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To Design the Low Cost Pilot Scale Self Watering Hydroponic System and to Study the Effect of Untreated Kitchen Waste Water on Plant Growth

Vinod Ganachari, Rohan Gurav

Visvesvaraya Technological University

Abstract: ***Availability of water and land are the two significant components in agricultural fields. As per the present scenario, fertile land and sufficient water availability are only feasible in some regions due to the high land cost. To overcome the abovementioned problem, an attempt has been made to design a low-cost self-watering hydroponic system for crop and medicinal plant growth. This research correlates everyday traditional farming practices on a pilot scale with a comparison of a pilot scale of a self-watering hydroponic system. In this study, we have compared the use of well water and untreated kitchen wastewater for the growth of plants and crops. The study also reflects and gives the overall picture of plant growth and the effect of well water and untreated kitchen wastewater on it. The study focuses growth parameters on selected medicinal plants like Insulin, Tulsi, and crops like spinach and lettuce. The result and discussion were made on growth parameters like Height, Number of leaves, Weight of the crop and plant, and visual observations. As per the result and discussion made in the study, there is no adverse effect on plant growth and crop growth when we use untreated kitchen wastewater as a substitute for fresh water.***

Keywords: Hydroponics, Pilot scale design, Medicinal and leafy plants, Growth rate

1. Scope and Importance of Hydroponics

Hydroponics can support traditional in-soil farming techniques. Numerous studies have examined hydroponics from various angles, compared it to conventional agriculture regarding carbon footprint, production yield, and sustainability, or evaluated hydroponic systems in terms of financial gain. Less research has been done on the difficulties of hydroponic farming and related opportunities to lessen Sweden's reliance on food imports and the distance between producers and consumers.

- Estimating the potential benefits and drawbacks of the hydroponic system in general and lettuce production in particular.
- Estimating the area and energy requirements for the construction of a hypothetical hydroponic lettuce-growing system in Sweden.
- Comparing the hypothetical hydroponic system's capacity to the actual lettuce production capacity (including conventional methods), import volume, location, and self-sufficiency rate in Sweden.

Types of Hydroponics

1) Nutrient Film Technology (NFT)
2) Deep Water Culture
3) Ebb and Flow System
4) Wick System
5) Drip System
6) Aeroponic systems

Kitchen Generated Wastewater

Kitchen wastewater tends to contain food scraps and grease, so it requires more effort and time to maintain the system than with those other grey water sources.

Treatment and management problem

The use of recycling water from the household kitchen sink for irrigation can decrease water waste and save our landscape in times of drought. Diverting kitchen water directly below the sink for easy access to the pipes and control valve.

Problems with Conventional Farming

The increasing demand for food and eatables, the lack of natural resources and good fertile lands, and present restrictions of energy consumption require an immediate solution regarding agricultural and field activities. This objective was to review hydroponics and compare it with conventional agriculture (soil culture) regarding its environmental impact and water and energy sources. The soil loss, the crop/soil contamination, erosion and the greenhouse emissions were the criteria for the ecological comparison of conventional soil culture and hydroponics. As for resource consumption, the water rates, energy consumption rates, and energy required were the criteria for comparing conventional agriculture with hydroponics. The advantages of hydroponics over traditional cultivation include zero-soil cultivation, land efficiency, planting environment cleanliness, fertilizer and nutrient saving, water consume reduction, and conservation. The disadvantages of hydroponics versus conventional cultivation include the highly initial costs, technical know-how requirements, and higher amount of demanded energy.

Objectives of the Study

1) To design fabricate the low-cost pilot scale self watering hydroponic system.
2) To select the suitable crops belonging to Leafy groups and which have Medicinal properties.
3) To study the Initial characteristics of untreated kitchen wastewater.
4) To study the effect of untreated kitchen wastewater used in a self-watering hydroponic system.

5) To study the growth parameter of crops and plants grown in a self-watering hydroponic system.
6) To study the Final characteristics of kitchen wastewater after successive growth of crops using a Hydroponic system.
7) To study the comparison between the Conventional methods of farming and self-water hydroponic systems for crop and medicinal plant using fresh water and Kitchen wastewater.

