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Wastewater Treatment by Root Zone Technology Option for Domestic Waste

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Abstract – **Root Zone Bed System is one of the lowest cost methods to treat wastewater. With the help of this system we can treat the Non-Point sources with the best results. To achieve this goal, we have to divide the Non-Point sources into constructing channels within the river bank followed by root zone bed or if the NonPoint Sources is coming from natural nalas we can provide this system within its Channel. For model practice, I have prepared reactor on which I have developed the root zone bed and have lab analysis of rector output on a 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. Planting Colacassia and Canna plant. Both plant get nearly same result but we can use planting as per requirement. The optimization is when we get better results with maximum flow. I have got satisfactory results for the detention time of Three days, Seven days and Fifteen day. With the help of this data I have designed the root zone bed system for the domestic wastewater. Coat of root zone technology is small as compared to conventional system.**

Keywords: **— Wastewater, Root Zone, COD, BOD, TSS, TDS, Cost Analysis etc.**

I. INTRODUCTION

Root zone frameworks are manually arranged wetlands including mud or plastic lined removal and rising vegetation developing on rock/sand blends and is otherwise called constructed wetland. This technique joins mechanical filtration, substance precipitation and organic corruption in one stage for the treatment of wastewater. Various elements like low working cost, less vitality prerequisite and simplicity of upkeep ascribe to influencing the root to zone framework an appealing option for wastewater administration. The term root zone incorporates the existence connections of different types of microscopic organisms, the base of the wetland plants, soil, air, sun and obviously, water. Root zone treatment is one of the common and alluring techniques for treating local, modern and agrarian squanders. It is a designed strategy for filtering wastewater as it goes through a misleadingly built wetland region. It is considered as a successful and dependable auxiliary and tertiary treatment strategy.

The root zone treatment is a characteristic upkeep free framework where the sewage wastewater is sanitized by the foundations of wetland plants. The root zone process capacities as per the law of nature, to viably cleanse local and modern effluents. The procedure joins the selfregulating progression of a biological community. Use of root zone innovation is finding more extensive worthiness in creating and created nations, as it seems to offer more temperate and biologically worthy answer for water contamination administration issue Root zone frameworks, regardless of whether common or developed, constitute an interface between the aquifer framework and earthbound framework that is the wellspring of the poisons. These are accounted for to be most reasonable for schools, doctor's facilities, inns and for littler networks.

II. LITERATURE SURVEY

Nanda Sahil (2017) has contemplated on Root Zone squander water Treatment for local sewage the wastewater is gathered from the septic tank when that floods are exchanged to the plant. At the plant, a touch of fundamental measurement is made. The elucidated sewage from the septic tank is made to go through the Root Zone pit. The length and broadness of the pit rely upon the volume of the wastewater to be dealt with every day. The pit is fixed via fixing with low Density Polypropylene sheets or rolls. In the event that fundamental, different sorts of common structure can be made in the treatment tank. The pit is filled layer by layer with layered made of sufficient porosity.

Mane Mahesh et.al. (2017) has considered in Introduction to Waste Water Treatment by Root Zone Technique. In This examination Increasing urbanization and human exercises adventure and influence the quality and amount of the water assets. This has brought about contamination of freshwater bodies because of expanded age of residential waste, sewage, mechanical waste and so forth. This paper surveys the Root Zone Treatment System, which is planted channel beds comprising of soil rock, sand and fine total. This Technique utilizes a characteristic method to successfully treat residential and modern effluents. RZTS are notable in calm atmospheres and are anything but difficult to work having less establishment, low upkeep, and operational expenses and fuses the automatic progression of a counterfeit soil eco-framework.

