Effect of agronomic management on soil microclimatic parameters and root yield of Sida hemp (*Sida alnifolia* L.)

ABSTRACT

Agronomic management exhibits great influence on growth and yield of crops by modifying physical, chemical and biological properties of soil and plants. Field experiment was conducted during June to December, 2018 to assess the effect of agronomic management *viz*. light intensity, application of manuring and weed management on soil microclimatic variations and its effects on root yield of Sida hemp (*Sida alnifolia* L.). The treatments included two levels of light intensity (open and 50 per cent shade), two levels of manuring (no manure and FYM@10 t ha^{-1}), and four weed management practices (black polythene mulching, organic mulching with paddy straw @ 5 t ha^{-1}, hand weeding at 1,3,5 MAP (Month after planting) and no weeding). Higher soil temperature at 10 cm depth was observed in open condition and under black polythene mulching throughout the growing period. Higher soil moisture content at 15 cm depth was recorded under shade and black polythene mulching. Black polythene mulching resulted in increase in soil temperature and soil moisture content by almost two percent as compared to bare soil in open condition. The highest root yield of 14.66 t ha^{-1} was noticed in plots with black polythene mulching with FYM under open condition. Soil temperature and light intensity showed positive correlation with root yield.

Key words: soil temperature, soil moisture, light intensity, mulching, root yield

1. INTRODUCTION

Plants accomplish a very vibrant role in sustaining and refining quality of human life. Plants which are commonly used for treating or preventing various ailments are generally considered as medicinal plants. Quality of raw drug is as important as its quantity in medicinal plant cultivation. Since bulk of the present requirement is met by wild collection from natural habitats, when the crop is brought under cultivation, with improved management techniques, it is indispensable to ensure its quality. Cultivating plants under a micro climate similar to its niche original is found to be the viable solution for ensuring its therapeutic properties.

Sida alnifolia is a species found in tropical and subtropical regions of India, belonging to the family Malvaceae. According to National Medicinal Plant Board, Sida is the 3rd most widely consumed drug in Ayurveda pharmaceutical industry (Ved and Goraya, 2007)[11]. Because of its high commercial value, the crop is included in the group of high volume traded medicinal plants sourced from waste lands. At present bulk of the present requirement is met in wild collection from natural habitats.

Management methods exhibit great influence on growth and yield of crops by way of modifying physical, chemical and biological properties of soil and plants. Organic manures provide a better environment for crop growth and root development by improving the soil physical, chemical, biological properties and supplying plant nutrients including micronutrients. According to Upadhyaya et al. (2010) [10], the

yield, total phenol and total flavanoid contents of medicinal plant *Adhatoda vasica*, improved significantly by the application of organic manures

Light is a physical factor which can influence growth, yield and secondary metabolites production. Both deficient and excessive light intensities may be injurious to plants and it will affect plant growth, development and yield (Safeer et al. 2013)[7].

Crop-weed competition is a common interaction occurring in cropped field significantly influencing crop growth and yield. Mulching is a non chemical weed management method which modifies the plant microclimate by modifying soil temperature, soil moisture and evaporation and the modified microclimate in turn affects growth and development of crops. According to Lalitha et al. (2010) [4], moisture content, soil temperature and nutrient availability increased under plastic mulching. Gunasekaran and Shakila (2014) [2] reported significant influence of mulching on tuber characters such as number of tubers, tuber length, tuber girth, and fresh tuber weight of medicinal coleus *Coleus forskohlii*.

As the information on influence of management methods on Sida hemp (*Sida alnifolia* L.). is limited, the present study was undertaken to assess the effect of agronomic management *viz*. light intensity, manuring and weed management on soil microclimatic variations and its consequent effects on root yield of sida hemp (*Sida alnifolia* L.)

2. MATERIALS AND METHODS

The study was conducted at Agronomy farm, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur (India) during June to December, 2018. Monthly weather data for the experimental period was given in the table 1.The area located at 13^{o} 32'N latitude and 76^{o} 26'E longitude. The altitude of the place is 40 m above mean sea level. The experiment was laid out in Randomized Block Design (Factorial), with 3 factors and three replications. Factor A consist of two light intensity (open and 50 per cent shade), factor B consist of manuring (no manure and FYM@10 t ha^{-1}), and factor C consist of four weed management practices (black polythene mulching, organic mulching with paddy straw @ 5 t ha^{-1}, hand weeding at 1,3,5 MAP and no weeding). One month old healthy, uniform sized seedlings were selected and transplanted in the main field on 2^{nd} June 2018 at a spacing of 50 cm x 25 cm. Soil temperature at 10 cm depth and soil moisture at 0-15 cm depth were recorded at weekly intervals using soil thermometer and gravimetric method respectively. The observation on root yield was recorded six months after planting (4^{th} December 2018) at seed maturation stage by uprooting of whole plants. Field view under open and shaded condition were given in Fig.1 and Fig.2 respectively.

