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Cost Effective Technology for Waste Management

Dr. R. Joshua
Internal Coordinator, Scheme of CDTP, Govt. of India, MHRD,
Mohamed Sathak Polytechnic College, Kilakarai, India
Dr. P. Vincent
Principal, Madurai Kamaraj University College, Sahthur, India

Abstract:
Sustainability in agriculture is the primary need of the country, especially for farmers in the society. Sustainable agriculture depends on, a. the quality and quantity of irrigational water used, b. Status of soil in the Land and c. the dimatic conditions of the environment. In most of the locations and for particularly in coastal regions such a ideal conditions could not be possible. Developing a new technology for sustainable agriculture is a one of the current challenges for agricultural scientist, Environmentalist and for younger scholars from various academic institutions. Focusing on this issue, a low cost model has been developed by integrating three different technologies together within a single frame of green chamber arrangement. The quality of irrigational water could be improved by having a solar still and the distillated output having sufficient level of sodium absorption ratio is utilized to irrigate the coir pith medium in a container. Coir pith waste with vermin mix in a particular proportion acts as soil surface within a dosed green chamber arrangement to execute the photosynthetic principle which provides sufficient climate conditions for the growth of plant within the closed chamber. An experimental study was carried out by growthing jasmine plants within the model. The growthing performance were analysed by measuring its shoot length, shoot weight, root length, root weight and biomass in different directions and were compared with the growthing performance in the normal soil medium. The growthing performance was found better in the model. It gives solutions to the issues.

i. The quality nature of unused water could be improved by having solar stills.
ii. Coir pith, the waste material which causes could be used as soil medium.
iii. Waste lands could be converted into cultivating surface.
iv. Young Rural Entrepreneurs could be motivated by developing such a community models in Rural sectors.

Keywords: *Integrated approach, Sustainable agriculture, Solution for environmental degradation.*

1.1. Contribution/ Originality

Sustainable Agriculture makes optimal use of locally available natural and human resources to produce high-quality and sufficiently safe food products which are economically feasible, ecologically sound, culturally adopted and socially justified. This sustainable agriculture includes conserving and protecting the quality of the resources that determine the performance of agriculture. The current study integrates three major technologies for sustainable agriculture as mentioned below,

- The technology on treatment of ground water for irrigational usage by having a low cost solar still.
- The technology of coir pith compost as an alternate for soil medium for the growth of plants.
- The technology on application of photo synthetic principle on a solar green chamber.

1.2. Aim and Objectives

In this work the natural resources, Renewable Energy Sources and Agro waste were combined together to develop a new model for sustainable Agricultural in the coastal region of Ramanathapuram district. These integrated approach leads,

- To assess the suitability of ground water for irrigational usage in Ramnathapuram District.
- To treat the saline water for irrigation purpose using solar still.
- To develop an irrigation model by integrating the solar still with green chamber.
- To analysis the performance of Integrated Solar still with green chamber.
- To study the growth rate of Jasmine plant in the soil less coir pith medium.

1.3. Irrigational Water Quality Parameters

As the work is related with irrigation technology, it is necessary to assess the water quality parameters which determine the suitability of water for irrigational usage. Electrical conductivity, total dissolved solids and Sodium absorption ratio are the three important water quality parameters, which determines the suitability for irrigational water. The permissible limit prescribed by various organizations for the suitability of irrigational water are represented in the Table 1,

Parameters Units (mg/l)	**World Health Organaization 1984**	**International Standard (1983)**		**Desirable limits as per IS : 10500, 1991 & 1993**
		Highest Desirable	Maximum Permissible	
Physical				
Turbidity(NTU)	5	-	-	5
EC (micro mhos/cm)	1400			
TDS	1000	500	1500	500
Chemical				
pH	6.5-8.5	7.0-8.5	6.5-9.2	6.5 – 8.5
Alkalinity	-	-	-	200
Hardness	500	-	300	300
Calcium	75	75	200	75
Magnesium	50	30	100	30
Sodium	200	-	-	-
Potassium	55	-	-	-
Chloride	250	250	1000	250
Sulphate	400	150	400	200
Bicarbonate	-	300	600	-
Carbonate	-	-	-	-
Nitrate	50	-	45	45

Table 1: Standard Limitations on quality parameters of irrigational water

In general, the qualities of ground water available in the coastal region are not suited for irrigational usage. The Experimental observations that the quality parameters of electrical conductivity, total dissolved solid and total hardness were found higher than that of the prescribed level by the standard organizations. To make use of this water for irrigational usage, it should be treated by adopting suitable technology using Solar Still.