Parmar Jigar et.al. (2016) has contemplated on Experimental investigation on post treatment of dairy wastewater is utilizing crossover reed bed innovation in this Study give information about dairy squander and the dairy squander and their compelling treatment. He had utilized the half breed reed plant for treatment of Dairy squander. It give from this examination affirmed that the Hybrid reed bed framework was profoundly compelling in evacuating BOD up to 14 mg/L and COD at up to 110 mg/L at 36 hours detainment time with an expulsion effectiveness of BOD is 97%, and COD is 92% of dairy wastewater. Decreases in TDS and TSS were not noteworthy. At first the pH of Dairy squander test was more soluble, however because of the strategies executed the pH was raised much close to the unbiased pivot.

Irfan Naseemul et.al. (2015) has considered in Holistic Household Waste Management at Source-An Experimental Study. He has examined related dark water and kitchen, strong waste administration. Straightforward sand channel bed technique for treatment and the sand channel with reed plant are tested and contrasted with Wastewater administration. It likewise proposes the technique for utilizing PVC channels for influencing fertilizer from the kitchen to squander. Phragmites Australis (privately known Canna) and canna Indica (privately known as cannas) were utilized as reed plants for wastewater treatment. This paper introduces the technique for development of reed overnight boardinghouse adequacy of evacuation of different contaminants utilizing root zone treatment process. The quality parameters of crude water and treated water tests were looked at and talked about.

Shitole Dhiraj (2014) has examined on Feasibility Study of Low Cost Treatment for Non Point Sources He had clarified about non point source and their treatment. In display situation the stream water has progressed toward becoming wastewater because of transfer of city squander through which it streams. Because of shameful and not well arranged framework advancement, the sewerage organize and treatment office are insufficient. At any spots, this prompts the improvement of unlawful sewage, coming about into Non-Point sources. A large portion of the current wastewater treatment plants are getting over The Root Zone Bed System is one of the most reduced cost strategies to treat wastewater. With the assistance of this framework we can treat the Non-Point sources with the best outcomes.

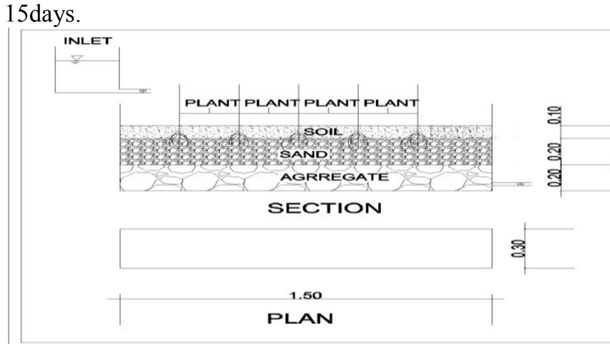
III. MATERIAL AND METHODOLOGY

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

Consider the length of reactor 1.5m, height 0.5m and thickness 0.3m. In above Fig. shows section and plan of constructing 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 with water before keeping in reactor similarly cleaned sand with water before keeping in the reactor. Filled all layers simultaneously in the reactor and keep it for one day. Prepare two systems parallel for cane 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 the backside of the tub and kept in the slanting position. Inlet and outlet flow rates were adjusted by using a 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 meters

Fig. 1 Plan and Section of root zone system.

(a) (b)

(b) (d)

Fig. 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 are planted clumps. The clumps can be planted during all seasons at 2 Nos / m2. Rhizomes grow best when planted in Pre-monsoon 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 H2S within the filter bed.

Fig. 3 Planting of Colacassia and Canna plant

To prevent entry of soil into under drain pipe and washing out of the soil a graded filter is provided on the blower portion of the reactor. The filter consists of crushed stone of gradation 40mm at the bottom near to under drain pipe to 5mm at the 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.

Uses of Colacassia plant: Taro's essential utilize is the utilization of its consumable corm and clears out. In its crude frame, the plant is poisonous because of the nearness of calcium oxalate, and the nearness of needle-formed raphides in the plant cells. In any case, the poison can be limited and the tuber rendered tasteful by cooking or by soaking in cool water medium-term.