2. Materials and Methodology

Germinating Medium

The developing medium for hydroponic cultivating is inactive and does not give any supplements to the plant. It just shows the premise of the roots to develop in Coco coir fiber, Rockwool, Perlite, Vermiculite, LECA, Expanded mud, Pulverized rock, Sand, Scoria, and Gravel are the different sorts of developing mediums accessible for developing plants hydroponically. A developing medium enables us to include the right measure of supplements and further screen the pH in a hydroponic framework.

A version of root pervasions, 2. Maintenance of satisfactory oxygen and water 3.Expanded air circulation and depleting.

Rockwool: It comes in different structures like solid shapes of all sizes, chunks, and destroyed bits. It has a few points of interest, including a lack of bias, great air circulation, and excellent water maintenance limit. Rockwool is frequently utilized with Drip or Ebb and Stream frameworks, yet it is being supplanted by cleaner, ecologically well-disposed substrates like coconut fibre and earth rocks. This rock wool was obtained from agro-based industries and can even be brought from any online marketing.

Coco peat: Coconut fiber was presented a couple of years prior for the nursery business as a substitute for rock wool when a productive and practical substitution was required. It is a by-result of the coconut husking process, created by tropical nations with extensive coconut ranches. The conventional one comprises hard blocks or chips in plastic sacks, which will extend massively when watered. This brand has fantastic water maintenance and cation trade limits and is sufficiently steady to not break down too quickly.

Self-watering hydroponic system

The self-watering hydroponic system, with its wicking action, has experienced tremendous growth. Plant health maintenance is now simpler than in the past, thanks to all the contemporary equipment and research in gardening. This system is ideal for modern and wishes to display a self-watering hydroponic system indoors while paying less attention to maintaining it. However, this one has advantages and disadvantages just like any other system.

Medium: For plant growth, a medium is much necessary, so we are using a Soil 10kg of (Red soil 60%+Black soil 10%), Vermi compost 2kg, cow dung 200 grams, perlite 100grams, and water 60 liters used. For the conventional method of farming. For growing leafy crops and medicinal plants. For the self-watering hydroponic system, the main thing is Fresh water or potable water and untreated kitchen wastewater used. Moreover, perlites 10%, 30 liters of water is used.

Duration: The study on the growing of crops and medicinal plants has a different time and nature of characters, so in this, we are considering as day 35 days, i.e., Five weeks of the duration to carry out the project.

Crop selected for study

Spinach seeds: Spinach (Spinaciaoleracea) is an eatable blooming plant in the family Amaranthaceae local to focal and western Asia. Its leaves are eaten as a vegetable. It is a yearly plant (once in a while biennial) developing as tall as 30cm(1ft). Spinach may make due over winter in calm areas. The blossoms are subtle, yellow-green, 3–4 mm (0.1–0.2 in) in width, developing into a little, hard, dry, uneven natural product group 5–10mm(0.2–0.4in) crosswise over containing a few seeds.

Lettuce seeds: Egyptians were the first to cultivate lettuce, turning it from a plant whose seeds were used to make oil into a significant food crop for its succulent leaves and oil-rich seeds. The Greeks and Romans introduced lettuce, and the latter gave it the name lactuca, which is where the English word lettuce comes from. Columbus introduced lettuce to the Americas for the first time from Europe in the late 15th century. Between the late 16th and the early 18th centuries, many variants were produced in Europe, especially in Holland. All of the lettuces we consume today, including iceberg and oakleaf varieties, are descended from wild plants that were altered 6,000 years ago in the Caucasus to enable the extraction of plant oil from their seeds.

Insulin seeds: Spiral flag, also known as Costus igneus Nak and Costus pictus D. Don, is a Costaceae plant that was recently brought to India from South and Central America. It is a perennial, erect, spreading plant that grows to a height of about two feet. It has spiral-shaped leaves and lovely flowers. It often grows as a decorative plant in southern India, and its leaves are used as a nutritional supplement to treat diabetes mellitus. Number of studies have recently been conducted to determine this plant's potential as an anti-diabetic

Tulsi seeds: The tulsi plant is cultivated for both its essential oil and for usage in traditional medicine and religion. It plays a part in the Hindu Vaishnava tradition, where devotees use holy basil plants or leaves to perform worship, and it is extensively used as a herbal tea, frequently used in Ayurveda.

Source of water: Water is the main source to supply the nutrients which are required for the plants to grow. So the Source is taken is Potable water.

