Domestic Wastewater Treatment by Root Zone Technology Option: Colacassia Plant

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ABSTRACT

Root Zone Technology is one of the low cost methods to treat wastewater. With the help of this system we can treat the Non-Point sources with best results. To achieve this goal we have to divide the Non-Point sources into constructed channels within the river bank followed by root zone bed or if the Non-Point Sources is coming from natural nallas we can provide this system within its Channel. We have prepared channel on which I have developed the root zone bed and have lab analysis of rector out put on number of parameters. Flow rate and Detention time are the two factors on which channels are to be designed. Therefore I am changing the flow rate and finding out the change in parameter with respect to detection time. The optimization is when we get best result with maximum flow. I have got satisfactory results for the detention time of Three day, Seven day and twenty one day and Three day. With the help of this data I have designed the root zone bed system for the selected actual Domestic Sources.

Keywords— Domestic Wastewater, Root Zone, COD, BOD, TSS, TDS

I. INTRODUCTION

Root zone treatment is one of the natural and attractive methods of treating domestic, industrial and agricultural wastes. It is an engineered method of purifying wastewater as it passes through artificially constructed wetland area. It is considered as an effective and reliable secondary and tertiary treatment method. The root zone treatment is a natural maintenance free system where the sewage wastewater is purified by the roots of wetland plants. The root zone process functions according to the law of nature, to effectively purify domestic and industrial effluents. The process incorporates the self-regulating dynamics of an eco system.

Root zone systems are artificially prepared wetlands comprising of clay or plastic lined excavation and emergent vegetation growing on gravel/sand mixtures and is also known as constructed wetland. This method combines mechanical filtration, chemical precipitation and biological degradation in one step for the treatment of wastewater. A number of factors like low operating cost, less energy requirement and ease of maintenance attribute to making root zone system an attractive alternative for wastewater management. The term root zone encompasses the life interactions of various species of bacteria, the root of the wetland plants, soil, air, sun and of course, water.

Application of root zone technology is finding wider acceptability in developing and developed countries, as it appears to offer more economical and ecologically acceptable solution to water pollution management problem Root zone systems whether natural or constructed, constitute an interface between the aquifer system and terrestrial system that is the source of the pollutants. These are reported to be most suitable for schools, hospitals, hotels and for smaller communities.

II. LITERATURE REVIEW

Nanda Sahil (2017) has studied on Root Zone waste water Treatment for domestic sewage the wastewater is collected from the septic tank when that overflows is transferred to the plant. On the plant, a pit of essential dimension is made. The clarified sewage from the septic tank is made to pass through the Root Zone pit. The length and breadth of the pit depends on the volume of the wastewater to be treated per day. The pit is lined by sealing with low Density Polypropylene sheets or rolls. If necessary, other types of civil structure can be made into the treatment tank. The pit is filled layer by layer with layered media of adequate porosity.

Mane Mahesh et.al. (2017) has studied on Introduction to Waste Water Treatment by Root Zone Technique . In This study Increasing urbanization and human activities exploit and affect the quality and quantity of the water resources. This has resulted in pollution of freshwater bodies due to increased generation of domestic waste, sewage, industrial waste etc. This paper reviews the Root Zone Treatment System which are planted filter beds consisting of soil gravel, sand and fine aggregate. This Technique uses a natural way to effectively treat domestic and industrial effluents. RZTS are well known in temperate climates and are easy to operate having less installation, low maintenance, and operational costs and incorporates the self-regulating dynamics of an artificial soil eco-system.

Parmar jigar et.al. (2016) has studied on Experimental study on post treatment of dairy wastewater is using hybrid reed bed technology in this Study give knowledge about dairy waste and the dairy waste and their effective treatment. He had use hybrid reed plant for treatment of Dairy waste. It give from this study confirmed that the Hybrid reed bed system was highly effective on removing BOD up to 14 mg/L and COD at up to 110 mg /L at 36 hours detention time with a removal efficiency of BOD is 97%, and COD is 92% for dairy wastewater. Reductions in TDS and TSS were not significant. Initially the pH of Dairy waste sample was more alkaline but due to the techniques implemented the pH was brought up much near to the neutral axis.

