mysore J. Agric. Sci. 26:239-243.

Lakshminarayana A, Murthy R K, Rao MR, Rao PA (1980). Efficiency of nitrogen utilization by roselle and kenaf. Indian J. Agric. Sci. 50(3):224-248.

Naidu MV, Prasad PR, Lakshmi MB (1996a). Influence of species, fertility level and stage of harvest on biomass production and pulp yield in mesta (Hibiscus sp.). J. Res. Angrau 24(3):1-4, 1996.

Naidu MV, Reddy AT, Prasad PR, Lakshmi MB (1996b). Response of mesta*(Hibiscus sabdariffa* L.) to NPK under rainfed conditions. J. Research, Angrau 24(2):79-81.

Pushpa K (2009), Studies on production potentials of mesta varieties as influenced by spacing, nutrient sources and intercropping systems in alfisols, Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

Sarma TC, Bordoloi DN (1995) Yield of pulpable biomass of Kenaf*(Hibiscus cannabinus)* varieties under various row spacing and nitrogen. Indian J. Agron. 40 (4):722-724.