Germination

For the soil plants, 18 3D squares of coco peat were utilized, and for the hydroponic plants, 18 blocks of Rockwool were utilized; both Rockwool and Coco Peat solid shapes were bored with holes at the base to guarantee the water waste was reasonable as this will keep the plants from drying. Twelve selected seeds of Spinach, twelve selected seeds of Lettuce, The above picture show the germination progress of the

selected seeds in Rockwool and coco peat media. The growth of roots in rockwool media showed promising results compared to coco peat media. Because One of the most essential characteristics of Rockwool is that plants can still extract water to grow with very low moisture tensions in the media. Hence, the germination in the rock wool media was pretty fair to coco peat media. The watering done during germination was about a few milliliters of water for 20 days.

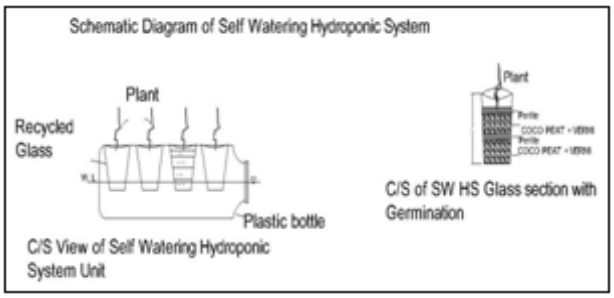

Figure 3.4.3: Schematic diagram of self watering hydroponic system

3. Results and Conclusion

Parameters of Crop Growth and Plant Growth: 1. Plant height 2. Number of Leaves 3.Final weight of the plant 4.Initial characteristics of kitchen wastewater 5. Final characteristics of kitchen wastewater.

Plant Height: Height of the plant or crop is measured by its height in cm units in the known interval**.**

Table 4.1.1: Variation of crop and plant height using well water by Conventional method

Sl no	Crop	1 (cm)	7 (cm)	14(cm)	21(cm)	28(cm)	35(cm)
1	Spinach	4	6	8	10	13	15
2	Lettuce	4	5	7	11	14	16
3	Insulin	5	7	9	13	15	22
4	Tulsi	5	7	8	12	14	18

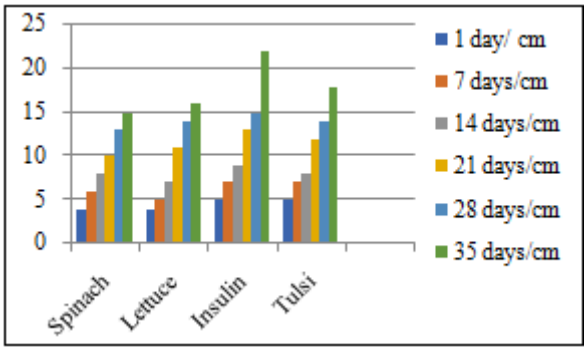

Figure 4.1.1: Graphical representation of crop and plant height using well water by conventional method

There is successive growth with respect to height parameter for Spinach, Lettuce, Insulin and Tulsi at 7 days, 14, 21, 35 days respectively. Results have been observed by using well water in the conventional method of farming. As per above graphical representation maximum height has been achieved by Insulin for the conventional method of farming when use well water as source at 35 days. Also it has been noticed lowest height of the crop i.e., 15cm for spinach at 35 days respectively.

Table 4.1.2: Variation of crop and plant height using untreated kitchen wastewater by Conventional method

S no	Crop	1 day (cm)	7 days (cm)	14 days (cm)	21 days (cm)	28 days (cm)	35 days (cm)
1	Spinach	4	6.5	8.6	10.6	13.5	15.5
2	Lettuce	4	5.6	7.6	11.5	14.6	16.6
3	Insulin	5	8	10	14.2	16.1	23.2
4	Tulsi	5	7	8.6	12.4	14.6	18.5

From the above graphical representation it has been clearly observed there is successive growth with respect to height parameter for Spinach, Lettuce, Insulin and Tulsi at 7 days,14, 21, 35 days respectively. Results have been observed by using untreated kitchen wastewater the conventional method of farming. As per above graphical representation maximum height has been achieved by Insulin for 23.2cm the conventional method of farming when use untreated kitchen wastewater at 35 days. Also it has been noticed lowest height of the crop i.e., 15cm for spinach at 35 days respectively.