Corms of the little round assortment are peeled and bubbled, sold either solidified, packed away in its own fluids, or canned. The leaves are wealthy in vitamins and minerals. It is likewise sold as a fancy sea-going plant. It is additionally utilized for Anthocyanin consider analyzes particularly with reference to biaxial anthocyanic fixation.

Fig. 4 Colacassia plant.

Canna plant: Canna (or canna lily, despite the fact that not a genuine lily) is a variety of 10 types of blooming plants. The APG II arrangement of 2003 relegates it to the clad attractiveness, in the monocots. Plants have substantial foliage and horticulturists have transformed it into a vast blossomed cultivate plant. It is likewise utilized as a part of horticulture as a rich wellspring of starch for human and creature utilization. In spite of the fact that a plant of the tropics, most cultivars have been produced in calm atmospheres and are anything but difficult to develop in many nations of the world as long as they get no less than 6– 8 hours normal daylight amid the mid year, and are moved to a warm area for the winter. See the Canna cultivar exhibition for photos of Canna cultivars.

Fig. 5 Canna plant

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Uses of Canna plant

A few animal categories and numerous cultivars are broadly developed in the garden in calm and subtropical locales. Now and again, they are likewise developed as pruned plants. Countless cultivars have been created. They can be utilized as a part of herbaceous outskirts, tropical plantings, and as a yard or decking plant.

1. Internationally, cannas are a standout amongst the most prevalent garden plants and a huge plant industry relies upon the plant.
2. The rhizomes of cannas are wealthy in starch, and it has numerous utilizations in horticulture. The greater part of the plant has business esteem, rhizomes for starch (utilization by people and domesticated animals), stems and foliage for creature grain, youthful shoots as a vegetable, and youthful seeds as an expansion to tortillas.
3. The seeds are utilized as dabs in jewelry.The seeds are utilized as the versatile components of the kayamb, a melodic instrument from Réunion, and additionally the hosho, a gourd shake from Zimbabwe, where the seeds are known as hota seeds.
4. In more remote areas of India, cannas are matured to create liquor.

IV. WORKING OF ROOT ZONE TECHNOLOGY

Sampling Methodology: I have taken sample at Nasardi River near Bombay Naka Nashik

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

This river polluted due to it fowling through 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

Root Zone Mechanism

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

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samples were collected and analyzed in laboratories.

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 methods. 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 and Canna plants

Sr	Description	Colacassia plant	Canna plant
1	Before treatment	6.8	6.8
2	After 3days	6.9	7.0
3	After 7days	7.1	7.2
4	After 15days	7.2	7.2

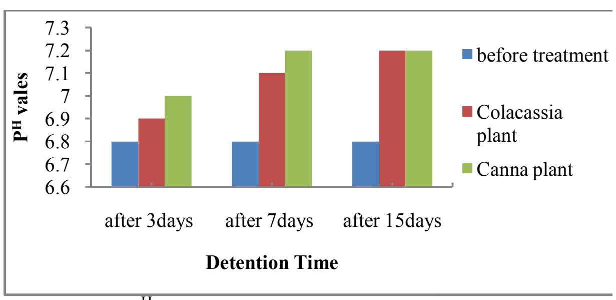

Fig. 6 P^H value of Colacassia and Canna plants

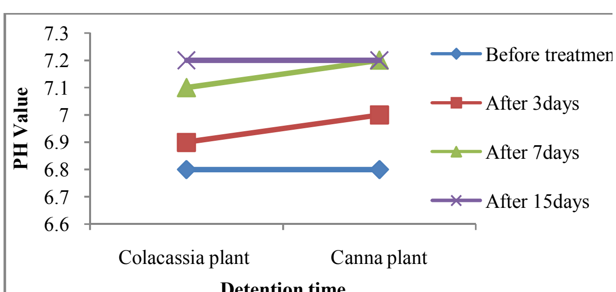

Fig. 7 P^H value of Colacassia and Canna plants

Table no. 2 BOD value of Colacassia and Canna plants

Sr	Description	Colacassia plant	Canna plant
1	Before treatment	340.5	340.5
2	After 3days	170.8	173.5
3	After 7days	89.5	85.5
4	After 15days	70.5	69.2

