Journal of Agricultural Science; Vol. 5, No. 3; 2013
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Growth and Yield Parameters of Mesta Varieties as Influenced by Spacing and Nutrient Sources

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Received: December 5, 2012 Accepted: January 8, 2013 Online Published: February 5, 2013

doi:10.5539/jas.v5n3p105 URL: http://dx.doi.org/10.5539/jas.v5n3p105

Abstract

Field experiment was conducted at GKVK, University of Agricultural Sciences, Bangalore, Karnataka to study the growth and yield parameters of mesta as influenced by varieties, spacing and nutrient sources.The plant height at harvest stage varied significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, HS-108 recorded significantly higher plant height (275.5 cm) and total dry matter (25.01 g) than AMV-4. The seed yield differed significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, AMV-4 recorded significantly higher seed yield (754.5 kg ha^{-1}) than HS-108 (581.5 kg ha^{-1}). Significantly higher seed yield was recorded under 45 cm x 10 cm spacing (687 kg ha^{-1}) than 30 cm x 10 cm (649.5 kg ha^{-1}). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered higher seed yield (698.0 kg ha^{-1}) compared to 100 per cent N equivalent through FYM (625.5 kg ha^{-1}). The fibre yield differed significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, HS-108 recorded significantly higherfibre yield (948 kg ha^{-1}) than AMV-4 (850 kg ha^{-1}). Significantly higher fibre yield was recorded under 45 cm x 10 cm spacing (923 kg ha^{-1}) than 30 cm x 10 cm (875 kg ha^{-1}). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered higher fibre yield (962 kg ha^{-1}) compared to 100 per cent N equivalent through FYM (803 kg ha^{-1}). The interaction effects between varieties, plant spacing and nutrient sources were found to be significant.

Keywords: mesta, variety, nutrient, fibre, spacing

1. Introduction

Mesta is one of the important crops which provides fibre, forage and paper pulp and has broadened our agricultural diversity to reduce pressure on forest resources. It is one of the important bastfibre crops which stand next to jute in production. It is the nearest ally of jute and plays an effective role in supplementing the short supply of jute industry. In recent years, this crop is gaining the attention of research workers since it is also used as a raw material in the paper industry substituting bamboo and eucalyptus whose supply is becoming scarce day by day. Mesta fibre is used as an alternative to jute fibre or for blending with jute in the manufacture of jute goods *viz.*, cordage, sackings, hessains, canvas and rough sack cloths. It is also used for making ropes, twines, fishing nets etc. The stalks are used in making paper pulp, structural boards, blends with wood pulp and for thatching huts. In recent years, it has been proved that the crop could be allowed to grow upto seed setting stage and the sticks after seed collection can be utilized for pulp production to manufacture all types of paper including newsprints. Its seed contains 18 to 20 per cent oil, which can be directly used in soaps and other industries. The crop possesses fleshy red calyces, which are used for preparing natural dyes, jam, jellies, pickles etc. and the leaves for preparing pickles and also as leafy vegetable. It also acts as a natural fibre substitute for fibre glass. It serves as raw material for automobile dash boards, carpet padding and is also used in moulded plastics.

2. Materials and Methods

The experiments was conducted in 19E block at field unit GKVK, University of Agricultural Sciences, Bangalore which is located at a latitude of 12°58′ north, longitude of 77°3′ east and at an altitude of 930 m above mean sea level in Eastern dry zone (zone 5) of Karnataka.The soil of the experimental site was Red Sandy Loam. The soil was near neutral in soil reaction with low organic carbon content. The soil was also found to be medium in available nitrogen, available phosphorus, and available potassium content.The experiment comprised 16 treatment combinations consisting of two varieties viz., AMV-4 (V_1) and HS-108 (V_2), two spacing viz., 30 cm x 10 cm (S_1) and 45 cm x 10 cm (S_2) and four nutrient treatments viz., 40:20:20 kg NPK ha^{-1}(N_1), 40:20:20 kg NPK ha^{-1} + 5 t ha^{-1} FYM (N_2), 30:20:20 kg NPK ha^{-1} + 7.5 t ha^{-1} FYM (N_3) and 100 per cent N equivalent through FYM (N_4). The experiment was conducted in double split plot design. Observation like growth parameters like plant height, number of leaves, stem diameter, total dry matter accumulation, leaf area and yield parameters like number of capsules/plant, number of seeds per capsule, seed weight, seed yield and fibre yield were taken using standard procedures.