Irfan Naseemul et.al. (2015) has studied on Holistic Household Waste Management at Source- An Experimental Study. He has discuss related grey water and kitchen solid waste management. Simple sand filter bed method of treatment and the sand filter with reeds are experimented and compared for Waste water management. It also suggests the method of using PVC pipes for making compost from the kitchen waste. Phragmites australis (locally known as nanal) and canna Indica (locally known as cannas) were used as reed plants for waste water treatment. This paper presents the method of construction of reed bed and the effectiveness of removal of various contaminants using root zone treatment process. The quality parameters of raw water and treated water samples were compared and discussed.

Shitole Dhiraj (2014) has studied on Feasibility Study of Low Cost Treatment for Non Point Sources He had explain about non point source and their treatment. In present scenario the river water has become wastewater due to disposal of city waste through which it flows. Due to improper and ill-planned infrastructure development, the sewerage network & treatment facility are inadequate. At any places, this leads to the development of illegal sewage, resulting into Non- Point sources. Most of the existing wastewater treatment plants are getting over The Root Zone Bed System is one of the low cost methods to treat wastewater. With the help of this system we can treat the Non-Point sources with best results.

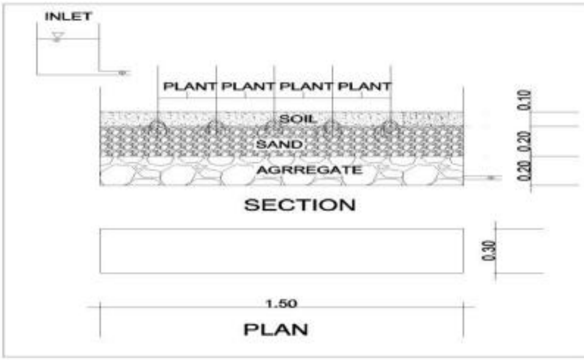
III. MATERIAL AND METHODOLOGY

1. Construction Wetland: I have designed constructed wetland of size 1.5m x 0.5m x 0.3m for both Colacassia and canna plant.

Consider length of reactor 1.5m, height 0.5m and thickness 0.3m. In above figure shows section and plan of constructed reactor. At lower level consider 200mm thick with aggregate 20mm size. Middle layer 200mm thick with natural sand and top layer of 100mm thick with black cotton soil.

The aggregate cleaned by water before keeping in reactor similarly cleaned sand by water before keeping in reactor. Filled all layers simultaneously in reactor and keep it for one day. Prepare two system parallel for canna plants and Colacassia plants.

2. Arrangement of Reactor: The rectangular tub with plant bed was provided with 100 slope with slight elevation at the bottom of backside of tub and kept in the slanting position. Inlet and outlet flow rates were adjusted by using bucket and timer. Inlet flow and outlet flow of wastewater were adjusted to maintain Hydraulic Retention Time (HRT) of 3days,7days and 15days.



All dimensions are in meter
Figure 1 Plan and Section of root zone system

Figure 2 (a) & (b) 200mm depth of bottom layer with aggregate (c) Experimental setup (d) under drainage pipe at bottom

3. Planting Arrangement: Reeds can be planted as rhizomes, seedlings or planted clumps. Clumps can be planted during all seasons at 2 Nos / m2. Rhizomes grow best when planted in Premonsoon and t 4 – 6 rhizomes can be planted per m2. Seedlings should be planted in Pre-monsoon with 3 – 5 seedlings per m2. Planting should be done from supporting boards to avoid compaction of the filter media. Initially the plants should be kept well watered, but not flooded. With well-developed shoots, the growth of weeds can be suppressed by periodical flooding. During the first growth period a sufficient supply of nutrients is required. If wastewater is used for initial watering precautions like avoidance of stagnation have to be taken to inhibit the formation of H_2S within the filter bed.

