WASTEWATER TREATMENT BY PHYTOREMEDIATION IN A CONSTRUCTED WETLAND

A Comparative Study using *Chrysopogon zizanioides* and *Phragmites karka*

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INTRODUCTION:

Water resources have become the site for dumping of solid wastes in their banks and draining the sewerage and effluent water in their streams. Agricultural runoff and industrial discharge without pretreatment contribute to the detrimental effects on water quality, not to mention public and environmental health.

The conventional wastewater treatment methods like methods used for treatment of contaminated soils and water, namely chemical, physical, and microbiological methods, are costly to install and operate. Some of the advanced wastewater treatment (active sludge treatment, microbial treatment, chemically enhanced primary treatment – CEPT, advanced integrated pond system – AIPS, stabilization ponds, aerated and non-aerated lagoons, etc.) methods are found superior than the conventional physical, chemical and microbiological processes but requires sound technical knowledge, continuous monitoring high investment costs. While searching for the cost effective and long lasting solution for the treatment of wastewater in natural way and with minimum aid of technique and technology, Phytoremediation treatment method in the constructed wetland was found to be the best feasible option.

EXPERIMENTAL SETUP:

An experiment was carried out to assess the efficiency of *Chrysopogon zizanioides* (Vetiver) and *Phragmites karka* (Common reed) in wastewater treatment. The experimental set up was made by constructing a green house cottage consisting of four wetlands separated by plastic lined earthen bunds and planted with Vetiver, Common reed, Both (mixed) and none (control).

Figure 1: Location of the Study site, (Google earth image, 17th September, 2014)

Design Features

The fundamental applied design features for the study were as follows (Figure 2):

Greenhouse Area	: 7m x 5m
Roof Materials	: Locally available materials (Bamboo, Common reed, plastic.
Wetland Pond Size	: 1m x 3m x (0.3m to 0.5m)
Number of Wetlands	: 4
Gradient Flow Separation	: 0.5m
Reeds	: Common reed and Vetiver (Mixed and alternative with control)
Refill Materials	: Brick pieces, Pebbles, Sand

The wastewater flow in each pond was maintained in such a way that the raw wastewater enter through 2 inch diameter PVC pipe into the porous pipe lined by gravel and wire net before the front row of each treatment pond so that the unwanted solid wastes are trapped and only liquid waste passes to the plants roots by subsurface flow. The treated water passed down the slope through each row and finally reached to the outlets at the end of each pond (Figure 3). The

monitoring holes were made randomly in between the rows in order to test and compare the physicochemical quality of wastewater after treatment. A narrow canal was dug around the study site in order to allow drainage of the surface drain water into other ways of outlet system to minimize the contamination error.