The data collected were statistically analysed and presented as per procedure given by Sheoran et al. 1998 [9].

Table 1. Monthly weather data during experimental period (June 2018-December 2018)

Months	Max temp. (^{0}C)	Min temp. (^{0}C	RH %	Rainfall (mm)	Rainy days	Total Evp. (mm)	Sunshine hours
June	29.8	23.2	89	730.0	23	65.7	51.2
July	29.6	22.5	88	793.2	22	79.6	58.0
Aug	29.2	22.2	87	928.0	21	70.7	68.4
Sep	32.2	22.5	75	29.0	1	99.6	216.2
Oct	32.8	22.9	76	393.0	13	94.4	176.0
Nov	32.7	23.3	68	66.6	5	102.3	207.5
Dec	33.0	22.5	63	0.0	0	109.5	215.7

Fig. 1. Filed view under open growing condition

Fig. 2. Filed view under shaded condition

3. RESULTS AND DISCUSSION

3.1 Soil temperature

The average soil temperature at 10 cm depth during the experiment period ranged from 24.1^{o}C to 28.5^{o}C. Throughout the growing period higher soil temperature was observed in open condition as compared to shaded condition (Fig. 3). As per Onwuka and Mang (2018) [6], the soil temperature is a function of amount of solar radiation from the sun that reached on the soil surface and amount that absorbed by the soil. Martias and Musil (2012) [5] also reported increase in soil temperature with increased solar radiation that reached the soil surface. Significant influence of manuring on soil temperature have not been observed in this experiment. Among different weed management practices, black polythene mulched soil recorded higher temperature (Fig. 4).The rise in soil temperature may due to solar energy trapped inside the mulch material through green house effect (Abhivyakti, et al., 2016) [1]. Organic mulched soil showed lower soil temperature as compared to hand weeded soil (Fig. 4). The reduction in soil temperature may due to retaining soil moisture by reducing soil evaporation through organic mulching (Zhang et al., 2017) [13].