2. Solar Still for Water Treatment

A domestic solar still model with an estimated cost of Rs.3,000 has been utilized for this study. A glass surface of $1m^2$ area has been used to collect the solar radiation. On examination, the quality and standards of the distillated output from the solar still was found fit for irrigation theoretically. The observed values of electrical conductivity, total dissolved solids and the calculated values of Sodium absorption ratio were all found within the standard values. For practical analysis a case study has been carried out in this work.

2.1. Nature of Soil

Soil condition is another important parameter which determines the rate of growth of the plant in a medium and it may differ from location to location and for season to seasons. As for as in Ramanathapuram district, mostly 60% of the total land were found not suited for cultivation. Because of its saline and alluvial nature the sustainable agriculture is not possible. To overcome this issue it is necessary to improve the physical and chemical conditions of the soil medium or certain changes could be made to improve the status of the soil condition with proper technology.

2.2. Need for Alternate Technology

Soil is the primary need for cultivation. Due to the frequent usage of chemicals and fertilizers the quality of soil becomes very poor condition and it is not possible to cultivate continuously. It is impossible to get better yield from such soil. Instead of improving the nature of soil, an alternate solution has been suggested for sustainable agriculture. Usage of coir pith compost as soil medium will provide better yield in agriculture sector. Previous studies are proving this technology.

2.3. Coir Pith as Rooting Medium

The coir extraction leaves a dusty, non fibrous spongy material called coir pith or coco peat which accounts for about 50-60 percentage of the husk mass having the soil application. The specialized structure of the coir pith helps to retain water and oxygen and prevents loss of vital nutrients from the farm. Hence the coir pith is being preferred as a rooting medium and considered as a better alternate for soil medium. It absorbs water up to eight time of its weight. The special features and the benefits of the coir pith were discussed,

Contains macronutrients – Nitrogen, Phosphorus and potassium

- Contains micronutrients – Calcium, copper and magnesium
- Contains natural enzymes
- Excellent water holding capacity
- Improves aeration
- Enhances strong heap root system
- Stimulates production of python hormones
- Ideal pH level – 5.6 to 6.4
- Eco-Friendly

2.4. Benefits of Coir Pith Compost

Coir pith compost having the following benefits,

- It improves the soil texture and structure.
- It improves the soil aggregation.
- It improves the water holding capacity (more than 5 times its dry weight) contributing towards increased soil moisture.
- The bulk density of both the sub surface (15-30 cm) soil is reduced to considerable extent with the application composted coir pith.
- Composted coir pith contains all plant nutrient elements and it can provide a supplemental effect along with inorganic fertilizers.
- There is improvement in caution exchange capacity of soils, where composted coir pith is applied.
- Coir pith compost application increased the soil native micro flora because of addition of humid materials.
- Ammonification, nitrification and nitrogen fixation are increased due to improved microbiological activity.

3. Experimental Studies on Coir Pith

The experimental analysis were made for a selective samples and the results on chemical analysis were discussed as detailed

- Nitrogen (0.21- 0.30%),
- Phosphorus (0.09-0.10%),
- Potassium (0.78-1.02%),
- Calcium (0.35-0.42%),
- Magnesium (0.36-0.70%),
- Carbon (20-26%)
- Cellulose (20-27%),
- Lignin (25-30%)
- Sulphur (0.04-0.20%),
- Ash (2-7%),
- Pentose (9.5%),
- Resin (1.28%) and
- Iron (1000ppm).
- The carbon nitrogen ratio in the coir pith is 112:1.