Figure 3 Planting of Colacassia plant

To prevent entry of soil into under drain pipe and washing out of soil a graded filter is provided at the blower portion of the reactor. The filter consist of crushed stone of gradation 40mm at bottom near to under drain pipe to 5mm at top just below the soil layer. A fertile soil layer of 20 cm thickness is provided above the filter. Over this 1-2cm thick layer of organic compost is laid over the soil layer. Plantation is done after these layers are laid and plants are watered. Different species of plants were considered for plantation in RZT system. Considering local availability, ability to consume the organic and inorganic matter from waste, and revenue by selling the plant, Elephants Ear or Arum was considered as the plant species in the RZTS

4. Types of Plant used System

Colacassia Plant (Alu): Colacassia esculenta is a tropical plant grown primarily for its edible corms, the root vegetables most commonly known as taro. It is believed to be one of the earliest cultivated plants. Linnaeus originally described two species which are now known as Colacassia esculenta and Colacassia antiquorum of the cultivated plants that are known by many names including eddoes, dasheen, taro and madumbi, but many later botanists consider them all to be members of a single, very variable species, the correct name for which is Colacassia esculenta.

Figure 4 Colacassia plant

Uses of Colacassia Plant

Taro's primary use is the consumption of its edible corm and leaves. In its raw form, the plant is toxic due to the presence of calcium oxalate, and the presence of needle-shaped raphides in the plant cells. However, the toxin can be minimized and the tuber rendered palatable by cooking or by steeping in cold water overnight.

Corms of the small round variety are peeled and boiled, sold either frozen, bagged in its own liquids, or canned. The leaves are rich in vitamins and minerals. It is also sold as an ornamental aquatic plant. It is also used for Anthocyanin study experiments especially with reference to biaxial anthocyanic concentration

IV. WORKING OF ROOT ZONE TECHNOLOGY

Sampling Methodology

I have taken sample at Nasardi River near Bombay Naka Nashik This river polluted due to it fowling hrough city area and slum area of city. Sample has taken in sample botle. Sample bottles: One litre or 2 ½ litre new PVC bottles to be used for all samples taken except samples taken for bacteriological, oil based or solvent analysis.

Sampling hand-pump with extension tube – to be used for depth sampling at low flow. Otherwise a sampling beaker (250ml, 500ml or 1000ml) with screw-in extension rods to be used for depth sampling with sufficient flow.

Figure 6 Sample before and after treatment & sample point at Nasaradi river Nashik

Root Zone Mechanism

Experimental procedures followed in present investigation were similar to those described elsewhere

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Colocasia esculenta and Canna is one of the prominent adaptive marshy plants in the India region which was used for treatment of wastewater. It was transplanted in the designed wetland system in the Angular Horizontal Subsurface Flow process of constructed wetland.

1. In Constructed system filled with washed aggregate first up to 200mm thick at bottom. And then filled with washed sand up to 200mm at middle layer of reactor. At top filled soil up to 100mm.
2. Initially, plants in bed were acclimatized for two weeks with suitable dilutions each time. As the time passed, the concentrations were increased such as 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% of sewage through plant treatment. These samples were treated using Colocasia esculenta and Canna by Phytoremediation technique and other set as control (without plant) also analyzed after their pre-treatment characterization
3. Two sets of buckets with different sizes and dimensions were used in each experimental set up. The vertical buckets as holding tank (Inlet) were used to hold the wastewater. The water storing capacity of tank was 50 liters each.
4. The rectangular tub with test plant bed was used as experimental test setup in each set for preparing root zone bed of size 1.5m length and height 0.5m having suitable outlet. The vertical pipe was placed above the tub in an inverted 'T' shape for equal distribution of wastewater which was connected with the rubber pipe to the inlet of holding tank in each set. The length of plastic pipe was 40 cm and the holes were provided at the interval of 5 cm and equal flow was adjusted manually through them.
5. Plastic cans were used for the collection of treated water after flowing out from the root zone bed through the outlets. Inlet, Root zone tub and outlet were connected to each other with taps by tubes and plastic water pipes. Treated water samples were collected and analyzed in laboratory.

Selection Parameters

Test samples before and after treatment were analyzed in both sets (Plant bed and control bed) for selective parameters like pH, TSS, TDS, TN,, COD, BOD, PO4, DO and using standard method.

Soils used in before and after treatment in both beds of CWs were analyzed. Finally, pollution reduction efficiency and treatment efficiency of the test plant were calculated.

