Hydroponics for the Cultivation of Medicinal Herbs

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Abstract: ***Increased population, sub urbanization of forest, improper agricultural practices like excessive use of pesticides and fertilizers have lead to the decrease in fertility of the soil. Also due to the global warming and climate changes there is a very less rain fall which has lead to water scarcity. Apart from these problems the forest remains the only source of many herbal medicines and we find it difficult to get these herbal plants because of the urbanization of the forest. As a solution for the above mentioned complications hydroponics is said to be a better alternative. Hydroponics is the soil less growth of plants in which water mixed with nutrients is used for the cultivation of plants. Hydroponics has been used for the cultivation of food crops in western countries. As the consumption of herbal medicine is increasing worldwide, hydroponics can be used for the cultivation of medicinal plants without losing its originality and medicinal values. This method of cultivation will decrease the necessity to relay on forest as the only source for herbal medicine. The hydroponics is considered to be a costly approach so we are planning to build a cost efficient system having a better yield. We have chosen three plants for this study namely Karisalankanni, Siriyanangai, and Marigold. We are also planning to build a cost efficient hydroponic system. We have designed natural media for the hydroponics suitable to grow the plants.***

Keyword: Hydroponics, Vermicompost Extract, Cattle shed soil Extract.

I. INTRODUCTION

In 20th century, there was an immense growth in the field of agriculture due to the advent of many useful equipment and various agriculture practices. On the other hand, human civilization and population explosion started to exploit various resources which play essential role in agriculture such as water, land etc. Due to rapid industrialization, the environment was greatly affected which made the fertile land to be not suitable for any sort of cultivation. To overcome these conflicts we have to develop a new trend that would make agriculture to be carried out in a most efficient manner. One such method is Hydroponics. Hydroponics is soilless agricultural practice in which the plants were grown in a medium consisting of nutrient solution. The word "Hydroponics" was first coined by Dr. W. F. Gericke in 1936. This term was derived from two Greek words 'Hydro' and 'ponos' in which 'hydro' means water and 'ponos' means labor. The first commercial practice of hydroponics was done by Dr. W. F. Gericke for growing tomatoes, lettuce and some other vegetables. The major advantages of hydroponics are as follows: a) More product yield can be obtained when compared to traditional agriculture practice, b) Usage of chemical pesticides and fertilizers can be prevented, c) Soil borne diseases can be eliminated, d) Comparatively healthy and fresher products can be obtained, e) Water scarcity can be overcome, f) No need for larger space for cultivation as like traditional practice and g) Plants will get balanced supply of air, water and nutrients[1].

Apart from the advantages, there are some limitations associated while employing hydroponics [1]. They are as follows: a) The investment is very high while adopting for a commercial purpose, b) A constant supply of water is needed for some type of systems, c) Constant power supply is needed in case of some flowering plants and d) Commercial scale requires well trained technicians. In traditional agricultural practice, the field medicinal herbs and plants were grown along with the food crops. Those people used those herbs for medicinal value. These herbs can provide permanent cure but takes long time. In the last century, a conventional medicine called molecular medicine was introduced and they can target the protein or the enzyme associated with the particular ailments. These conventional medicines can exhibit rapid cure of diseases but they are not said to be a permanent cure. It also has some side effects. But during the past decade people again started to practice folk herbal medicines. Nowadays, these herbs have a great demand among the markets. So, we should take some measures regarding these issues. Hydroponics can do some miracles with the development of medicinal herbs [1].

There are different types of hydroponic system available commercially in markets. They are simple wick system, water culture, ebb and flow system, drip system (recovery/non recovery), Nutrient Film Technique (NFT) and aeroponic system. In this background, a hydroponics system was developed with natural means. It was planned to grow the medicinal herbs such as a) *Eclipta prostrata*,b) *Andrographi spaniculata* and C) *Tagetes erecta* in a hydrophonics system which was designed in-house.