3.1. Moisture Content in Coir Pith

To calculate the moisture content a known weight of the coir pith sample was taken in a crucible and kept in hot air oven at 103°C till it attained constant dry weight. From this, the percentage of moisture content and the dry weight were calculated using the following relation:

$$\text{Percentage of moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where, W_1 = Weight of crucible

W_2 = Weight of Wet coir pith with crucible

W_3 = Weight of dried coir pith with crucible

Dry coir pith obtained from mechanical process was found to be effective in retaining the moisture. Use of coir pith as a soil less growth medium has a great advantage, since the coir pith has a low weight and high water holding capacity. Coir pith resists degradation and it is not easily composted because of the presence of linins and cellulose. Coir pith is having high ion exchanged property. It has a low calorific value between 4000 and 4500 cal/g. It does not burn in its natural state. Coir pith compost contains macronutrients. It can absorb water up to eight times its weight, Coir pith, when added to sandy soil at 2 per cent increases the water holding capacity was experimentally as 40%.

3.2. Chemical Contents in Vermin Compost

To improve the fertile quality of coir pith it is necessary to mix the vermin composting material with the coir pith in the ratio of 10:1. Before mixing the organic composting material into coir pith it is necessary to analyze the chemical components present in the vermin composting material. Vermin compost is the product of decomposition of animal waste with a mix of agro waste, cow dung; excreta of the cattle, crop residues, gar bag, kitchen waste etc. Selected type of vermin is allowed to live in the mixing unit for a particular period of 45 days. After, decomposition and permutation de composting materials as vermin could be available. These available vermin compost contains rich nutrient value suitable as fertilizers. The samples collected from the testing unit were analyzed thoroughly in the testing laboratory at coastal saline research station, Ramanathapuram. The chemical components present in the vermin compost were reported in Table 2.

Parameters	Values
pH	6.80
EC (mhos /cm)	11.70
Total nitrogen (%)	1.94
Nitrate nitrogen (ppm)	902.20
Phosphorous (%)	0.47
Potassium (%)	0.70
Calcium (%)	4.40
Sodium (%)	0.02
Magnesium (%)	0.46
Iron(ppm)	7563.00
Zinc(ppm)	278.00
Manganese(ppm)	475.00
Copper (ppm)	27.00
Boron (ppm)	34.00
Aluminum (ppm)	7012.00

Table 2: Chemical components in Vermin compost

3.3. Nutritive Value of Composted Coir Pith

The coir pith obtained from the mechanical process has high nutrients. Coir pith compost is used as a source of plant nutrition, when compared to other major nutrients. The nutrient content of coir pith mix with vermin compost was examined at the testing laboratory in coastal saline research centre and its values were reported in the Table 3.

Sl. No.	Parameters	Values (%)
01	Lignin	4.80
02	Cellulose	10.10
03	Carbon	24.00
04	Nitrogen	1.24
05	Phosphorous	0.06
06	Potassium	1.20
07	Calcium	0.50
08	Magnesium	0.48
09	Iron(ppm)	0.09
10	Manganese(ppm)	25.00
11	Zinc(ppm	15.80
12	Copper (ppm)	6.20
13	C:N ratio	24:1

Table 3:.Nutrient content

The potassium is in relatively higher quantity in the coir pith. Coir pith has gained importance owing to its properties for use as growth medium in Horticulture. Because, of wider carbon and nitrogen ratio and lower biodegradability due to high lignin content. Coir pith is composted to reduce the wider C:N ratio, reduce the lignin and cellulose content and also to increase the manorial value of pith. Composting of coir pith reduces its bulkiness and converts plant nutrients to the available form.

4. Integrated Solar Still with Green Chamber

The three individual units of I) solar still with water inlet tank, II). Coir pith container with vermin mix and III). Green chamber grow thing unit were integrated together to evaluate the study.

An inlet tank with 5ltr capacity is permitted to enter into the solar collecting area through a narrow pipe. Then it is treated and the distillated output is allowed to pass over the coir pith container enclosed in a green chamber. The entire experiment arrangement is as shown in Figure 1.

Figure 1: Integrated solar still with green chamber

The experimental study has been conducted during the hot weather season at Mohamed Sathak Polytechnic College campus, Kilakarai for a period of 42 days. The growth rate has been observed and recorded during the period. During the study the following observations were made periodically to evaluate the performance of the experimental arrangement.

