J. Indian Soc. Coastal agric. Res. 34(1): 46-50 (2016)

Studies on Biometric Parameters and Water Requirement of Medicinal Plants under an Agro-shade Net Irrigated with Micro-sprinklers in Coastal Odisha

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Received: 16.10.2014 Accepted:12.05.2016

An experiment was conducted in an agro shade-net house in the Precission Farming Development Center (PFDC), Central Farm, OUAT, to determine the growth and yield of medicinal plants namely Tulsi (*Ocimum sanctum*) and Ghikunari (*Aloe vera*) irrigated by micro-sprinklers. The medicinal plants were planted inside the shade net house as well as in open field condition to evaluate the different growth parameters and water requirement. It was observed that overall growth of medicinal plants in terms of height, number of branches, and coverage area per plant inside shade net house were less as compared to the field condition. Plant height at harvest (after 7th month) inside shade net was 21.5% less in *Aloe vera* and 16.4% less in *Ocimum sanctum* than open field condition as measured in the field. Number of branches inside shade net was 7.26% lower in *Aloe vera* as compared to the open field condition. For *Ocimum sanctum* the number of branches was 7.6% lower inside shade net as compared to the open field. Coverage area of the plant is also lower inside shade net which was 3.31% lower in *Aloe vera* and 28.5% lower in *Ocimum sanctum* as compared to the open field condition. Overall growth of the medicinal plants was more in open field condition as compared to the inside of the shade net due to lack of light intensity and more humidity inside shade net. So agro-shade net is not suitable for both the medicinal plants during their growth period, rather open field condition are more suitable for the plants in the present condition. However, water requirement of the medicinal plants were found to be less inside shade net than in open field condition.

(***Key words*****:** *Medicinal plants, Micro sprinklers, Moisture content, Relative humidity, Shade net house, Tulsi, Water requirement*)

Medicinal plants are the nature's gift for the mankind. India is one of the world's richest sources of medicinal plants, comprises of nearly 45,000 species, but only 60 species are of major commercial use as per the National Medicinal Plant Board. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world. Hence the demand of the medicinal plants is growing day by day in our country as well as in the state.

Ocimum sanctum is commonly known as *Tulsi* or *Holy Basil*, which is a species worshipped by the Hindus. The economically important part of *Ocimum sanctum* is its herb (leaves and tender parts of the shoots). In ayurveda the *Ocimum sanctum* leaves, flowers and occasionally the whole plant is used medicinally in the treatment of heart and blood diseases, leucoderma, strangury, asthma, bronchitis, lumbago and purulent discharge of the ear. The leaf juice possesses diaphoretic, antiperiodic, stimulant and expectorant properties. *Ocimum sanctum* thrives well on a variety of soils and climatic conditions. Rich loam to poor laterite, alkaline to moderately acidic soils are well suited for cultivation of *Ocimum sanctum*. Well drained soils help in better vegetative growth. It flourishes under fair to high rainfall and humid conditions. Long days and high temperatures have been found to be favorable for plant growth and higher oil production. Tropical and subtropical climate is suited for its cultivation.

Aloe barbadensis. popularly known as *Aloe vera* was originated in the warm, dry climates of Africa. However, because of its wide adaptability as well as its importance as medicinal plants, it is well distributed in other countries. In India, it is grown commercially for its high demand in cosmetic industries as well as in preparation of medicines. The succulent leaves are economical part of this plant. *Aloe* is known by several names in India such as *Ghrit Kumari, Kunvar pathu* and Indian *Aloe*. The gel produced from its mature leaves is used in cosmetic industry for preparation of shampoo, face creams and moisturizing agents.

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A shade house is a structure enclosed by agro net or any other woven material to allow required moisture and air to pass through the gaps. It creates an appropriate micro climate conducive to the plant growth. It is also referred as shade net house or net house. It helps in cultivation of flower plants, foliage plants, medicinal plants, vegetables and spices. It can also be used for fruit and vegetable nurseries as well as for raising of forest species etc. (Suresh, 2010).

The purpose of micro irrigation is to apply water relatively frequently at low application rates. Since distribution patterns are typically non-overlapping, discharge variations in individual emitter are repeated in subsequent irrigation events. Small differences in individual emitter discharges can be magnified when irrigations are made on a daily basis and the deviation accumulated. Therefore, it is essential that emitter flow variations should be maximized for efficient water utilization. Micro-irrigation conserves irrigation water easily doubling the command area of a water source and can give yield advantage up to 50%. Its initial capital cost is high and as such without government's active financial support and incentives, it is unlikely to become popularly acceptable. Micro-irrigation systems have been widely used in horticultural production and in landscape irrigation. Micro-sprinklers are a new innovation in micro-irrigation and are a modification to conventional sprinklers and drip. Presently, micro-sprinklers are being preferred in place of drippers because of various advantages such as high discharge rates which reduce the time of operation, increase in wetting diameter, quick and easy detection of faults, less clogging problem etc.