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II. MATERIALS AND METHODS

A. Seeding

The seed mix consist of a mixture of the following coconut coir, coco peat, cotton, micro and macro nutrients need for the plants growth and trace amounts of compost to nourish the growth of plants. First we know the mode of propagation of our plant. In this study we used three plants namely Mariegold – Calendula officinalis; Karisalankanni – Eclipta prostrate; and Siriyananghai – Andrographi spaniculata. The seed mix can capable of retaining the moisture for a long period so that the plant can grow efficiently. It should be watered continuously to prevent from drying. Once after the plants reached a certain height it should be transferred to the hydroponic system. Usually it takes for about 10-15 days for a plant to grow to the required range.

B. Hydroponic Setup

Hydroponics setup consists of a rectangular tank with two holes to which the water and the nutrient solution is filled in. The plants are suspended from baskets at the top. The baskets are provided with large pores for the roots to touch the solution. They are usually filled with some supporting medium. Here we used LECA as a supporting medium. LECA stands for Light weight Expanded Clay Aggregate. It is made up of expanded clay pellets used for holding the moisture content and they are neutral in pH. The holes are provided through which the air pump is connected externally for aeration. The roots of the plant are dipped into the solution thus they get the nutrients for their growth.

C. Formulation Of Natural Media For Hydroponics:

Vegetable Waste Extract Vegetable waste was collected from vegetable market in Rajapalayam. The waste contains seed, pulp and peels. They were soaked into the water and closed air tied. They incubate up to 15 days in a dark room. After a period of 15 – 20 days the solution achieved with the formation of carbon-di-oxide appeared. The solution was filtered to get a concentrated solution. The observed solution is highly viscous and has an acidic odour. The solution was diluted in a ratio of 1:10 (10mL of solution and 90 mL of water) for implement hydroponics.

Vermicompost Extract

The vermicompost was purchased commercially from a farm in Madurai. The vermicompost was packed in a packed bed reactor and water was passed through it to obtain the extract. For instance we used a burette as the column for the packed bed reactor. To prevent the flushing out of the vermicompost the bottom of the burette was sealed using cotton. The vermicompost was added to it and packed tightly. Water was allowed to percolate through the column to get a concentrated solution. The solution was collected using a beaker it was slightly yellow in color. The procedure is repeated for about 20 days to get about 300 ml of extract. Two packed bed reactors were used simultaneously to get a higher yield of solution.

D. Panchakavya

The panchakavya solution was purchased from the commercial vendor. It was diluted in a ratio of 1:10 (1mL of panchakavya and 99mL of water) Karisalankanni plant was used.

E. Cattle Shed Soil Extract

The top layer of the soil from the cattle shed was collected and prepared extract. The soil was placed in a muslin cloth and water will allow percolating through it and the extract was collected. The solution was darkly colored.

F. Estimation Of Plant Growth

The length of the stem, the width of the stem, the number of leaves and the color of leaves was noted during the time of implementation and continuously monitored upto 20 days.

G. Chlorophyll Assay

Chlorophyll, a green pigment plays a vital role in photosynthesis. The amount of chlorophyll a and b was found out for both the control and the test (Vermicompost Extract {positive control}, Cattle shed soil Extract). First the leaves were weighed, and then it was grinded using mortar and pestle by adding a small amount of methanol. Leave it for some time as the methanol evaporates Transfer this sample into an tube. Observed the optical density using spectrophotometer for chlorophyll ‘a’ at 663 nm, 645 for chlorophyll ‘b’ and methanol was used as blank (Arnon1949).

III RESULT

A. Seeding

The seeds were planted in the seed mix for marigold and siriyanangai. The stem was planted for karisalankanni in the seed mix. The karisalankanni and siriyanangai were growth in the hydroponics system. The marigold plant is not suitable for the hydroponics system. The seeing of herbs was showed in Fig 1. The commercially available hydroponis set was reported in Fig 2

Fig 1 Seedings of Plant

Fig 2: Commercially available Hydroponics Setup

B. Formulation Of Natural Media For Hydroponics

The plants Karisalankanni and Siriyanangai was implemented in vegetable waste extract, vermicompost extract, Panchakavya and cattle shed soil extract at various concentration like 0.5:10, 1:10, 2:10, 5:10. The

setup allowed growing with aeration. The results were reported in Table 1 and Figure 3 and 4. From our observation, the cattle shed soil extract shows the higher growth than the positive control Vermicompost extract.