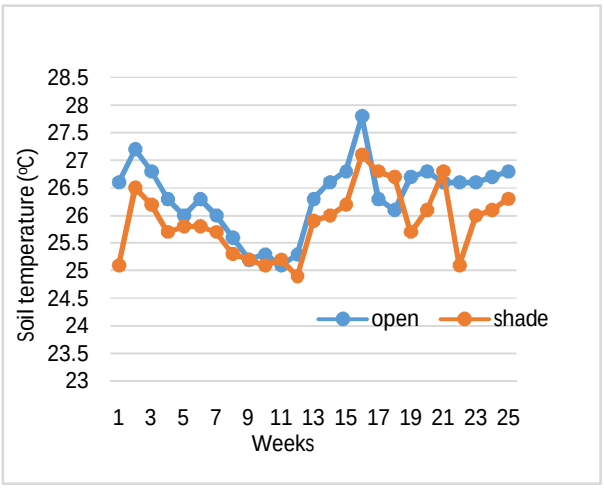

Fig. 3. Effect of growing condition on soil temperature (°C) at 10 cm depth

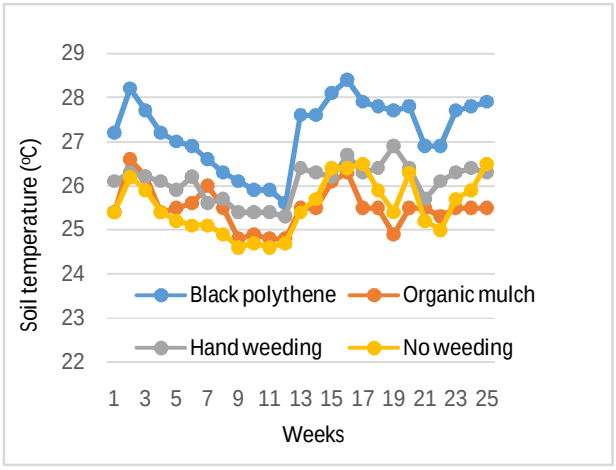

Fig 4. Effect of weed management on soil temperature (°C) at 10 cm depth

3.2 Soil moisture

The average soil moisture at 15 cm depth ranged from 12.7 per cent to 33.5 per cent throughout the growing season. Plots under shade recorded higher soil moisture content at 15 cm depth except from 2nd week to 13th week (Fig. 5). This exception was due to monsoon rains received during this period. Youn *et al.* (2021) [12] also observed higher soil moisture under shaded condition. Soil moisture content was unaffected by manuring. Weed management practices significantly influenced the soil moisture content at 15 cm depth. Black polythene mulching recorded higher moisture content as compared to other weed management practices except from 2nd week to 13th week (Fig. 6). According to Sakthivel (2019) [8], mulching with black polythene sheet conserved soil moisture by reducing rate of evaporation. Soil moisture content in organic mulched soil was found to be lesser as

compared to no weeding soil from 14th week to 25th week (After south west monsoon). This may be due to increased weed biomass serve as protection for soil surface against weather aggressions to maintain soil moisture.

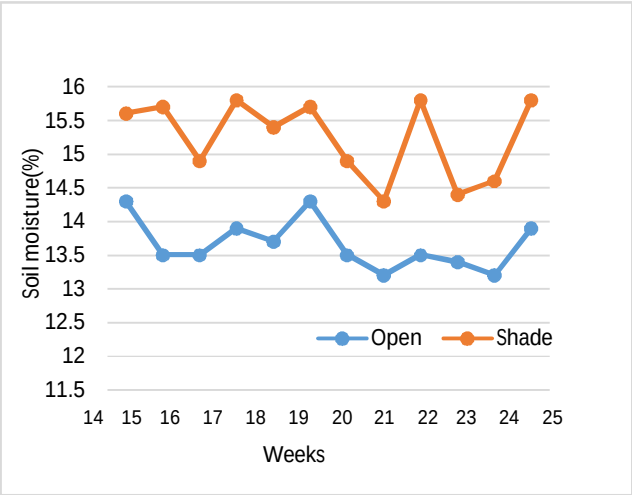

Fig. 5 Effect of growing condition on soil moisture (%) at 0-15cm depth

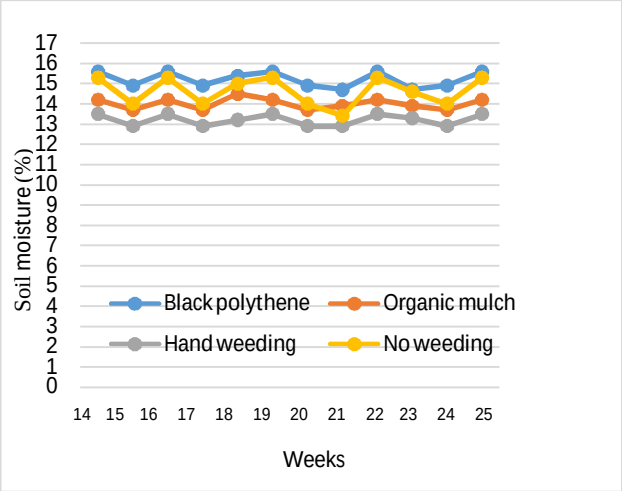

Fig.6 Effect of weed management on soil moisture (%) at 0-15cm depth

3.3 Root yield

The highest root yield of 14.66 t ha^{-1} was recorded in treatment combination, black polythene mulching with FYM under open condition followed by black polythene mulching without manure under open condition (Table 1). The lowest root yield was recorded in no weeding plots without manure under 50 per cent shade (5.14 t ha^{-1}). Under best treatment combination of manuring and weed management (FYM @ 10 t ha^{-1} x black polythene mulching), by altering only growing condition, a yield increase of 4.84 t ha^{-1} could be observed. This indicates the sun loving nature of *Sida alnifolia*. Optimum soil microclimatic conditions in this combination might have contributed to higher root yield.