V. RESULT AND DISCUSSION

Table no. 1 P^H value of Colacassia plants

Sr	Description	Colacassia plant
1	Before treatment	6.8
2	After 3days	6.9
3	After 7days	7.1
4	After 21days	7.2

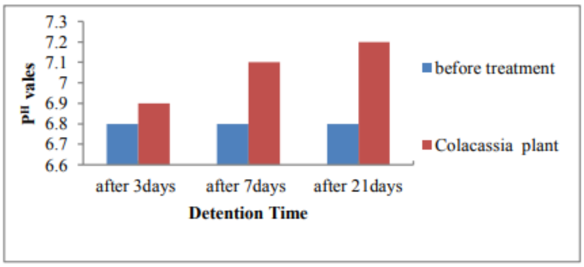


Chart no. 1 P^H value of Colacassia plants

Table no. 2 BOD value of Colacassia plants

Sr. no.	Description	Colacassia plant
1	Before treatment	340.5
2	After 3days	170.8
3	After 7days	89.5
4	After 21days	70.5

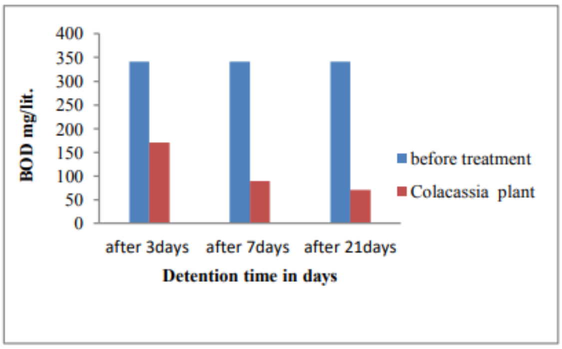
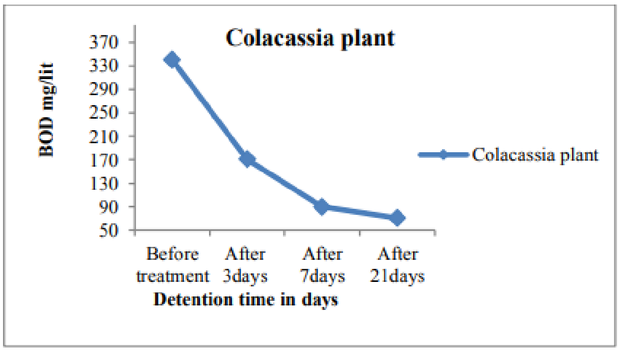


Chart no. 2 BOD value of Colacassia plants



Graph no. 2 BOD value of Colacassia plants

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Table no. 3 COD value of Colacassia plants

Sr. no.	Description	Colacassia plant mg/lit
1	Before treatment	443.5
2	After 3days	212.8
3	After 7days	91.2
4	After 21days	80.5

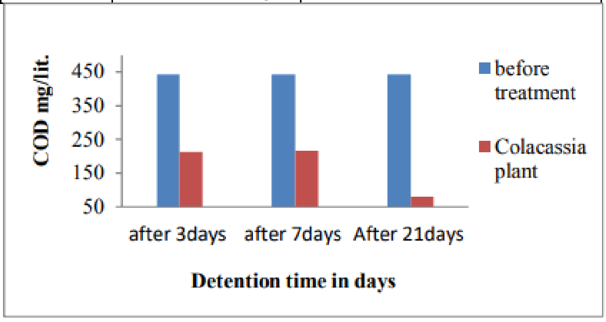

Chart no. 3 COD value of Colacassia plants

Table no. 4 TDS value of Colacassia plants

Sr. no.	Description	Colacassia plant mg/lit
1	Before treatment	900.5
2	After 3days	604.5
3	After 7days	552.8
4	After 21days	480.2

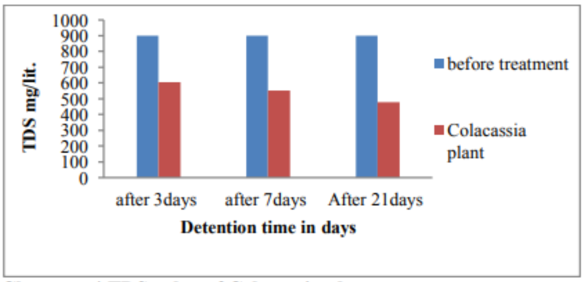

Chart no. 4 TDS value of Colacassia plants

Table no. 5 TSS value of Colacassia and Canna plants

Sr. no.	Description	Colacassia plant
1	Before treatment	185.5
2	After 3days	132.4
3	After 7days	74.8
4	After 21days	64.2

