Mysore J. Agric. Sci., 55 (3) : 69-74 (2021)

Agronomic Investigations on Sida Hemp (*Sida alnifolia* L.) - A Medicinal Plant for Future

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Abstract

A field experiment was conducted to assess the effect of agronomic management on growth, yield and rhizosphere variations of Sida hemp (*Sida alnifolia* L.) during June 2018 to December 2018. Study comprised two growing conditions *viz*., open and 50 per cent shade, two levels of manuring *viz*., no manure and FYM@10 t ha^{-1} and four weed management practices *viz*., mulching with black polythene sheet, organic mulching with paddy straw @ 5 t ha^{-1}, hand weeding and no weeding. Taller plants were observed under 50 per cent shaded condition. Open condition showed superiority in case of biomass yield per plant and root shoot ratio at all growth stages of Sida hemp.The highest root yield per plant was recorded in treatment combination, black polythene mulching with FYM under open condition (11.81g). Total population of bacteria, actinomycetes and fungi and soil microbial biomass carbon were significantly higher under open condition.Among manuring, FYM @ 10 t ha^{-1} recorded higher biometric characters, total population of bacteria, actinomycetes and fungi and soil microbial biomass carbon. Mulching with black polythene recorded higher biometric characters and root yield where as soil microflora and soil microbial biomass carbon were enhanced by organic mulching.

Keywords : Sida hemp, Growing condition, Manuring, Weed management, Soil microflora, Soil microbial biomass carbon

Sida is a large genus with about 200 species distributed throughout the world. This genus has pronounced prominence in the Indian traditional system of medicine and is one among the most widely used raw drug in the production of different Ayurvedic formulations for over 2000 years. *Sida alnifolia* is a species belonging to family 'Malvaceae', found in tropical and subtropical regions of India. There are different common names *viz.,* Arrow leaf sida or Sida hemp (English), Bala (Sanskrit), and Kurumthotti (Malayalam). Roots are used in a variety of Ayurvedic medicines and oils to improve strength of bones, muscles and joints. The main Ayurvedic preparations containing *Sida* includes Bala Taila, Balarishta, Balahathadi Taila, Chandanbala lakshadi taila, Sudarshan churna and Balaguduchyadi Taila. According to National Medicinal Plant Board (NMPB), *Sida* is the 3rd most widely used drug in Ayurveda pharmaceutical industry and is mostly collected from the wild. Because of its high commercial value, the crop is included in the group of high volume traded medicinal plants sourced from waste lands. Cultivating plants under a micro climate similar to its niche original is found to be the viable solution for ensuring its therapeutic properties. An experiment therefore, designed to study the rhizosphere variations, growth and yield of Sida hemp as influenced by agronomic management.

Material and Methods

A field experiment was conducted in the Department of Agronomy, College of Horticulture, Vellanikkara during June - December 2018, using Randomized Block Design (factorial) with 16 treatment combinations and three replications. The plot size was 3 m x 2 m with a plant spacing of 50 cm x 25 cm. The treatments consisted of two growing conditions (open and 50 per cent shade), two manuring levels (no manure and FYM@10 t ha^{-1}), and four weed management practices (mulching with black polythene sheet of 25 micron thickness, mulching with paddy straw @ 5 t ha^{-1}, hand weeding at 1st, 3rd and 5th months and no weeding). Shade was introduced artificially by providing green colour shade net with 50 per cent permeability of sunlight. No fertilization was done except FYM (10 t ha^{-1}) which was applied as basal in half of the plots as per the treatments. One month old healthy, uniform sized seedlings (80,000 ha^{-1}) were transplanted in the main field as per treatments.

Randomly selected five plants per treatment and replication were tagged and observations *viz*., plant height, shoot biomass and root biomass were recorded at 1, 3, 5 months after planting and at harvest. For measuring shoot and root biomass, randomly selected plants in each treatment and replication were uprooted and average fresh weight per plant were calculated and expressed in grams. The fresh weight and dry weight of shoot and root was recorded separately. Total population of bacteria, actinomycetes and fungi were isolated from soil using serial dilution followed by pour plate method at initial, 4 MAP and at harvest. Soil microbial biomass carbon was analyzed by fumigation and extraction method at initial, 4 MAP and at harvest. The data collected were subjected to analysis of variance using the statistical package 'OPSTAT'.