Table I: Formulation of Natural Media for Hydroponics

S.No	Hydroponics Solution	Result
1	Food Waste Extract	-
2	Vermicompost Extract (positive control)	+
3	Panchakavya	-
4	Cattle shed soil Extract	+

Fig 3: Vermicompost Extract Solution

Fig 4: Cattle Shed Soil Extract Solution

C. **Estimation Of Plant Growth From Different Media**

Comparing the chemical media, positive control with cattle shed soil extract solution, the plant growth and number of leaves were produced were observed and estimated. It was reported in Table 2. Our data reveals that the growth of plant will be increased in cattle shed soil extract as compared to the others from the day 1 itself.

TableII: Estimation of Plant growth from different media

S.No	Media	Plant Length (cm)			Plant Breadth (cm)			No of Leaves		
		1st	10th	20th	1st	10th	20th	1st	10th	20th
1	Chemical Media	16	18	22	0.30	0.35	0.35	9	12	18
2	Vermicompost Extarct	16	21	25	0.25	0.27	0.27	10	18	25
3	Cattle shed soil Extract	16	19.5	23	0.35	0.35	0.35	12	14	20

D. **Chlorophyll Estimation**

The concentrations of chlorophyll content of leaves were estimated for the leaves grown in chemical media, vermicompost extract and cattle sheld soil extract. It was reported in Table 3. From our observation, the high level of chlorophyll was estimated in Cattle shed soil extract than the chemical media and vermicompost extract.

Table III: Chlorophyll Estimation

S.No	Media	Chlorophyll Content (mmol/L)
1	Chemical media	0.64
2	Vermicompost Extract (positive control)	0.85
3	Cattle shed soil Extract	0.79

IV DISCUSSION

Due to rapid industrialization, the environment was greatly affected which made the fertile land to be not suitable for any sort of cultivation. To overcome these conflicts a researches develop a new trend that would make agriculture to be carried out in a most efficient manner as hydroponics. Even though hydroponics has many advantages but some disadvantages are showed as used of chemicals. So we developed the hydroponics as natural manner without artificially synthesized chemicals. In our present study, we selected the medicinal herb such as a) *Eclipta prostrata*, b) *Andrographi spaniculata* and C) *Tagetes erecta* for the hydroponics setup. We designed a hydroponics setup with natural means such as vermicompost extract, Vegetable waste extract, Panchakavya and Cattle shed soil extract. Before the plants were growing in hydroponics solution, they were processed by seeding to optimize their growth for further process.

Several years, the world scientist studied about the effects of “the liquid composts“, i.e. water extracts from composts and vermi-extracts on plants [2, 3]. The vermi-extract applied in the agriculture field to increased the maize grain yield if the ap-plication doses were at the level of 130 to 170 dm3·ha-1. It also increase the starch content in grain carry out the presowing application of vermi-extract [2].

Panchagavya is a combination of five by-products of cow along with certain other ingredients, has the potential to promote the palnt growth and providing immunity in plant system. It also plays a major role in organic farming [4].

Vegetable waste consists of of seed, skin, rind, and pomace, containing bioactive compounds, such as carotenoids, polyphenols, dietary fibers,

vitamins, enzymes, and oils, among others. These phytochemicals can be used in many industries including the food industry, for functional development or enriched foods, the health industry for medicines and pharmaceuticals, and the textile industry, among others [5].

The seeds were planted in the seed mix for marigold and siriyanangai. The stem was planted for karisalankanni in the seed mix. The karisalankanni and siriyanangai were growth in the hydroponics system. The marigold plant is not suitable for the hydroponics system.