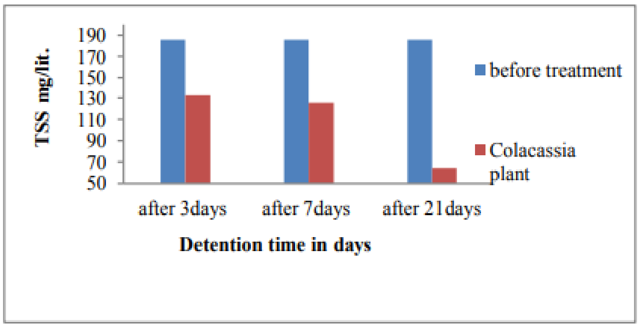

Chart no. 5 TSS value of Colacassia plants

Table no. 6 Nitrogen value of Colacassia and Canna plants

Sr. no.	Description	Colacassia plant
1	Before treatment	60.5
2	After 3days	27.6
3	After 7days	13.8
4	After 21days	11.5

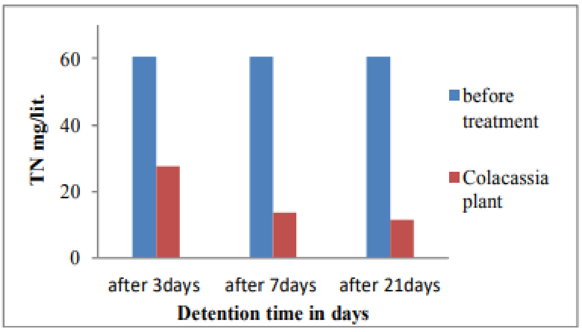

Chart no. 6 Nitrogen value of Colacassia plants

Table no. 7 Phosphate value of Colacassia plants

Sr. no.	Description	Colacassia plant
1	Before treatment	32.5
2	After 3days	22.6
3	After 7days	11.8
4	After 21days	9.5

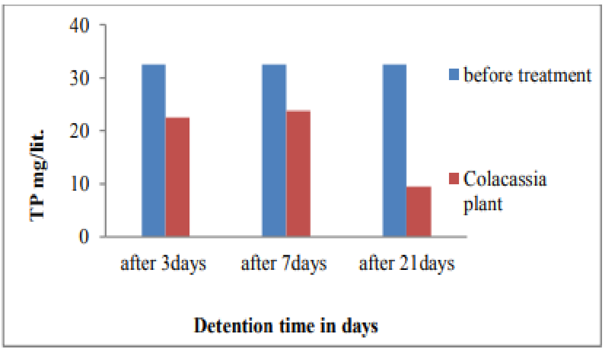

Chart no. 7 Phosphate value of Colacassia plants

VI. CONCLUSION

Construction Wetlands are being extensively used in developing countries to treat domestic, agricultural and industrial wastewater and urban and highway runoff for current status of application of root zone system especially used for domestic's wastewater.

It is concluded from above project that the method of RZT is capable to reduce pollutant level shown below.

1. The Initial P^{H} of before treatment is 6.8 and after treatment by Colacassia plant RZT s 7.2
2. BOD decreasing by Colacassia root zone after 3days, 7days, 21days and are 50%, 74%, 79% respectively..
3. COD decreasing by Colacassia root zone after 3days, 7days, 21days are 52%, 78%, 82% respectively
4. TDS decreasing by Colacassia root zone after 3days, 7days, and 21days are 33%, 39%, 47% respectively.
5. TSS decreasing by Colacassia root zone after 3days, 7days, and 21days are 29%, 60%, 65% respectively.
6. Nitrogen decreasing by Colacassia root zone after 3days, 7days, and 21days are 54%, 77%, 81% respectively
7. Phosphate decreasing by Colacassia root zone after 3days, 7days, 21days are 30%, 64%, 70% respectively.

The overall study strongly recommends the use of CWs for treatment of domestic waste water for pathogenic bacteria, besides pollutants.

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