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EFFECTIVENESS OF NYLON NET SCRAP AS GROW MEDIA IN AQUAPONICS FOR TOMATO PLANT

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Abstract - *During this COVID-19 pandemic period, scope of aquaponics have been increased for indoor in small units.The search for a new material with light weight and sustainable properties is important. Nylon is a polymer having very good mechanical properties and widely used for fish net uses. It is estimated that 6,40000 tonnes of fishing nets are disposed in the oceans every year. The reuse of nylon nets as growing media in aquaponics is suitable due to its high mechanical strength which provide support for the plant and root system to take hold and its high surface area provides space to grow bacteria and perform their important nitrifying process. This project aimed at the comparison of the aquaponics systems by using different grow media. The different grow media used are gravel and nylon net scrap. Gravel media having high weight, so here we implementing use of nylon net scrap as grow media instead of gravel as grow bed. The physico-chemical parameters of water in pond were tested and the growth of plants and weight of fish measured in equal intervels of time. Tomato was the plant taken for the comparison of growth.*

Key Words: Aquaponics; Mechanical filtration; Biological filtration; Nylon net scrap; Moving bed bio reactor

1.INTRODUCTION

Aquaponics is a bio integrated system that recirculating aquaculture (growing fish and other aquatic animals) with hydroponics. Nutrient-rich water from fish tanks is used as liquid fertilizer to fertilize hydroponic production beds.[2] These nutrients in the water produced from fish manure, algae, and decomposing fish feed which otherwise increases the toxic levels in the fish tanks affecting the fish growth. Aquaponics is one environmentally friendly technique to supplement food availability in an urban environment. These systems cultivate both fish and plants in a closed sustainable environment. By recirculating both water and nutrients, this system drastically reduces the demand for both. This project is based on media based aquaponics. Nylon is a polymer having very good mechanical properties and widely used for fish net uses. The reuse of nylon nets as growing media in aquaponics is suitable due to its high mechanical strength which provide support for the plant and root system to take hold and its high surface area provides space to grow bacteria and perform their important nitrifying process[4]. This project aimed at the comparison of the aquaponics systems by using different grow media. The different grow media used are gravel and nylon net scrap. Gravel media having high weight, so here we implementing use of nylon net scrap as grow media instead of gravel as grow bed.

1.1 Advantages of media based aquaponics system

They are relatively simple and inexpensive and is suitable for all kinds of plants, from leafy greens to larger fruiting plants, Minimal cleaning is required. For a further breakdown of fish waste, red worms can be added to the gravel bed. The media perform a filtering action, preventing debris from returning to the tank. The air is present between media particles, supplying oxygen to the roots.

1.2 Disadvantages of media based aquaponics system

A good-quality medium can be relatively expensive. The pore spaces in the medium may get clogged over time, causing anaerobic conditions that are poor for your plants. It can require cleaning of the grow bed. By itself, this style system is not usually suitable for commercial purposes due to lower productivity and difficulty in a large-scale implementation

2. AQUAPONICS

Aquaponics is a bio integrated system that recirculating aquaculture (growing fish and other aquatic animals) with hydroponics. Nutrient-rich water from fish tanks is used as liquid fertilizer to fertilize hydroponic production beds. These nutrients in the water produced from fish manure, algae, and decomposing fish feed which otherwise increases the toxic levels in the fish tanks affecting the fish growth. Aquaponics is one environmentally friendly technique to supplement food availability in an urban environment. Aquaponics systems cultivate both fish and plants in a closed sustainable environment. By recirculating both water and nutrients, this system drastically reduces the demand for both.[6]

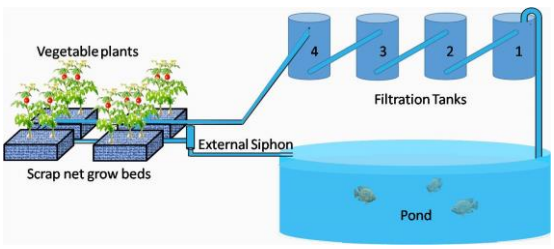


Figure -1: Aquaponics system layout

A) Components of aquaponics system

1. Pond

The fish pond with a capacity of 1000 liters have been used in the study. Nylon tarpaulin sheet is used as tank liner. The dimension of the pond is 1 meter width ,1.5 m length, and 1 m depth. The water level maintained at 1litre volume. A submersible electric motor is used for to pump the water from the pond to the treatment units. The model of motor is JTP 3800 and having flow rate 4000 litre/hour. It is plastic material and black in colour.