The plants Karisalankanni and siriyanangai was implemented in vegetable waste extract, vermicompost extract, Panchakavya and cattle shed soil extract at various concentration like 0.5:10, 1:10, 2:10, 5:10. The setup allowed growing with aeration. The plants Karisalankanni and siriyanangai was implemented in vegetable waste extract, panchakavya were dried and decayed. In the vermicompost extract and the cattle shed soil extract, Karisalankanni shows maximum growth compared to the siriyanangai. Vermicomposting of cow manure using earthworm species *E. andrei* [6] and *E. foetida* [7] favoured nitrification, resulting in the rapid conversion of ammonium-nitrogen to nitrate-nitrogen. Therefore it improves the nutrient cycling and helping to convert unavailable nitrogenin available forms to plants.

So we selected Karisalankanni for further process. Our data reveals that the growth of plant will be increased in cattle shed soil extract as compared to the others from the day 1 itself and the chlorophyll content of the leaves were estimated. It reported that the chlorophyll content of leaves from the media cattle shed soil extract show higher level than the other. Cattle shed soil consists of the cow urine, cow dung. It used as manure for soil fertility and also used as bio-fertilizers in agriculture field. Cowdung manure and vermicompost increases soil organic matter content, and this leads to improve water infiltration and water holding capacity as well as an increased cation exchange capacity[8].Thus, we conclude that cattle shed soil extract have been used for the hydroponics method instead of chemical media.

V. CONCLUSION

Hydroponics has many advantages but some disadvantages are showed as used of chemicals. So we developed the hydroponics as natural manner without artificially synthesized chemicals. In our present study, we selected the medicinal herb such as a) *Eclipta prostrata*,b) *Andrographi spaniculata* and C) *Calendula officinalis* for the hydroponics setup. We designed a hydroponics setup with natural means such as Vermicompost extract, Vegetable waste extract, Panchakavya and Cattle shed soil extract. Before the plants were growing in hydroponics solution, they were processed by seeding to optimize their growth for further process. Among these natural media, cattle shed soil extract and vermicompost extract show positive result for *Eclipta prostrata*. The plant *Calendula officinalis* is not suitable for the hydroponics setup. The plant *Andrographi spaniculata* showed less growth. From our observation we conclude that the cattle shed soil extract have been used for the hydroponics method instead of chemical media.

REFERENCES

1. C. Sonneveld, Effects of salinity on substrate grown vegetables and ornamentals in greenhouse horticulture, 2000.
2. P. Kováčik, M. Renčo, V. Šimanský, E. Hanáčková, and B. Wiśniowska-Kielian, "Impact of Vermicompost Extract Application Into Soil and on Plant Leaves on Maize Phytomass Formation," Journal of Ecological Engineering, vol. 16, 2015.
3. R. Ghorbani, A. Koocheki, M. Jahan, and G. A. Asadi, "Impact of organic amendments and compost extracts on tomato production and storability in agroecological systems," Agronomy for sustainable development, vol. 28, pp. 307-311, 2008.
4. R. S. Kumar, P. Ganesh, K. Tharmaraj, and P. Saranraj, "Growth and development of blackgram (Vigna mungo) under foliar application of Panchagavya as organic source of nutrient," Current Botany, 2011.
5. N. A. Sagar, S. Pareek, S. Sharma, E. M. Yahia, and M. G. Lobo, "Fruit and vegetable waste: Bioactive compounds, their extraction, and possible utilization," Comprehensive Reviews in Food Science and Food Safety, vol. 17, pp. 512-531, 2018.
6. R. Atiyeh, S. Subler, C. Edwards, G. Bachman, J. Metzger, and W. Shuster, "Effects of vermicomposts and composts on plant growth in horticultural container media and soil," Pedobiologia, vol. 44, pp. 579-590, 2000.
7. P. Hand, W. Hayes, J. Satchell, and J. Frankland, "Vermicomposting of cow slurry," Earthworms in waste and environmental management/edited by Clive A. Edwards and Edward F. Neuhauser, 1988.
8. A. Raj, M. K. Jhariya, and P. Toppo, "Cow dung for eco-friendly and sustainable productive farming," Environ Sci, vol. 3, pp. 201-202, 2014.

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