Results and Discussion

Plant Height at 1, 3, 5 MAP and at Harvest

Taller plants were observed under 50 per cent shaded condition with black polythene mulch and FYM @ 10 t ha^{-1}throughout the growth stages (15.28cm, 123.33 cm, 135.07cm and 139.20 cm at 1, 3, 5 MAP and at harvest, respectively) (Table 1). As per Liu *et al.* (2016), plants that grow in shade tend to have elongated growth due to the activity of auxin, gibberillins and brassinosteroids. The significant increase in plant height with FYM application was due to the addition of secondary and micronutrients along with the major nutrients (Banik *et al*., 2006). Increase in soil temperature and soil moisture contents in the plots with black polythene mulching compared to bare soil might have contributed to better plant height in these plots (Ashrafuzzaman *et al.,* 2011).

Shoot Biomass

Significantly higher biomass yield per plant was recorded in crops grown under open condition (6.99g, 24.09g, 42.39g and 58.91g at 1, 3, 5 MAP and at

Table 1

Plant height of Sida hemp at different growth stages as influenced by manuring and weed management practices

Treatments	Plant height (cm)							
	1 MAP		3 MAP		5 MAP		Harvest	
	Open	50% shade	Open	50% shade	Open	50% shade	Open	50% shade
No manuring x Black polythene	9.47	13.63	74.58	118.78	84.35	128.10	91.10	134.50
No manuring x Organic mulch	8.40	10.77	68.23	99.53	78.39	101.37	86.50	106.53
No manuring x Hand weeding	9.07	11.67	50.29	89.43	72.35	97.23	85.27	108.63
No manuring x No weeding	8.13	9.90	39.47	47.71	53.40	60.63	64.50	70.67
FYM @ 10t/ha x Black polythene	11.60	15.28	94.30	123.33	104.63	135.07	108.00	139.20
FYM @ 10t/ha xOrganic mulch	10.27	11.23	89.30	102.53	99.23	110.53	103.77	115.67
FYM @ 10t/ha xHand weeding	10.87	13.43	65.65	97.67	75.53	104.40	87.53	111.10
FYM @ 10t/ha xNo weeding	6.47	10.63	57.53	54.54	67.36	64.20	68.43	72.13
CD (0.05)	NS		3.34		3.95		5.16	
SE(m)	0.99		1.16		1.37		1.79	

TABLE 2

Effect of treatments on biomass yield per plant of Sida hemp at different growth stages

Treatments	Biomass yield per plant (g)			
	1 MAP	3 MAP	5 MAP	Harvest
Growing condition				
Open	6.99	24.09	42.39	58.91
50% Shade	6.09	16.45	29.15	42.20
CD (0.05)	0.80	1.16	1.16	1.37
SE(m)	0.092	0.03	0.21	2.08
Manuring				
No manure	6.20	18.17	31.09	44.89
FYM @ 10t/ha	6.88	22.36	40.45	56.22
CD (0.05)	NS	1.16	1.16	1.37
SE(m)	0.092	0.03	0.21	2.08
Weed management				
Black polythene	9.65	33.80	71.01	91.17
Organic mulch	6.38	18.60	30.63	47.69
Hand weeding	5.41	15.50	24.71	38.39
No weeding	4.72	13.17	16.74	24.97
CD (0.05)	1.14	1.64	1.64	1.93
SE (m)	0.13	0.04	0.30	4.16

harvest, respectively) (Table 2). Preference of open condition for better growth and performance of *Sida cordifolia* was reported by Latha and Radhakrishnan (2015). Significant variation was observed for biomass yield per plant with manuring. The highest biomass yield per plant was obtained in plots with FYM @ 10 t ha^{-1}at all growth stages (6.88g, 22.36g, 40.45g and 56.22g at 1, 3, 5 MAP and at harvest, respectively). Improved biomass yield and crop growth of different crops with addition of FYM was reported by Dejene and Lemlem (2012). Weed management significantly influenced the biomass yield per plant of *Sida alnifolia*. Black polythene mulching recorded the higher biomass yield per plant (9.65 g, 33.80g, 71.01g and 91.17 g at 1 MAP, 3 MAP, 5 MAP and at harvest, respectively). Significant increase in biomass yield of chilly with black polythene mulching was reported by Ashrafuzzaman *et al.* (2011). High soil moisture retention, optimum soil temperature and reduced weed density might have contributed to the increased biomass yield per plant under black polythene mulch.