Various studies on water requirement, growth conditions and biometrical parameters of *Aloe vera* have been done by Willem and Cok (1991), Saks *et al*. (1995) and Alejandra *et al*. (2000). Singh *et al*. (2001), reported the performance evaluation of micro jets (classified as non pressure compensating) in respect to pressure–discharge relationship, emission uniformity, wetted diameter. These parameters were determined for different combinations of pressures ranging from 0.5 to 1.7 kg cm^{-2} and stake heights of 0 to 10 cm. The emission uniformity was found to be more than 90%. The wetted diameter increased with increase in operating pressure and stake height of micro jets.

Manjulatha *et al*. (2005 a & b), reported testing of micro sprinklers at 0.5, 1.0, 1.5 and 2.5 kg cm^{-2} pressure and for four heights (20 cm, 35 cm, 50 cm, and 65 cm). However this study was limited to single applicator (Non pressure compensated) and overlaps were not done.

Keeping this in view, a study was conducted at the Precision Farming Development Centre (PFDC) farm, OUAT, Bhubaneswar under the project to study the growth of medicinal plants under a shade net fitted with micro sprinklers as well as under open field condition and also to find out irrigation water requirement of medicinal plants during the growth period.

MATERIALS AND METHODS

Two most common medicinal plants, grown in the tropical coastal belt of Odisha, namely *Tulsi* or *holi basil (Ocimum sanctum)* and *Ghikuanri (Aloe vera)* were grown in the agro shade net house. Different agro-climatic conditions require specific design of the agro shade net house best suited according to the local climatological parameters and the crop requirement for the optimum performance with economical considerations (Suresh, 2010). In the Precision Farming Development Centre (PFDC), OUAT, a shade net house made up of G.I. structure covering an area of 100 m^2 oriented in North-South direction was used for study. The shade house was covered with nylon made agro shade net of 75% opening. The height of the shade net house from the floor to the roof top was 3.0 m. The micro sprinklers were fitted at a height of 2.0 m from the ground surface (Fig.1).

The sprinkler network was laid out with main, sub-main and lateral PVC pipes of diameter 50 mm, 30mm and 16 mm respectively. The pressure compensated micro sprinklers (Rondo micro sprinkler, blue color), supplied by Plasto Plashon Ltd, Pune were selected for its constant discharge irrespective of pressure. The system was connected to a pump house with a 1 HP electric pump set. The water flow was regulated by gate valves and measured by water meter.

Fig.1. *Inside view of the agro-shade net*

The experiment was statistically designed with Complete Randomized Design (CRD) method having plot size of 2.10 × 1.50 and 3.00 × 1.10 m^2 for outside and inside the shade net, respectively and plant spacing of 45X50 cm. The experiment was conducted for a period of 7 months i.e. from 15th October 2009 to 15th May 2010.

Different biometric parameters of the two medicinal plants grown inside the shade net house and outside the shade net house (open field condition) were measured. These biometric parameters were plant height, number of branches and coverage area of plants during the experimental period. Climatic data like temperature, relative humidity, light intensity and wind velocity were measured at regular intervals with the help of thermo-anemometer, hygrometer and lux meter. The tensiometers were employed for measuring the soil moisture at different depths.

Soil moisture depletion in an interval

The irrigation was provided only when the moisture was depleted to 50% of available soil moisture. The depleted moisture level is given by:

$$\text{Depleted moisture} = (FC - WP) \times 0.5 \quad (1)$$

Where,

FC = Field capacity

WP = Wilting Point

The net irrigation requirement is the depth of the irrigation water, exclusive of precipitation, ground water contribution and soil moisture. It is the amount of irrigation water required to bring the soil moisture level in the effective root zone to field capacity. Thus it is the difference between field capacity and soil moisture content in the root zone before starting irrigation (Michael, 1978). It may be calculated as follows:

$$\text{Formula} \quad d = \frac{\sum M_{bi} - M_{ai} * (BD)_i * D_i}{100} \quad (2)$$

Where,

d = net amount of water to be applied during an irrigation, cm

M_{bi} = field capacity moisture content at the 'I' th layer of the soil, percent

M_{ai} = moisture content before irrigation in the 'I' th layer of the soil, percent

BDi = bulk density of the soil in 'i' th layer. (g cm^{-3})

Di = depth of "i" th layer in cm, within the root zone

RESULTS AND DISCUSSIONS

The biometric parameters like plant height, branches per plant and coverage area of medicinal plants were presented below. The height of medicinal plants was measured in every 30 days interval and the values were averaged out (Table 1). It was observed that the height of both the plants were more in open condition than the shade net.