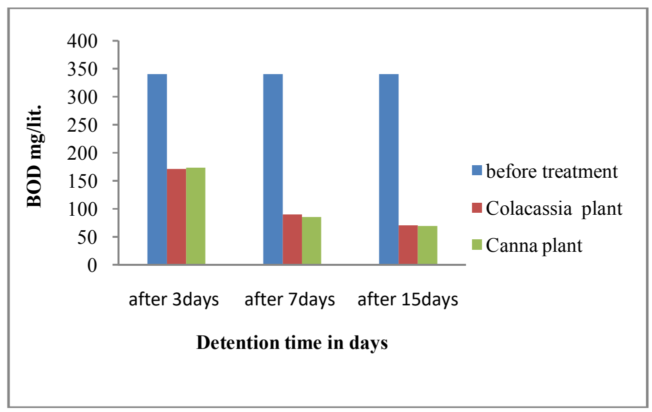

Fig. 2(a) BOD value of Colacassia and Canna plants.

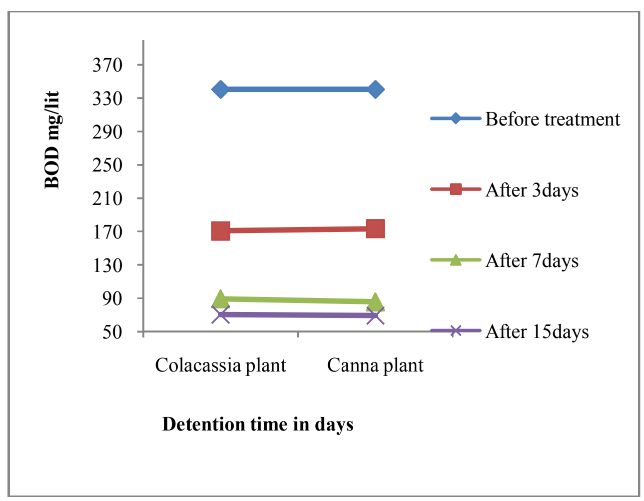

Fig. 2 (b) BOD value of Colacassia and Canna plants

Table no. 3 COD value of Colacassia and Canna plants

Sr. No.	Description	Colacassia plant Mg/lit	Canna plant Mg/lit
1	Before treatment	443.5	443.5
2	After 3days	212.8	217.2
3	After 7days	91.2	94.8
4	After 15days	80.5	82.8

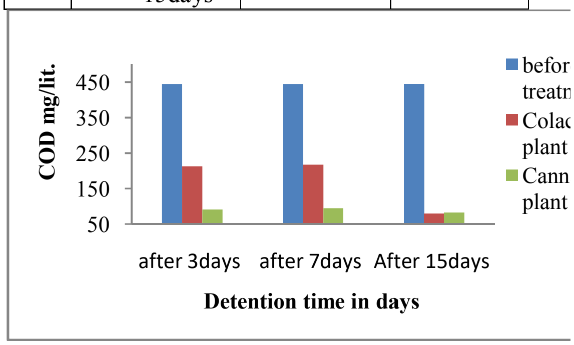

Fig. 3 COD value of Colacassia and Canna plants

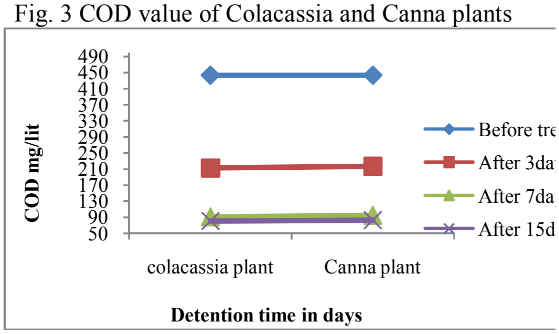

Fig. 3 COD value of Colacassia and Canna plants

Table no. 4 TDS value of Colacassia and Canna plants

Sr. No.	Description	Colacassia plant Mg/lit	Canna plant Mg/lit
1	Before treatment	900.5	900.5
2	After 3days	604.5	600.2
3	After 7days	552.8	550
4	After 15days	480.2	485.8