Root Biomass

Growing condition, manuring and weed management significantly influenced the root:shoot ratio of *Sida alnifolia* (Table 3). Lower root:shoot ratio was observed under shaded condition throughout the growth period. This can be correlated with higher plant height and lower biomass yield per plant under shade (Table 1 and 2). In wheat, a negative correlation of root: shoot ratio with plant height was reported by Narayanan and Vara Prasad (2014). Higher root:shoot ratio was recorded in FYM applied plots (0.14, 0.26, 0.34 and 0.42 at 1, 3, 5 and harvest, respectively). According to Ibrahim *et al.* (2010), FYM provides a better environment for root development by improving the soil structure and this could be the reason for the increase in root volume and root yield with FYM

TABLE 3

Effect of treatments on root:shoot ratio of Sida hemp at different growth stages

Treatments	Root:shoot ratio			
	1 MAP	3 MAP	5 MAP	Harvest
Growing condition				
Open	0.15	0.26	0.35	0.42
50% Shade	0.13	0.23	0.29	0.38
CD (0.05)	0.01	0.02	0.01	0.01
SE(m)	0.008	0.024	0.002	0.009
Manuring				
No manure	0.13	0.23	0.31	0.38
FYM @ 10t/ha	0.14	0.26	0.34	0.42
CD (0.05)	NS	0.02	0.01	0.01
SE(m)	0.008	0.024	0.002	0.009
Weed management				
Black polythene	0.15	0.29	0.38	0.44
Organic mulch	0.14	0.26	0.34	0.41
Hand weeding	0.13	0.23	0.31	0.40
No weeding	0.12	0.20	0.36	0.33
CD (0.05)	0.02	0.03	0.02	0.02
SE (m)	0.008	0.034	0.002	0.012

application. Among different weed management, black polythene mulching recorded higher root:shoot ratio. This might be due to better microclimate under black polythene mulch.

Interaction effect of growing condition, manuring and weed management was significant with respect to root biomass per plant (Table 4). The highest root biomass per plant was recorded in the treatment combination, black polythene mulching with FYM under open condition (11.81 g) followed by black polythene mulching without manure under open condition (8.57 g). Under all treatment combinations open condition recorded superiority in case of root yield per plant. This indicated the sun loving nature of *Sida alnifolia*. Ideal growing condition, nutrient availability, and reduced weed infestation in this combination might have contributed to higher root yield per plant.

TABLE 4

Interaction effect of growing condition, manuring and weed management on root biomass (g) of sida hemp

Treatments	Root biomass (g)	
	Harvest	
	Open	50% shade
No manuring x Black polythene	8.57	5.78
No manuring x Organic mulch	6.42	5.35
No manuring x Hand weeding	5.22	5.01
No manuring x No weeding	4.84	4.47
FYM @ 10t/ha x Black polythene	11.81	7.05
FYM @ 10t/ha x Organic mulch	7.82	5.92
FYM @ 10t/ha x Hand weeding	5.11	5.04
FYM @ 10t/ha x No weeding	4.94	4.57
CD (0.05)	2.44	
SE(m)	8.84	

Total Population of Bacteria, Actinomycetes and Fungi

At four MAP and at harvest, total population of bacteria (20.38 x 10^6 cfu g^{-1} and 16.92 x 10^6 cfu g^{-1}), actinomycetes (68.33 x 10^4 cfu g^{-1} and 72.75 x 10^4 cfu g^{-1}) and fungi (15.33 x 10^4 cfu g^{-1} and 18.17 x 10^4 cfu g^{-1}) were higher under open condition as compared to shaded condition (Table 5). Under 50 per cent shade, soil could receive reduced rhizodeposites by the host plant due to lower plant growth. Supply of rhizodeposites by the host plant greatly affected the size and functions of the soil microbial community (Siemannan and Roger, 2003). The higher microbial population in open condition is in accordance with higher soil microbial biomass carbon under full light intensity. Soil microbial biomass carbon had a close relationship with microbial biomass. Among manuring, FYM plots recorded higher population of bacteria (19.75 x 10^6 cfu $g^{-1}$and 16.46 x 10^6 cfu g^{-1}) actinomycetes (65.50 x 10^4 cfu g^{-1} and 68.75 x 10^4 cfu g^{-1}) and fungi.(13.54 x 10^4 cfu g^{-1} and 16.21 x 10^4 cfu g^{-1}) at 4 MAP and at harvest, respectively. According to Yassen *et al.* (2010), when farmyard manure is applied to soil, activity of soil microorganisms increases. Total population of bacteria (21.92 x 10^6 cfu g^{-1} and 19.29 x 10^6 cfu g^{-1}) and actinomycetes (66.92 x 10^4 cfu g^{-1} and 72.75 x 10^4 cfu g^{-1}) were higher under paddy straw mulch, where as fungal population (15.08 x 10^4 cfu g^{-1} and 17.25 x 10^4 cfu g^{-1}) were higher under plots without weeding. There are reports of the increased microbial population in soil under organic mulching (Kher *et al*., 2010). Organic mulching could increase the organic carbon content in the soil, which became food for the useful earthworms and microbes in the soil.