Table 4.1.3: Variation of crop and plant height using well water by self watering hydroponic method

S no	Crop	1 day (cm)	7 days (cm)	14 days (cm)	21 days (cm)	28 days (cm)	35 days (cm)
1	Spinach	4	6.5	8.6	10.6	13.5	15.5
2	Lettuce	4	5.6	7.6	11.5	14.6	16.6
3	Insulin	5	8	10	14.2	16.1	23.2
4	Tulsi	5	7	8.6	12.4	14.6	18.5

From the above graphical representation it has been clearly observed there is successive growth with respect to height parameter for Spinach, Lettuce, Insulin and Tulsi at 7 days, 14, 21, 35 days respectively. Results have been observed by using untreated kitchen wastewater the conventional method of farming. As per above graphical representation maximum height has been achieved by Insulin for 23.8 the conventional method of farming when use untreated kitchen wastewater at 35 days. Also it has been noticed lowest height of the crop i. e., 15.6 cm for spinach at 35 days respectively.

Table 4.1.4: Variation of crop and plant height using untreated Kitchen Wastewater by Hydroponic Method

S. no	Crop	1 day (cm)	7 days (cm)	14 days (cm)	21 days (cm)	28 days (cm)	35 days (cm)
1	Spinach	4	6.8	8.8	10.8	13.9	15.7
2	Lettuce	4	5.9	7.9	11.8	14.9	16.9
3	Insulin	5	8.2	10.4	14.4	16.5	23.4
4	Tulsi	5	7.8	8.8	12.8	14.8	15.6

From the above graphical representation it has been clearly observed there is successive growth with respect to height parameter for Spinach, Lettuce, Insulin and Tulsi at 7 days,14, 21, 35 days respectively. Results have been observed by using untreated kitchen wastewater the conventional method of farming. As per above graphical representation maximum height has been achieved by Insulin for the conventional method of farming when use untreated kitchen wastewater at 35 days. Also it has been noticed lowest height of the crop i.e., 15cm for spinach at 35 days respectively.

ii. No. of Leaves: The number of leaves which are grown in the specified time interval is recorded.

Table 4.2.1: Variation of crop and plant's showcasing number of leaves using Well Water by Conventional Method

S. no	Crop	1 day (nos)	7 days (nos)	14 days (nos)	21 days (nos)	28 days (nos)	35 days (nos)
1	Spinach	4	4	6	8	10	12
2	Lettuce	4	4	6	8	10	12
3	Insulin	4	4	8	10	12	14
4	Tulsi	4	4	8	10	14	16

The above chart shows the initial day i.e. 1day when the leaves are counted physically, shows almost all same and after certain time intervals of 7 days it was noted. And finally 5th week no. of leaves of Tulsi plant has higher number of leaves. By conventional method using potable/well water.

Table 4.2.2: Variation of crop and plant's showcasing number of leaves using Kitchen Wastewater by Conventional Method

S.no	Crop	1 day (nos)	7 days (nos)	14 days (nos)	21 days (nos)	28 days (nos)	35 days (nos)
1	Spinach	4	4	6	8	10	12
2	Lettuce	4	4	6	8	10	12
3	Insulin	4	4	8	10	12	14
4	Tulsi	4	4	8	10	14	16

The above chart shows the initial day ie 1day when the leaves are counted physically, shows almost all same and after certain time intervals of 7 days it was noted. And finally 5th week no. of leaves of Tulsi plant has higher number of leaves. By conventional method using Kitchen Wastewater.

Table 4.2.3: Variation of crop and plant's showcasing number of leaves using Well Water by Hydroponic Method

Sl no	Crop	1 day (nos)	7 days (nos)	14 days (nos)	21 days (nos)	28 days (nos)	35 days (nos)
1	Spinach	4	4	6	8	10	14
2	Lettuce	4	4	6	8	12	14
3	Insulin	4	4	8	10	14	16
4	Tulsi	4	4	8	12	14	18

The above chart shows the initial day ie 1day when the leaves are counted physically, shows almost all same and after certain time intervals of 7 days it was noted. And finally 5th week no. of leaves of Tulsi plant has higher number of leaves. By Self watering Hydroponic method using potable/well water.