- Temperature variation above and inside the green chamber.
- Moisture content of the coir pith container.
- Growthing rate of the plant in different directions.

4.1. Selection of Plant

Four numbers of jasmine plants having the same initial life period has been selected to perform the growth rate in the coir pith container. The performance of the growth rate of the same plant in natural soil has been recorded to compare the growthing performance in the alternate coir medium. Four numbers of Jasmine plants has been planted in four different directions at the coir pith unit and it is allowed to growth for a period of 42 days in a coir pith medium. Distillated output water from the fabricated solar still is permitted to irrigate the coir medium. To assess the uniformity of moisture content it is necessary to evaluate the moisture content present on four different directions in the coir pith container.

4.2. Green Chamber Experimental Arrangements

The green chamber is an experimental system or it is a growth chamber, which offers the possibilities of the excellent climatic conditions for the growth of plant in the coir pith medium. The objective of the solar green unit structure is to allow maximum visible radiation to strike the plant. So that the plants can receive their fare and share of sunlight. This structure with transparent green shaded cover uses to allow solar energy to provide environmentally controlled plant growth facility. This is a cost effective design which creates a pleasant improvement for temperature control. The growthing chamber which is identical to that of green house unit was developed for this study. The green shaded cover with Polythene material was tightly enclosed on the metallic frame of dimensions of length, breadth and height of 1 meter each.

A coir pith mix with vermin in the ratio of 10:1 was enclosed in a separate container of size 0.75 meter in length and breadth with a height of 0.25 meter. The total weight, which measures 15 kg was spread uniformly within the container. The entire containers were divided into four sectors to growth one plant in each direction. Four samples of jasmine plant having the same life period from the horticulture farm was selected for testing. The growth rate of the plant was studied under the enclosed green chamber for the period of six weeks time (6 x 7 = 42 days). The continuous performance of the growth rate was examined during this study and its progress was reported in this chapter.

4.3. Theory on Photo Synthetic Effect in Green Chamber

Green Chamber works on Photosynthetic effect. It is a reaction of sunlight in green plants. In photosynthesis is the radiant energy of sun is absorbed by the green pigment chlorophyll in the plant and is stored within the plant in the form of chemical bond energy. In this reaction, water and CO_2 molecules broken down and a Carbohydrate is formed with the release of pure oxygen.

This process can be expressed as,

$CO_2 + H_2O$ + light + Chlorophyll $\longrightarrow$ $(H_2CO)_{6+O}2$ + Chlorophyll

(Or)

$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6$ (Sugar) $+ 6H_2O + 6O_2$

Hence, the Photosynthesis in a plant is a biological conversion of solar energy into sugars and starches which are energy rich compounds.. Visible light having a wavelength below 700°A is absorbed by the green Chlorophyll which becomes activated and passes its energy on to the water molecules.

A hydrogen atom is then released and reacts with the carbon dioxide molecule to produce H_2CO and oxygen. H_2CO is the basic molecule forming carbohydrate, stable at low temperature; it breaks at high temperature, releasing an amount of heat equal to 112000 cal/mole. The absorbed energy of protons should be possible to produce large amount of carbohydrate by growing algae under optimum condition in green house frame.

4.4. Process of Photosynthesis

The process of photosynthesis has two main steps splitting of water molecules into Hydrogen and Oxygen under the influences of chlorophyll and sunlight. This phase of reaction is called the light reaction. In this phase, light is absorbed by chlorophyll causes photolysis of water. Oxygen escapes and Hydrogen is transformed into some unknown compound this solar energy is converted into potential chemical energy. In the second phase, hydrogen is transferred from this unknown compound to CO_2 to form starch (or) sugar. Formations of starch or sugar are dark reaction not requiring sunlight. The important conditions necessary for photosynthesis are concentration of CO_2 and temperature.

CO_2 is the primary raw material for photosynthesis. Increase in CO_2 artificially results a linear increment in the yield. Hence one of the methods of increasing the biomass is by supplying additional CO_2 to the plant. The main sources to increase the amount of CO_2 to the plant are animal respiration and the decay of organic matter by bacteria.