3. Results

3.1 Growth Parameters

Pooled data on growth parameters like plant height, number of leaves, stem diameter, total dry matter production and leaf area of mesta varieties as influenced by the plant spacing and nutrient sources at harvest stages of crop growth are presented in Table 1. The plant height at harvest stage varied significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, HS-108 recorded significantly taller plants (275.5 cm) and total dry matter (25.01 g) than AMV-4. Significantly taller plants (231.5 cm), number of leaves (11.70), stem diameter (0.99 cm^2 plant^{-1}), total dry matter (24.75 g) and leaf area (107.5 cm) was recorded under 45 cm x 10 cm spacing than 30 cm x 10 cm. Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered taller plants (236.0 cm) compared to 100 per cent N equivalent through FYM (221.0 cm). The interaction effects between varieties, plant spacing and nutrient sources were found to be significant

3.2 Yield Parameters

Pooled data on number of capsules per plant, number of seeds per capsules, seed weight per plant (g), seed yield (kg ha^{-1}) and fibre yield (kg ha^{-1}) of mesta varieties as influenced by the plant spacing and nutrient sources at harvest stage of crop are presented in Table 2. The number of capsules per plant differed significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, variety AMV-4 recorded significantly more number of capsules per plant (30.5), number of seeds per capsule (25.0), seed weight (5.75 g palnt^{-1}) and seed yield (754.5 kg ha^{-1}) than HS-108. Significantly higher number of capsules per plant (27) number of seeds per capsule (24.5), seed weight (4.99 g palnt^{-1}) and seed yield (687.0 kg ha^{-1}) was recorded under 45 cm x 10 cm spacing than 30 cm x 10 cm. Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered higher number of capsules per plant (30) compared to 100 per cent N equivalent through FYM (20). All the interaction effects between varieties, plant spacing and nutrient sources were found to be non-significant.

Table 1. Growth parameters of mesta varieties as influenced by plant spacing and nutrient source at harvest stage

Treatments	Plant height (cm)			No. of leaves			Stem diameter (cm)			Total Dry matter accumulation (g)			Leaf Area		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Variety (V)															
AMV-4 (V_1)	181	182	181.5	12.3	12.8	12.55	0.92	0.94	0.93	22.79	23.47	23.14	109	116	112.5
HS-108 (V_2)	276	275	275.5	9.6	9.7	9.65	0.99	1.02	1.01	24.88	25.12	25.01	88	97	92.5
S.Em ±	0.07	0.19	0.13	0.02	0.06	0.04	0.004	0.001	0.003	0.02	0.02	0.02	0.11	0.04	0.08
C.D. (0.05)	0.22	0.56	0.30	0.08	0.22	0.14	0.012	0.003	0.009	0.04	0.05	0.05	0.34	0.13	0.22
Plant Spacing (S)															
30 cm x 10 cm (S_1)	225	226	225.5	10.4	10.6	10.50	0.94	0.96	0.95	23.09	23.47	23.28	94	99	96.5
45 cm x 10 cm (S_2)	232	231	231.5	11.5	11.9	11.70	0.97	0.10	0.99	24.38	25.12	24.75	102	113	107.5
S.Em ±	0.18	0.24	0.20	0.02	0.08	0.05	0.004	0.005	0.005	0.01	0.02	0.01	0.08	0.02	0.05
C.D. (0.05)	0.51	0.66	0.47	0.07	0.25	0.16	0.012	0.013	0.015	0.03	0.05	0.03	0.22	0.06	0.14
Nutrient source (N)															
40:20:20 kg/ha (N_1)	227	231	229.0	11.6	11.8	11.70	0.98	1.01	0.98	24.14	24.45	24.30	103	109	106.0
40:20:20 kg/ha + 5 t FYM/ha (N_2)	235	237	236.0	11.9	12.2	12.05	0.10	1.03	0.60	24.43	25.25	24.84	106	113	109.5
30:20:20 kg/ha + 7.5 t FYM/ha (N_3)	228	229	228.5	10.8	10.9	10.85	0.97	0.10	0.54	23.82	24.13	23.98	98	106	102.0
100 per cent N equivalent through FYM (N_4)	220	222	221.0	9.7	10.2	10.00	0.87	0.88	0.88	22.55	23.34	22.95	85	98	91.5
S.Em ±	0.12	0.47	0.29	0.10	0.15	0.11	0.006	0.005	0.005	0.01	0.02	0.02	0.12	0.01	0.07
C.D.(0.05)	0.25	1.31	0.85	0.25	0.44	0.35	0.015	0.016	0.015	0.03	0.04	0.04	0.25	0.03	0.20
Interactions															
VxS S.Em ±	0.34	0.61	0.48	0.06	0.20	0.12	0.012	0.011	0.012	0.02	0.03	0.03	0.27	0.06	0.18
C.D.(0.05)	0.95	1.72	1.38	0.18	0.45	0.38	0.038	0.026	0.030	0.06	0.10	0.08	0.79	0.15	0.52
VxN S.Em ±	0.26	1.21	0.70	0.24	0.40	0.32	0.018	0.012	0.014	0.03	0.06	0.05	0.37	0.07	0.22
C.D.(0.05)	0.72	2.59	2.01	0.82	1.11	0.96	0.050	0.024	0.028	0.6	0.13	0.10	0.87	0.24	0.62
SxN S.Em ±	0.47	0.24	0.38	0.24	0.41	0.33	0.018	0.016	0.017	0.03	0.06	0.05	0.34	0.04	0.19
C.D.(0.05)	1.07	0.61	0.92	0.75	NS	0.92	NS	0.036	0.038	0.07	0.13	0.10	0.72	0.12	0.55
VxSxN S.Em ±	0.04	0.66	0.30	0.14	0.22	0.19	0.020	0.018	0.020	0.02	0.03	0.03	0.17	0.13	0.15
C.D.(0.05)	0.12	1.38	0.75	NS	0.60	0.55	NS	0.038	NS	0.06	0.09	0.08	0.50	0.34	0.44