Table 4.2.4: Variation of crop and plant's showcasing number of leaves using Kitchen Wastewater by Hydroponic Method

S. no	Crop	1 day (nos)	7 days (nos)	14 days (nos)	21 days (nos)	28 days (nos)	35 days (nos)
1	Spinach	4	4	6	8	12	16
2	Lettuce	4	6	8	10	14	17
3	Insulin	4	6	8	10	12	18
4	Tulsi	4	8	10	14	16	20

The above chart shows the initial day i.e., 1 day when the leaves are counted physically, shows almost all the same, and after particular time intervals of 7 days, it was noted. And finally, in the 5th week, no. of the Tulsi and Insulin plants had more leaves. And both plants belong to the medicinal group By Self-watering hydroponic method using Kitchen wastewater.

iii. Weight of the Crop: Weight of the crop is taken in the specified time interval

Table 4.3.1: Variation of initial and final crops and plants weight using Well Water by Conventional Method

S. no	Crop	1 day Initial weight (gms)	35 days Final weight (gms)
1	Spinach	4	72
2	Lettuce	4	85
3	Insulin	6	90
4	Tulsi	5	68

The weighing of the crop is another characteristic of the resulting technique. The produce is weighed initially and then at the last 5th week only. In between, we cannot consider the crop weight because if we want to measure, it is removed from the soil and then weighed. After weighing, we cannot re-plant the crop. So only initial and final weights are taken. The above chart shows the weight of the Insulin crop has the highest weight than other crops in the Conventional method using Potable/Freshwater.

Table 4.3.2: Variation of crop and plant weight using Kitchen Wastewater by Conventional Method

S. no	Crop	1 day Initial weight (gms)	35 days Final weight (gms)
1	Spinach	4	75
2	Lettuce	4	88
3	Insulin	6	92
4	Tulsi	5	70

The above chart shows the weight of Insulin crop has a highest weight than other crops in Conventional method using Kitchen wastewater.

Table 4.3.3: Variation of crop and plant weight using Well Water by Hydroponic Method

S. no	Crop	1 day initial weight (gms)	35 days Final weight (gms)
1	Spinach	4	79
2	Lettuce	4	90
3	Insulin	6	95
4	Tulsi	5	72

The above chart shows the weight of Insulin crop has a highest weight than other crops in Hydroponic method using Potable/Fresh water.

Table 4.3.4: Variation of initial and final crop and plant weight using Kitchen Wastewater by Hydroponic Method

S. No	Crop	1 day initial weight (gms)	35 days Final weight (gms)
1	Spinach	4	82
2	Lettuce	4	95
3	Insulin	6	98
4	Tulsi	5	75

The above chart shows the weight of Insulin crop has a highest weight than other crops in Self watering Hydroponic method using Kitchen Wastewater.

4. Conclusion

In present study attempt has been made to design low cost pilot scale self watering hydroponic system for the crop

growth and medicinal plant growth After the result and discussion made in the report the following conclusion were drawn from the present study.

1) The low cost pilot scale self watering hydroponic system has been designed and fabricated effectively by reusing waste plastic bottles and cups, using untreated kitchen wastewater for the crop growth and plant growth.
2) To study the effects of untreated kitchen wastewater on the leafy crop like spinach, lettuce and medicinal plants like insulin and Tulsi have been selected to study the growth parameter. And also analyzed and compared with conventional method and self watering hydroponic system.
3) It has been observed and concluded that Maximum height among the leafy crop is for Lettuce i.e 16.,8 cm at 35 days of harvesting. Similarly trend has been observed for medicinal plant growth i.e insulin highest height i.e 23.2 cm at 35 days harvesting.
4) As per the observation and discussion made on maximum Number of leaves has been achieved by the crops and plants by self watering hydroponic system compare to conventional method of farming. Lettuce leaves gives 17 maximum number of leaves at 35 days and Tulsi gives 20 n umbers of leaves at 35 days of harvesting.
5) As per the analysis and variation of crop and plant weight parameter the untreated kitchen wastewater with self watering hydroponic system gives maximum weight over the conventional method of farming that indicates among leafy crop Lettuce gives highest weight at 35 days harvesting. Similar trend observed with medicinal plant and Insulin plant gives highest weight compare to Tulsi plant effectively in self watering hydroponic system.
6) We can also conclude that there is no visual rejection of leafy crop and medicinal plant with respect to plant's colour, appearance, healthiness etc..
7) Hence it can be recommended the use of untreated kitchen waste water, and it can become substitute for the potable water for the growth of plant and crop in self watering hydroponic system and conventional method of farming.

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