5. Bio Conversion and Biomass

Biomass means organic matter. In photosynthesis the solar energy is stored in the form of chemical energy. In this process, the energy is not transformed as heat but it is utilized in atomic and molecular systems by undergoing the chemical changes and biomass is produced. This biomass is used directly, to produce more convenient liquid by harnessing of solar energy. Thus the conversion involves,

Solar Energy $\longrightarrow$ Photosynthesis $\longrightarrow$ Biomass $\longrightarrow$ Energy generation

5.1. Experimental Observations

Temperature variation and the moisture content in coir pith are two important physical parameters, which determine the growth rate of a plant in the coir medium within the closed green environmental conditions. Experimental observations were made for a period of 42 days. The hourly variation of ambient temperature, temperature of air in the green chamber and the temperature of the coir pith medium were recorded during the study. The average variations of the above temperature during the study were reported in the Figure 2

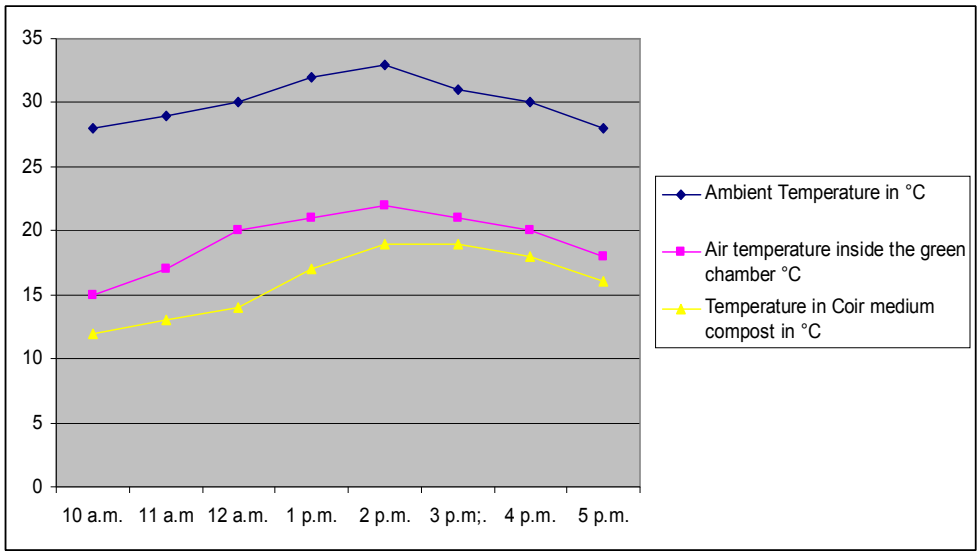

Figure 2: Performance of Temperature variation

From the Figure 2 , it may be observed that, the variation in air temperature inside the green chamber and the temperature of the coir pith compost depends on the ambient temperature. It is observed that the maximum ambient temperature during the study was 33°C

and its corresponding variation in the air temperature inside the green chamber and the coir compost were found 22°C and 19°C respectively. The temperature of the coir pith container was found much suitable for better growth rate of the selected plant.

5.2. Study on Moisture Content in the Coir Pith Container

The growth rate of the jasmine plant in the coir pith medium has been analyzed by measuring the moisture content of the coir pith compost medium. The coir pith medium requires minimum water for its growth. The water holding capacity is more than eight times than that of the soil medium. To ensure uniformity in irrigation it is necessary to measure the moisture content in four different directions. Hence, samples were collected along four different directions from the coir pith container periodically to measure its moisture content. The moisture content was measured weakly once and the average values were calculated. The variations of moisture content during the study were given in Figure 3