DAS-Days After Sowing; FYM- Farm Yard Manure; NS-Non-significant.

3.3 Fibre Yield

The fibre yield differed significantly due to different plant spacing, varieties and nutrient sources. Among the varieties, HS-108 recorded significantly higher fibre yield (948 kg ha^{-1}) than AMV-4 (850 kg ha^{-1}). Significantly higher fibre yield was recorded under 45 cm x 10 cm spacing (923 kg ha^{-1}) than 30 cm x 10 cm (875 kg ha^{-1}). Further, application of 5 t of FYM per ha along with 40:20:20 kg NPK per ha fertilizer registered higher fibre yield (962 kg ha^{-1}) compared to 100 per cent N equivalent through FYM (803 kg ha^{-1}). The interaction effects between varieties, plant spacing and nutrient sources were found to be significant.

Table 2. Yield and yield parameters of mesta varieties as influenced by plant spacing and nutrient source at harvest stage

Treatments	Number of capsules/plant			Number of seeds/capsule			Seed weight (g/plant)			Seed yield(kg/ha)			Fibre yield (kg/ha)		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Variety (V)															
AMV-4 (V_1)	30	31	30.5	25	25	25.0	5.32	6.18	5.75	735	774	754.5	819	880	850
HS-108 (V_2)	21	19	20.0	22	23	22.5	3.75	4.08	3.92	565	598	581.5	921	974	948
S.Em ±	1.08	0.90	0.99	0.41	0.19	0.30	0.002	0.002	0.002	2.03	0.37	1.20	2.49	4.28	3.39
C.D. (0.05)	3.13	2.88	3.00	1.18	0.59	0.89	0.005	0.006	0.006	6.48	1.08	3.78	6.72	12.43	9.18
Plant Spacing (S)															
30 cm x 10 cm (S_1)	25	23	24	23	23	23.0	4.35	5.02	4.69	631	668	649.5	845	905	875
45 cm x 10 cm (S_2)	27	27	27	24	25	24.5	4.72	5.25	4.99	670	704	687.0	896	949	923
S.Em ±	0.22	0.29	0.26	0.32	0.17	0.25	0.003	0.002	0.003	2.14	0.30	1.22	2.57	3.79	3.18
C.D. (0.05)	0.61	0.81	0.71	0.91	0.47	0.69	0.007	0.004	0.006	5.93	0.83	3.38	7.14	10.54	8.84
Nutrient source (N)															
40:20:20 kg/ha (N_1)	27	27	27.0	23	24	23.5	4.77	5.26	5.02	666	697	681.5	904	943	924
40:20:20 kg/ha + 5 t FYM/ha (N_2)	30	29	29.5	25	25	25.0	5.09	5.41	5.25	684	712	698.0	948	975	962
30:20:20 kg/ha + 7.5 t FYM/ha (N_3)	25	25	25.0	22	23	22.5	4.49	5.14	4.82	651	684	667.5	891	923	907
100 per cent N equivalent through FYM (N_4)	20	19	19.5	21	22	21.5	3.98	4.71	4.35	601	650	625.5	738	868	803
S.Em ±	0.47	0.78	0.63	0.45	0.30	0.38	0.003	0.002	0.003	2.66	0.41	1.54	3.60	5.82	4.71
C.D.(0.05)	0.98	1.60	1.32	0.93	0.63	0.78	0.006	0.004	0.006	5.48	0.84	3.16	7.44	12.00	9.72
Interactions															
VxS S.Em ±	2.21	1.90	2.01	1.05	0.51	0.78	0.002	0.002	0.002	5.90	0.96	3.43	7.16	11.45	9.31
C.D.(0.05)	NS	6.12	NS	NS	NS	2.18	0.006	0.005	0.006	NS	2.60	9.96	20.31	NS	20.01
VxN S.Em ±	2.45	2.62	2.54	1.37	0.85	1.11	0.006	0.003	0.005	7.67	1.25	4.46	10.14	16.62	13.38