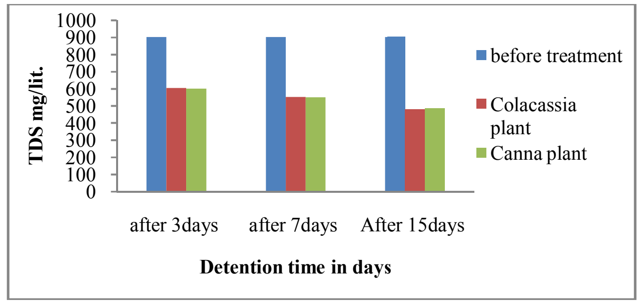

Fig. 4 TDS value of Colacassia and Canna plants

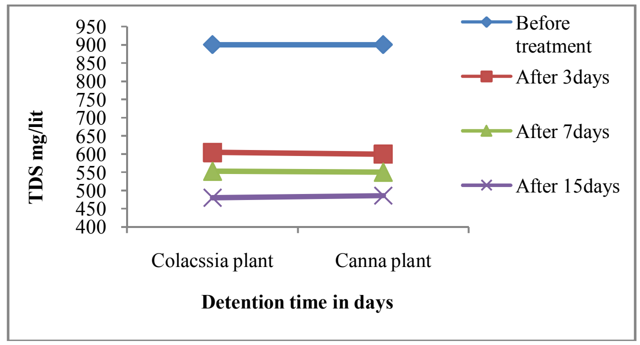

Fig. 4 TDS value of Colacassia and Canna plants

Table no. 5 TSS value of Colacassia and Canna plants

Sr. No.	Description	Colacassia plant	Canna plant
1	Before treatment	185.5	185.5
2	After 3days	132.4	125.6
3	After 7days	74.8	79.2
4	After 15days	64.2	63.8

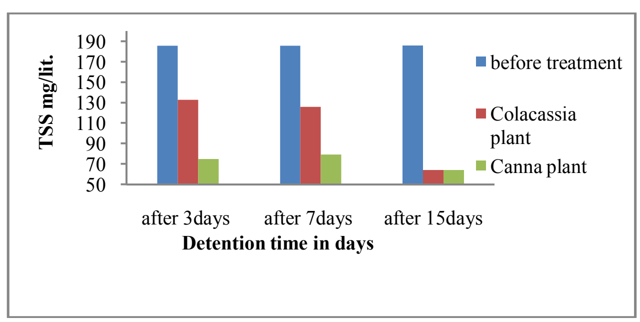

Fig. 5 TSS value of Colacassia and Canna plants.

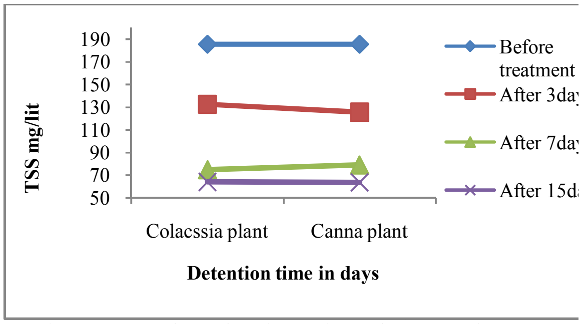

Fig. 5 TSS value of Colacassia and Canna plants.