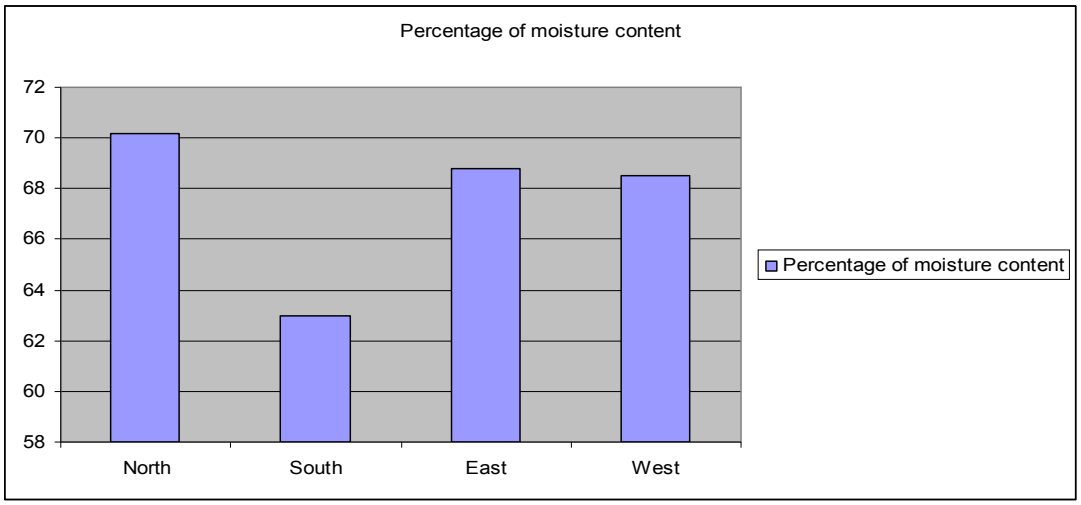

Figure 3: Variations of Moisture content within the coir pith container

From the above bar chart it is observed that the presence of moisture content within the coir pith compost container during the studying period was clearly explained that the moisture content is almost uniform in all the directions except south. The variation is due to the water absorbing capacity is less in south direction. This is because the outlet of the solar still has been integrated with the growthing chamber along the north direction.

5.3. Study on Growthing Parameters

Root length, Shoot length, Root weight, Shoot weight and the total weight of the biomass are the important growthing parameters to assess the growthing rate performance of the jasmine plant within the covered green chamber. After a growthing period of 42 days the measured values of the above parameters were recorded in Table 4.

Plants Direction	Shoot length (cm)	Root length (cm)	Total length (cm)	Shoot weight (g)	Root weight (g)	Total Biomass
North	32.97	18.24	44.5	17.487	3.213	20.696
South	25.45	14.72	40.15	15.891	2.777	18.812
West	22.7	12.37	35.07	15.235	2.986	18.235
East	32.95	16.54	49.53	17.610	3.718	21.339
Growth rate in Soil	18.4	11.25	29.65	14.300	2.700	17.000

Table 4: Measurements and calculations of grow thing parameters

The growthing rate performance of shoot length, root length, shoot weight and root weight were observed in four different directions. The performances of the same parameters were also observed for the same plant on the ordinary soil medium. The growthing rate within the green chamber on the coir pith container after a period of 42 days were compared with the same performance of the plant on the soil medium in Figures 4