C.D.(0.05)	NS	NS	NS	3.24	1.86	2.55	0.012	0.006	0.009	NS	2.96	12.84	22.74	37.65	27.02
SxN S.Em ±	1.24	1.99	1.62	1.28	0.83	1.06	0.009	0.006	0.008	7.78	1.16	4.47	10.21	16.14	13.2
C.D.(0.05)	NS	4.14	NS	NS	1.74	3.04	0.020	0.012	0.016	16.64	2.47	9.56	21.70	34.15	27.93
VxSxN S.Em ±	0.66	1.10	0.88	0.64	0.43	0.54	0.018	0.012	0.015	3.75	0.58	2.17	5.09	8.22	6.66
C.D.(0.05)	NS	NS	NS	NS	NS	1.49	0.052	0.028	0.040	10.88	1.68	6.28	14.76	24.66	19.96

DAS-Days After Sowing; FYM- Farm Yard Manure; NS-Non-significant.

4. Discussion

4.1 Growth Parameters

The importance of varieties with high yield potential combined with its wider adoptability for boosting up production of mestafibre 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-c1imatic conditions of a region to assess their performance and selecting the best ones to exploit their yield potentiality through various agro-techniques.

Maximum plant height at harvesting (275.5 cm) was observed in HS-108 over AMV-4 (181.5 cm). Among spacing, 45 X 10 cm (S1) recorded 231.5 cm tallness compared to 30 X 10 cm spacing (225.5 cm). Similarly, application of recommended dose of fertilizer i.e., 40: 20:20 kg/ha and 5 MT of FYM ha^{-1} recorded the higher plant height of 236.0 cm and it was lower with only organic source (221.0 cm) alone. The significantly superior growth parameters were observed with recommended dose of fertilizer i.e., 40:20:20 kg ha^{-1} and 5 tonnes of FYM ha^{-1} when compared to 100 per cent through organic source. This might be due to the beneficial effects observed with the application of organic matter in conjunction with inorganic source. The organic matter serves as nutrient source to the soil microorganisms, improves the soil physico-chemical properties resulting in good soil health. Hence, the organic matter has been considered as the back bone of soil fertility and productivity. However, the poor growth parameters recorded with application of FYM alone might be due to longer time taken for decomposition and mineralization of nutrients. This might be also due to the immobilization of available nutrients when incorporated into the soil leading to lower availability to plants. FYM supplemented with fertilizer increased the growth parameters significantly. It might be due to the initial nutrient supply through inorganic source and later it was from decomposition of FYM, resulting in continuous supply of nutrients to crop. Higher plant height of HS-108 variety over AMV-4 could be attributed to their genetic character and longer duration as they belong to *H. sabdariffa* group.