Soil Microbial Biomass Carbon

As compared to the pre experimental soil, higher soil microbial biomass carbon was observed at harvest stage (Table 5). Soil microbial biomass carbon was higher under open condition (265.25 µg g^{-1} and 287.97 µg g^{-1}) at 4 MAP and at harvest, respectively. Soil microbial biomass carbon is one of the indicators of soil microbial population. Lalfakzuala *et al.* (2006) reported a linear relationship between soil microbial population and microbial biomass carbon. Higher microbial biomass carbon was recorded in FYM applied plots as compared to no manure plots (245.29 µg g^{-1} and 274.94 µg g^{-1}) at 4 MAP and at harvest, respectively. Gogoi *et al.* (2010) observed increased microbial biomass carbon in plots applied with FYM and microbial biomass carbon increased with soil

TABLE 5

Effect of treatments on total population of bacteria, actinomycetes, fungi and soil microbial biomass carbon in the rhizosphere of Sida hemp at different growth stages

Treatments	Total population of bacteria (x106cfu g-1)		Total population of actinomycetes (x104cfu g-1)		Total population of fungi (x104cfu g-1)		Soil microbial biomass carbon (µg g-1) of soil	
	4 MAP	Harvest	4 MAP	Harvest	4 MAP	Harvest	4 MAP	Harvest
Growing condition								
Open	1.29 (20.38)	1.22 (16.92)	1.82 (68.33)	1.85 (72.75)	1.16 (15.33)	1.25 (18.17)	265.25	287.99
50% Shade	1.22 (16.83)	1.17 (14.88)	1.70 (51.00)	1.74 (55.46)	0.99 (10.96)	1.09 (12.83)	166.92	205.90
CD (0.05)	0.05	0.03	0.04	0.04	0.09	0.05	3.66	3.42
SE(m)	0.08	0.04	0.06	0.06	0.09	0.07	4.06	4.60
Manuring								
No manure	1.22 (16.46)	1.16 (14.89)	1.72 (53.83)	1.77 (59.46)	0.89 (12.75)	1.12 (14.79)	186.88	218.94
FYM @10 t/ha	1.28 (19.75)	1.21 (16.46)	1.80 (65.50)	1.83 (68.75)	1.09 (13.54)	1.19 (16.21)	245.29	274.94
CD (0.05)	0.05	0.03	0.04	0.04	0.09	0.05	3.66	3.42
SE(m)	0.08	0.04	0.06	0.06	0.09	0.07	4.06	4.60
Weed management								
Black polythene	1.22 (17.08)	1.17 (14.83)	1.76 (59.42)	1.79 (62.33)	0.87 (12.00)	1.14 (14.33)	181.50	207.93
Organic mulch	1.33 (21.92)	1.27 (19.29)	1.82 (66.92)	1.85 (72.75)	1.02 (13.08)	1.21 (16.92)	239.00	290.47
Hand weeding	1.20 (16.17)	1.17 (14.83)	1.68 (49.58)	1.73 (54.50)	0.83 (11.42)	1.10 (13.00)	134.75	161.19
No weeding	1.25 (19.25)	1.22 (16.78)	1.79 (62.75)	1.82 (66.83)	1.17 (15.08)	1.24 (17.75)	309.08	328.16
CD (0.05)	0.07	0.04	0.05	0.05	0.14	0.07	5.04	4.83
SE(m)	0.07	0.05	0.05	0.05	0.17	0.09	5.06	4.96
At sowing	14.00		63.33		17.00		95.33	

** Logarithmic transformed values, Original values are in parentheses

organic carbon. Among different weed management practices, no weeding plots (309.08 µg g^{-1} and 328.16 µg g^{-1} at 4 MAP and at harvest, respectively) recorded higher microbial biomass carbon followed by organic mulched plots. This is in line with the reports of Kher *et al.* (2010). According to them organic mulching could increase the organic carbon and microbial population under soil. This might be the reason for higher MBC under organic mulching plots.

Management methods exhibited great influence on growth and yield of Sida hemp by way of modifying rhizosphere properties. Open condition, application of FYM @ 10 t ha^{-1} and weed management by black polythene mulching can be recommended as optimum for better growth and yield for Sida hemp.

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(*Received :* May 2021 *Accepted :* September 2021)