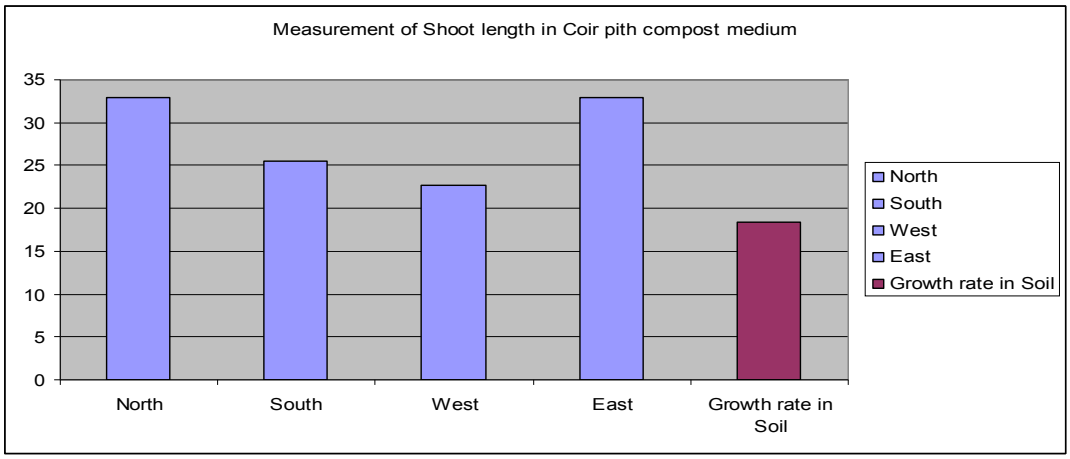

Figure 4 (a): Analysis of Shoot length

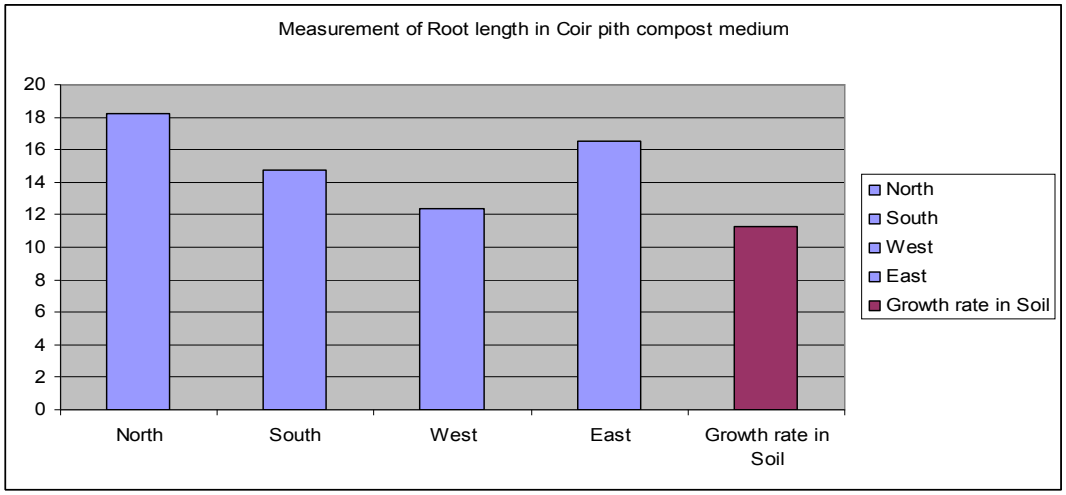

Figure 4 (b): Analysis of Root length

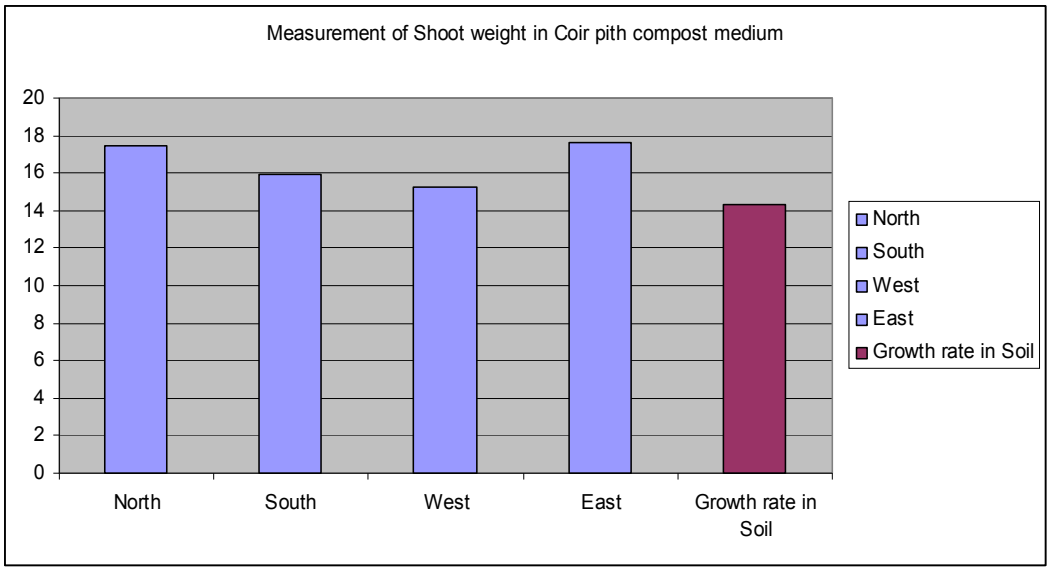

Figure 4 (c): The variations of Shoot weight

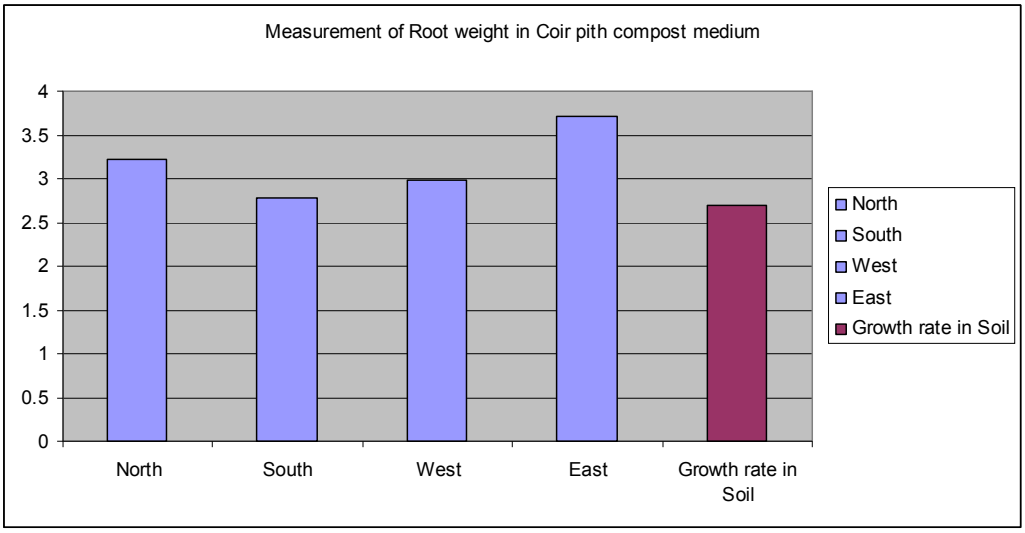

Figure 4 (d): The variations of Root weight

From the above Figure 4 (a) and (b), maximum shoot length and the root length were observed in the north direction. In this direction the water flow rate from the still is high whereas, in the west direction the shoot length and the root length were found minimum. This direction receives maximum amount of heat radiation. This is the reason for its variation.

From the above Figure 4 (c) and (d) it is observed that the shoot weight and root weight were found higher than that of the results obtained with the same plant in the ordinary soil medium. It shows that the performance rate is better in coir pith medium than that of the normal soil medium.

The average shoot weight of the plant above the coir pith medium was found 16 grams whereas the shoot weight of the same plant in the soil medium is around 14 grams for the period of 42 days. Hence, the healthy growthing appears on the coir pith medium than that of the soil medium. The variation is due to the care taken on the growth of the plant inside the green chamber.

The average Root weight of the plant below the coir pith medium was found 3 grams whereas the Root weight of the same plant in the soil medium is around 2.7 grams for the period of 42 days. Here also the healthy growthing appears on the coir pith medium than that of the soil medium. Hence the coir pith has considered as one of the best rooting medium for the growth of plants.

From the observation It is obvious that the Northern side had the highest amount of moisture contest. But, the moisture contents at eastern and western sides were more or less equal. It was observed that in this short duration the plant beard buds and flowers. This showed that coir pith was able to sustain a crop similar to that of soiled medium. From the bio mass estimation, it was found that maximum growth was in plants grown in eastern side of still. This could have happened because of sufficient sunlight and hence enhanced irrigate in that side. These would in turn could increase the photosynthetic activity of plant and thereby the growth rate. Such a technology should be extended in waste land area for sustainable agriculture. Thus, sustainable agriculture could be possible in the closed green environmental than the normal soil medium.

6. Conclusion

For a wealthy growth of any plant it needs healthy soil, quality water and controlled green environment conditions. In coastal district like Ramanathapuram, these ideal conditions are not possible to carry out the sustainable agriculture. In this situation, the integrated technology introduced in this study will lead for sustainable agriculture. The case study on Jasmine plant proves the possibilities of this success technology for implementation. This integrated technology leads towards harmful work on agriculture without pain.

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