Figure -2: Pond

2. Aeration

Aeration was done with the help of six-head aerator. Aeration provided continuously by using electricity.

Figure -3: Aeration equipements

Specifications of submersiblemotor are ;

Width	26 cm
Height	14 cm
Depth	16 cm
Inlet diameter	1 cm
Outlet diameter	2 cm
weight	1500 g
Other dimensions	0

3. Fish used

Hundred Nile tilapia (Oreochromis Niloticus) fish seeds of one inch size were placed to the pond. The fish foods given are floating fish food pellets, azolla, leaves of tapioca, and leaves of giant taro.

4. Filtration units

The grow media can serve as very efficient filters for mechanical and biological filtration in a media-based aquaponics system. The media-based system utilizes the combination of filters for the water and plant growing area for the plants. In addition, it also provides a place for mineralization to occur. However, high stocking densities can overwhelm the mechanical filtration that can risk having the media clogged and producing dangerous anaerobic spots.

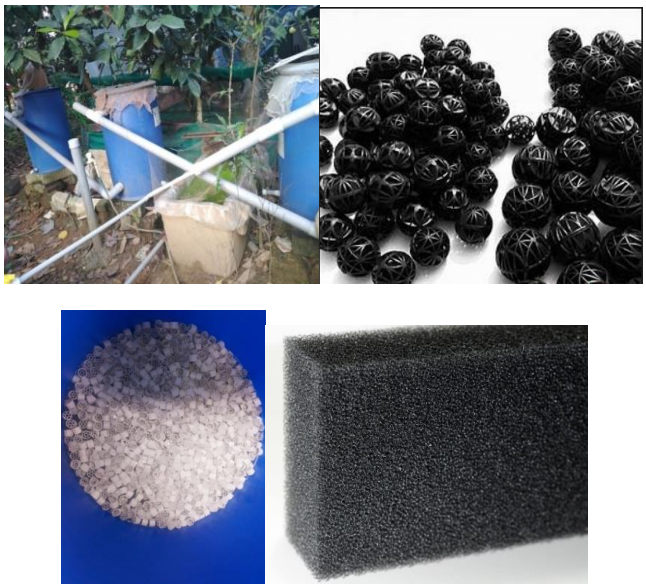


Figure -3: Filtration units

The water was proceeded to three consecutive mechanical-sedimentation filtration tanks. Each of these filtration tanks consists of a scrap nylon net layer at the bottom, a bio sponge of 60 cm diameter as next layer, again the scrap nylon net was used to fill the tank until outlet. Other sedimentation mechanical filter tanks were also same as this. The outlet at the top of the first tank connected to the next tank at the bottom. The other mechanical filtration tanks also connected like this, i.e. the outlet from one tank at the bottom is connected with the next tank in the bottom as inlet as shown in the figure. The biological filters were acclimated for 30 days for the establishment of nitrifying bacteria. Throughout the experiment, no water was exchanged, only

dechlorinated freshwater was added to compensate for evaporation losses.

5. Grow bed

After these filtration units the water is subsequently passed to different grow bed media which are gravel and nylon net scrap in equal flow rate. The grow bed consists each of 4 sq.feet area, cylindrical plastic container of diameter 70cm. the container was filled with a media at a height of 1 feet. Scrap net media was prepared by arranging nylon net layer by layer in a uniform manner. A layer of gravel is placed above the net scrap media for about 2 inch depth for avoiding displacement of net. Gravel media with same dimension also arranged for comparison. The inlet to the grow media tank was given over the media. The outlet from the bottom is regulated by external siphon system. The maximum water level in the media was maintained one inch below from the top of the gravel media. The outlet from these grow bed tanks was charged to the pond through the siphon system.

Figure -4: Experimental setup preparation

The stream of water circulation was maintained in the pond by taking water from one side of the pond and given back from the either side of the pond. The water losage by evaporation was compensated by adding equal amount of water to the pond in alternate days.

Figure -5: Nylon net scrap use as grow media

3. WORKING PROCEDURE

The aquaponic system and the experimental setup was created in my home itself, which is located at Cheruvadi, Calicut district, Kerala. The experiment was set up in a pond of 6 m^2 area,& 2m height, covered with 1.5 mm plastic liner and 50% luminosity reduction using sun shade net.The technique used for plant cultivation was media-based technique that using nylon scrap as grow media. Four grow bed aquaponics systems with different types of water treatment technique were set-up. System 1 equipped with both mechanical and biological filter in a compact vessel (System1). Settling tank by axial flow (System 2) was use as the mechanical filter and biological filter (System 3) using bio ball as filtration media. Aquaponics system with metal as grow media, in two plastic pots and aquaponics system with nylon scrap as grow media in another two plastic pots was used as baseline system (System 4) in this study.