Table no. 6 Nitrogen value of Colacassia and Canna plants

Sr. No.	Description	Colacassia plant	Canna plant
1	Before treatment	60.5	60.5
2	After 3days	27.6	29.5
3	After 7days	13.8	15.5
4	After 15days	11.5	12.2

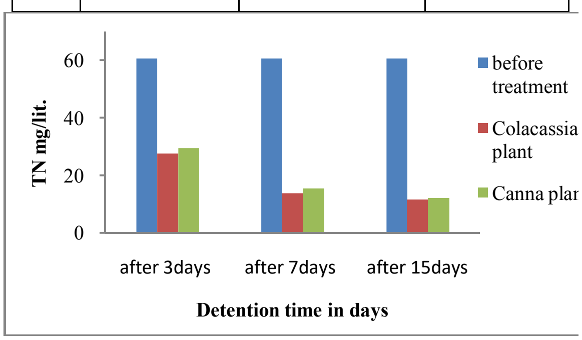

Fig. 6 Nitrogen value of Colacassia and Canna plants

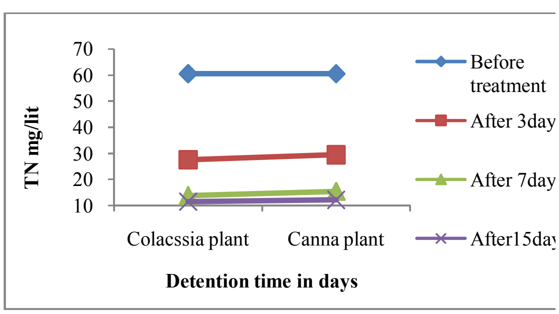

Fig. 6 Nitrogen value of Colacassia and Canna plants

Table no. 7 Phosphate value of Colacassia and Canna plants

Sr. No.	Description	Colacassia plant	Canna plant
1	Before treatment	32.5	32.5
2	After 3days	22.6	23.8
3	After 7days	11.8	12.5
4	After 15days	9.5	9.4

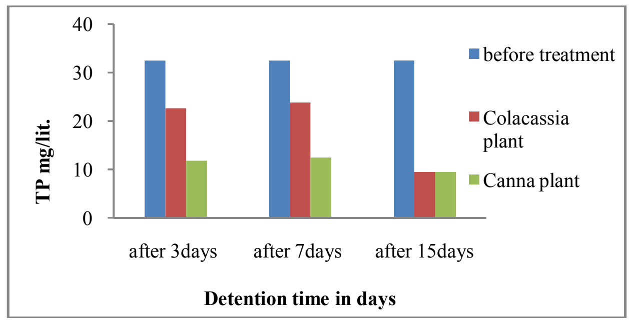

Fig. 8 Phosphate value of Colacassia and Canna plants

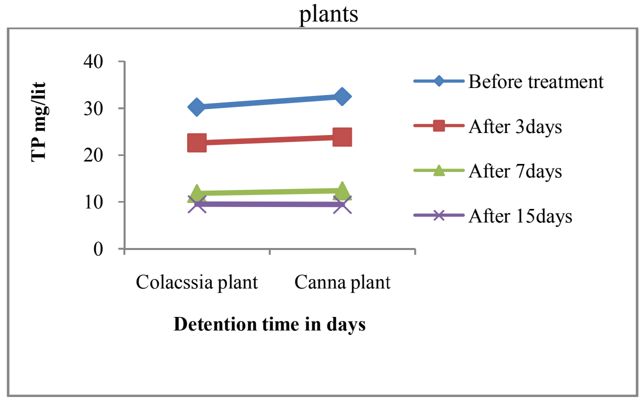

Fig. Phosphate value of Colacassia and Canna plants.

VI. COST ANALYSIS

4.2 Cost Analysis

Cost of conventional method of sewage treatment

Cost analysis of conventional treatment with Activated Sludge Process (ASP) including primary treatment, secondary treatment and chlorination is given below. The construction cost of ASP plant = 90 lakh per MLD.