Table 1. Effect of growing condition, manuring and weed management on root yield of Sida hemp

Treatments	Root yield (t ha^{-1})	
	Harvest	
	Open	50 per cent shade
No manuring x Black polythene	11.92	8.06
No manuring x Organic mulch	7.45	5.95
No manuring x Hand weeding	7.09	5.50
No manuring x No weeding	6.05	5.14
FYM @ 10 t ha^{-1} x Black polythene	14.66	9.82
FYM @ 10 t ha^{-1} x Organic mulch	8.85	6.18
FYM @ 10 t ha^{-1} x Hand weeding	7.67	6.10
FYM @ 10 t ha^{-1} x No weeding	6.89	5.87
CD (0.05)	2.09	

3.4 Correlation studies

Correlation between microclimatic factors and yield at vegetative and harvest stages is depicted in Table 2. At both stages, positive correlation was observed between light intensity, soil temperature and root yield. However, a negative correlation was observed between soil moisture and light intensity (-0.628 and -0.533 at vegetative and harvest stages respectively). Positive correlation between soil temperature and total yield using plastic mulch and row covers on cucumber was reported by Ibarra Jiménez *et al.* (2004) [3].

Table 2. Correlation between microclimate factors and root yield at vegetative and harvesting stage

Vegetative stage

	Soil temperature	Soil moisture	Light intensity	Yield
Soil temperature	1.000			
Soil moisture	-0.391**	1.000		
Light intensity	0.180	-0.628**	1.000	
Yield	0.373**	-0.041	0.449**	1.000

Harvesting stage

	Soil temperature	Soil moisture	Light intensity	Yield
Soil temperature	1.000			
Soil moisture	-0.357**	1.000		
Light intensity	0.254	-0.533**	1.000	
Yield	0.596**	0.161	0.452**	1.000

3.5. Economics

The data on economics (Rs ha^{-1}) of cultivation of Sida hemp under different growing condition, manuring and weed management is furnished in Table 3. Highest cost of cultivation was observed with black polythene mulch with FYM @ 10t ha^{-1} in open condition and in 50% shade, black polythene mulch with FYM @10t ha^{-1} (Rs. 72250) and the lowest cost of cultivation was observed in no weeding without manure in open condition (Rs. 35,000). A higher B:C ratio of 1.73 was obtained from black polythene mulch with manure under open condition. Hand weeding with and without manure under shaded condition recorded lower B:C ratio (0.82).

Table 3. Interaction effect of growing condition, manuring and weed management on Benefit : Cost ratio

Treatments	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio
A1B1C1	66250.00	101354.00	35104.00	1.53
A1B1C2	43688.00	63342.00	19654.00	1.45
A1B1C3	57250.00	60259.33	3009.33	1.05
A1B1C4	35000.00	51396.67	16396.67	1.47
A1B2C1	72250.00	124610.00	52360.00	1.73
A1B2C2	49688.00	65223.33	15535.33	1.31
A1B2C3	63250.00	75242.00	11992.00	1.19
A1B2C4	41000.00	58559.33	17559.33	1.43
A2B1C1	66250.00	68464.67	2214.67	1.03
A2B1C2	43688.00	50580.67	6892.67	1.16
A2B1C3	57250.00	46727.33	-10522.67	0.82
A2B1C4	35000.00	43644.67	8644.67	1.25
A2B2C1	72250.00	83447.33	11197.33	1.15
A2B2C2	49688.00	52598.00	2910.00	1.06
A2B2C3	63250	51850	-11400	0.82
A2B2C4	41000	49900.67	8900.67	1.22

A1 – Open C1 – Black polythene sheet

A2 – 50% shade C2 – Organic mulch

B1 – No manure C3 – Hand weeding

B2 – FYM @ 10t/ha C4 – No weeding

- Labour charges (Rs.600/day)
- Cost of polythene sheet – Rs.7/m^{-2}
- Cost of FYM – Rs. 1200/tonne
- Cost of organic mulch – Rs.6/Kg

4. CONCLUSION

The current research work was carried out to assess the effect of variations in growing conditions, manuring and weed management on soil microclimatic parameters and root yield of Sida hemp. Growing condition significantly influenced the soil temperature, soil moisture and root yield of Sida hemp. Eventhough, manuring had significant effect on root yield, soil microclimatic parameters were not influenced by manuring. Among different weed management methods, black polythene mulching showed higher soil temperature, soil moisture (except from 2nd week to 13th week) and root yield. From the present study, the combination of open condition, application of FYM @ 10 t ha^{-1} and weed management by black polythene mulching can be

recommended as optimum agronomic management for better soil microclimatic parameters and root yield of Sida hemp.

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COMPETING INTERESTS

Authors have declared that no competing interests exist**.**

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