IMAGES OF EXPERIMENTAL STUDY

RESULTS AND DISCUSSION

TABULAR AND GRAPHICAL REPRESENTATION OF THE OBSERVATIONS

Table and graph shows the difference in height of tomato plant in four sets in the period of six months.

Duration(in months)	Set 1	Set 2	Set 3	Set 4
0	8	10	8	10
0.5	52	50	56	52
1	56	52	51	52
2	65	60	63	62
3	70	68	72	86
4	73	72	76	72
5	76	75	79	75
6	0	0	0	0

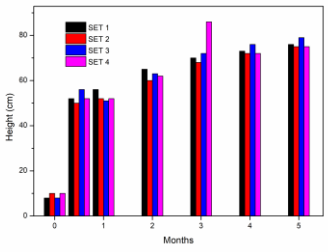


Table and graph shows the difference in number of leaves of tomato plant in four sets in the period of six months.

Duration(in months)	Set 1	Set 2	Set 3	Set 4
0	22	20	22	20
0.5	38	36	43	38
1	40	35	37	36
2	45	44	48	44
3	45	43	45	43
4	47	45	47	45
5	50	52	50	52
6	0	0	0	0

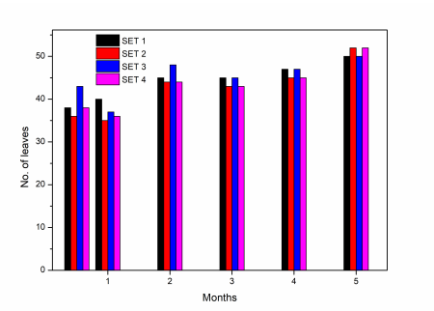


Table and graph shows the difference in number of flowers of tomato plant in four sets in the period of six months.

Duration(in months)	Set 1	Set2	Set3	Set4
0	0	0	0	0
0.5	0	0	0	0
1	2	2		
2	4	5	4	2
3	6	6	2	2
4	6	4	2	2
5	4	1	1	0
6	0	0	0	0

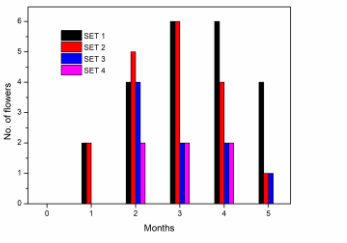
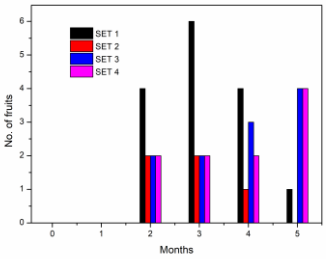


Table and graph shows the difference in number of fruits of tomato plant in four sets in the period of six months

Duration(in months)	Set 1	Set2	Set3	Set4
0	0	0	0	0
0.5	0	0	0	0
1	0	0	0	0
2	4	2	2	2
3	6	2	2	2
4	4	1	3	2
5	1	0	4	4
6	0	0	2	0



CONCLUSION

Inorder to get an idea about effectiveness of nylon net scrap as grow media in aquaponic system, 2 sets of pot filled with nylon scrap as grow media arranged and the plant growth was measured. Two other sets are filled with gravel as grow media and the growth is compared with the first set. Four sets of water treatment techniques were used. The technique include axial flow, bio filter, combination of axial flow and biofilter in a compact vessel and grow media itself as filter. Water quality, nutrient concentration, growth rate and yield of Nile tilapia fish and the plants were measured as performance of the aquaponics system. Based on six months of collected data ,the results notified that the nylon net scrap grow media in aquaponics system itself was sufficient to act as a support media instead of using gravel media. And it was sufficient to act as filtration and nitrifying media. Hence produced good performance in most parameters measured. The plants in nylon net scrap media shows the best performance like in gravel grow media. Growth rate of tilapia fish together with moderate result in growth rate and yield of plants. Water quality also was good. With consideration of maintenance works involved and long run performance , these results suggested that the use of nylon net scrap as grow media was quite beneficial and cost effective. The degradation of nylon net scrap occurs very slowly and it may take years, so this will not create any environmental problem in big manner. Nylon net scrap is light in weight and easy to handle for the indoor aquaponics system purposes.

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