On an average, at the time of harvest the medicinal plants inside the shade net were 21.5% and 16.4% shorter than the open field condition for *Aloe vera* for *Ocimum sanctum,* respectively. The number of branches of medicinal plants was measured in every 30 days interval and the values were averaged out. The numbers of branches were illustrated in Table 2.

On an average, at the time of harvest the no. of branches inside the shade net were 7.26% and 7.6% lower in case of *Aloe vera* and *Ocimum sanctum,* respectively as compared to the open field condition. The coverage area of medicinal plants was measured in every 30 days interval and then they were averaged out. The coverage area was illustrated in Table 3.

Table 1. *Average maximum height of medicinal plants under shade net and open field condition*

Days after planting	*Aloe vera* (cm)		*Ocimum sanctum* (cm)	
	Shade net	Open	Shade net	Open
0	8.1	8.0	16.2	8.7
30	14.5	22.1	24.5	19.8
60	17.7	23.9	31.3	42.9
90	18.7	26.1	34.6	54.4
120	21.4	31.4	40.6	66.1
150	25.8	37.0	51.8	70.0
180	29.8	39.7	58.4	73.0
210	32.3	41.8	59.0	73.0

Table 2. *Average number of branches of medicinal plants under shade net and open field condition*

Days after planting	*Ocimum sanctum*		*Aloe vera*	
	Shade net	Open	Shade net	Open
0	0.0	0.0	5.3	5.6
30	5.6	4.5	6.0	6.8
60	9.0	9.0	6.7	7.5
90	13.8	16.0	6.8	8.2
120	15.0	18.0	7.3	8.3
150	16.0	18.0	8.8	9.3
180	16.0	18.0	9.3	9.8
210	16.0	18.0	9.6	10.3

Table 3. *Average coverage areas (cm^2) of medicinal plants under shade net and open field condition*

Days after planting	*Aloe vera*		*Ocimum sanctum*	
	Shade net	Open	Shade net	Open
30	357.5	682.4	110.6	188.5
60	630.6	930.3	220.8	1695.0
90	857.6	1379.6	298.7	2514.0
120	1163.2	1511.0	767.5	3026.0
150	1558.7	1629.9	1136.0	3301.2
180	1700.6	1794.7	1641.0	3583.0
210	1859.3	1923.0	2653.8	3719.0

Table 4. *Total water requirement of the medicinal plants under shade net and open field condition*

Medicinal plants	Effective rainfallin cm		Depth of irrigation in cm		Total water requirement in cm	
	Shade net	Open field	Shade net	Open field	Shade net	Open field
Aloe vera	7.5	8.18	53.6	115.02	61.1	123.2
Ocimum sanctum	7.5	8.18	72.2	102.52	79.7	110.7

On an average, at the time of harvest the coverage area inside and outside the shade net were 3.31% and 28.5% lower in case of *Aloe vera* and *Ocimum sanctum*, respectively as compared to the open field condition.

Water Requirement

The total water required for full growth of the medicinal plants inside and outside the shade net were the difference between field capacity and wilting point in each case. It is the summation of the irrigation water applied and effective rainfall. Daily moisture content was taken with the help of tensiometer and at the time of required moisture level as described earlier irrigation was given to the plot. It was found out that total number of irrigations of the medicinal plants in open field condition were more as compared to the inside shade net house in both cases of plants (Table 4). It was found that total water requirement of medicinal plants inside the shade net house were 53.4% and 29.55% less in *Aloe vera* and *Ocimum sanctum,* respectively over open field condition. Hence, the water requirement was less in shade net house as compared to the open field condition in both cases of medicinal plants.

CONCLUSIONS

The water requirement of both medicinal plants was less inside the shade net as compared to the open field condition. The water requirement of *Aloe vera* and *Ocimum sanctum* inside the shade net were 53.5% and 29.6% less as compared to the open field condition. The variation is due to significant reduction in light intensity of sun and increase in mean relative humidity inside the shade net as compared to open field conditions in both types of medicinal plants. The water requirement is low inside the shade net because the evapotranspiration is less inside the shade net as compared to the open field condition. The different biometric parameters of both the plants were observed to be more for open field condition

than the shade net condition. So agro-shade net is not suitable for both the medicinal plants during their growth period, rather open field condition is more suitable for the plants in the present condition.

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