Further the beneficial effect of both nutrients as organic and inorganic sources were found to increase other growth parameters were also reported thetotal dry matter accumulation per plant varied significantly due to spacing and nutrient source. Maximum total dry matteraccumulation at harvest was observed with HS-108 (25.01 g $plant^{-1}$), 45 X 10 cm (24.75 g $plant^{-1}$) and withrecommended dose of fertilizer + 5 MT of $FYMha^{-1}$ (24.84 g $plant^{-1}$). The higher dry matter production might be due to the number of leaves, higher plant height, stem diameter. This has provided more photosynthitically active leaf area and also for a longer period might have helped in production of higher photosynthates resulting in higher drymatter accumulation.

Total dry matter production and its greater portioning into stem depend upon photosynthetic capacity of the plant during its vegetative period 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. Dry weight of leaves in AMV-4was significantly superior over HS-108 at all the growth stages. At harvest, AMV-4 variety recorded significantly higher dry weight of leaf per plant and showed lower translocation of photosynthates from leaf to stem resulting in poor dry matter accumulation in stem.

4.2 Yield and Yield Parameters

The seed yield in any crop is dependent upon the photosynthetic source it built. A sound source in terms of plant height, number of leaves to support and hold the leaves are logically able to increase the total dry matter and later lead to higher grain yield. Partitioning of dry matter production and its distribution in different parts is important for determination of total yield of the crop (Donald, 1962). Seed yield differed significantly among the varieties. AMV-4 recorded 29.75 per cent higher seed yield (754.5 kg ha^{-1}) over HS-108 (581.5 kg ha^{-1}) (Anon, 1990).

Pooled data of two years revealed that the varieties had differential yield potentials and significantly differed with regard to fibre yield. The variety HS-108 produced higher fibre yield (948 kg ha^{-1}) when compared to AMV-4 (850 kg ha^{-1}). HS-108 showed 11.5 per cent yield advantage over AMV- 4. Anuradha and Rao (1999), and Sarma (1999) reported significantly superior fibre yields with new improved varieties over local varieties.

Seed yield per hectare differed significantly due to variation in plant population. The lower plant population at 45 cm x 10 cm plant spacing recorded significantly higher seed yield (687 kg ha^{-1}) as compared to higher plant populations at 30 cm x 10 cm (649.5 kg ha^{-1}) (Table 2). Higher seed yield at lower plant population level might be due to significantly higher yield contributing characters *viz.*, number of capsules, seed weight per plant and 100-seed weight. Both number of capsules and seed weight per plant decreased with increase in plant population from 0.25 to 0.38 million per ha. Reduction in seed yield with increase in plant population from 0.25 to 0.38 million per ha could be attributed to significantly lower number of capsules and seed weight per plant and these reductions might not have been compensated by the enhanced plant population per ha.

Seed yield increased significantly with the application of 5 t FYM per ha along with 40:20:20 kg NPK per ha (698.0 kg ha^{-1}) when compared to application of 100 per cent N equivalent through FYM alone (625.5 kg ha^{-1}). Higher seed yield with the application of 5 t FYM per ha along with 40:20:20 kg NPK per ha could be attributed to increased number of capsules per plant, number of seeds per capsules and seed weight per plant (Table 2). The results obtained confirm the findings of Biwas (2004) and Venkatakrishnan et al. (2004).

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. Dry stalk yield is the ultimate factor which decides the final fibre yield. While in fresh biomass yield, stalk portion constitutes nearly 70 per cent and remaining 30 per cent is constituted by leaf, petiole and reproductive parts. In the present investigation also, varieties which were superior with respect to fresh biomass or dry stalk yield recorded higher fibre yield. In the present study, 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., 1996)

Fibre yield depends on the vegetative growth of individual plants in respect of height and basal stem girth. Varietal differences in fresh biomass and dry stalk yields could be related to their performance on individual plant basis. At harvest, HS-108 was significantly taller (275.5 cm) than AMV- 4 (181.5 cm) by 51.8 per cent, higher fibre yield per hectare and fibre weight per plant of HS-108 was mainly attributed to its higher plant height and stem girth when compared to AMV-4. Variation in fibre yield among the varieties also depends on fibre produced by individual plants. Among the varieties, fibre weight was significantly higher with HS-108 (3.54 g plant^{-1}) compared to AMV- 4 (2.99 g plant^{-1}). HS-108 registered 18.4 per cent higher fibre weight per plant over AMV- 4. Therefore, higher fibre yield of HS-108 variety could be attributed to its ability to yield more fibre per plant.

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