Land requirement / MLD plant = 1 acre.
Land cost/MLD = 30 lakh per acre.

Therefore, Capital Investment required for setting up 1MLD sewage treatment plant consisting activated

Sludge process = Cost of construction + Cost of land required = 90, 00,000 + 30, 00,000 = Rs 1, 20, 00,000 /-

The operational and maintenance cost including interest on capital, electricity consumption, skilled and unskilled labor cost, repair and maintenance cost and depreciation of civil and mechanical works ,the revenue obtained is worked out to Rs 12 per 1000 liters of sewage. Thus the operation and maintenance cost for operating conventional sewage treatment plant of 1 MLD is about Rs 43,80,000/year.

Cost analysis of Root Zone Technology treatment plant

For comparing the cost economics of root zone technology with conventional method, sewage treatment plant of 1MLDconsisting root zone technology is considered.

Land requirement/MLD = 3.5 acres.

Cost of land = 30 lakh per acre = 30 x 3.5 acres=70 lakh.

Cost of excavation for construction of RZT reactor = 18 lakh.

Cost of filter media = 40 lakh.

Cost of polyethylene sheeting = 14 lakh.

Therefore, capital investment required for setting up the Root Zone Technology (RTZ) treatment plant, = Cost of construction + Cost of land = (18 lakhs + 40 lakhs + 14 lakhs) +105 lakhs = Rs 177 lakhs /- The operational and maintenance cost or treatment cost is determined considering following items,

i) Labor for watering, cutting and maintenance.
= 3 labors per acre x Rs 200 x 365 days x 3.5 acres.
= Rs 7, 67,000 /-

ii) Interest on investment at 8 % = Rs 1416000 /-

iii) Revenue generated from plants per year = Rs 600000 /-

Treatment cost =Labor cost+ Interest on investment at 8% - Revenue obtained by selling the plant. Treatment Cost = 7, 67,000 + 14,16,000 – 6,00,000= Rs 15,08,000 /- Total sewage treated per year = 365X 1 MLD=365 million liters=365 X 1000 X1000 liters. Therefore, treatment cost per m3 of sewage = (15,08,000) /(365X1,000) = Rs 4.13/- Therefore the treatment cost of sewage using Root Zone Technology is Rs 4.13 per 1000 liters or Rs 4.13 per m3 which is very less as compared to the treatment cost of Rs 12 per m3 for Conventional Sewage treatment

VII. CONCLUSION

Constructed 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 the root zone system especially used for domestic's wastewater.

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

- The Initial P^H of before treatment is 6.8 and after treatment by Colacassia plant RZT s 7.2 And by a cane plant is 7.2
- BOD is decreasing by Colacassia root zone after 3days, 7days, 15days and are 50%, 74%, 79% respectively. And Canna root zone after 3days, 7days,15days are 49%, 75%, 80% respectively.
- COD decreasing by Colacassia root zone after 3days, 7days, 15days are 52%, 78%, 82% respectively. And Canna root zone after 3days, 7days, 15days are 51%, 79%, 81% respectively.
- TDS decreasing by Colacassia root zone after 3days, 7days, and 15days is 33%, 39%, 47% respectively. And Canna root zone after 3days, 7days 15days are 33%, 38%, 46% respectively.
- TSS decreasing by Colacassia root zone after 3days, 7days, and 15days is 29%, 60%, 65% respectively. And Canna root zone after 3days, 7days, 15days are 32%, 57%, 65% respectively.
- Nitrogen decreasing by Colacassia root zone after 3days, 7days, and 15days is 54%, 77%, 81% respectively. And Canna root zone after 3days, 7days, 15days are 51%, 74%, 80% respectively.
- Phosphate decreasing by Colacassia root zone after 3days, 7days, 15days is 30%, 64%, 70% respectively. And Canna root zone after 3days, 7days, 15days are 27%, 61%, 71% respectively.

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

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