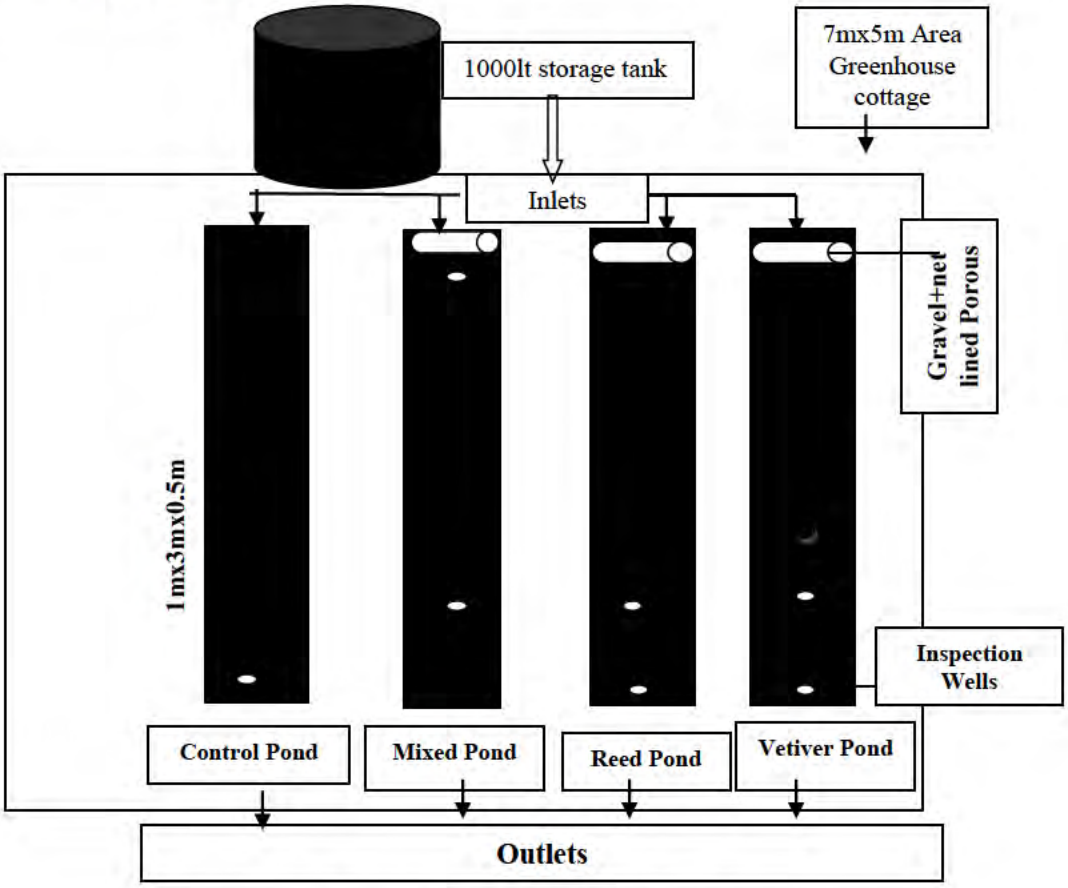

Figure 2: Construction Design

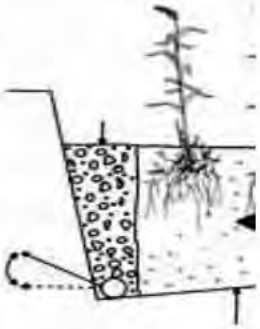

Figure 3: Direction of wastewater flow with the gradient

RESEARCH OBJECTIVES

The objectives were to determine the Morphological (height, hedge, leaf color, decay and rebirth) in plants, Physical (pH, Temperature, Conductivity, Turbidity) chemical (BOD_5, COD, NO_3-N, TP, Chloride, CO_2) and Microbial (Total Coliform) Parameters of wastewater before and after treatment and to study their relation with soil nutrient change (Percent Organic matter, percent organic Carbon, percent Total Nitrogen and Average Phosphorus).

DATA COLLECTION TECHNIQUES AND RESULTS

Morphology Change:

The morphological data was taken by field observation. Saplings of Vetiver and Common reed were respectively 6 cm and 32cm during plantation which after four months of plantation, reached the equal height of 156cm. Net increase in height for Vetiver was 225.8±9.66cm while that of Common reed was 164.6±7.35cm in six months with appearance yellow patches and drying of old leaves.

Change in Water Quality:

Water samples were taken at interval of two weeks after three months of plantation and preserved in refrigerator at less than 4^oC above freezing point within 10 hours of collection. The physico-chemical parameters tests were done according to APHA-AWWA-WPCF, 2005 and General Experiments on Physiochemical parameters of Water, 2007. The results showed that on the sixth month the overall concentration of BOD5, COD, NO_3- N, TP, Free CO_2 and Chloride content in the effluent after treatment were reduced by 92.30%, 80.76%, 90.90%, 87.5%, 78.12%, 81.13% by *Chrysopogon zizanioides* pond 76.92%, 35.38%, 81.18%, 55%, 56.25%, 52.83% by *Phragmites karka* pond, 84.61%, 53.84%, 84.09%, 60%, 62.5%, 60.37% by the mixed pond and 53.84%, 28.12%, 30%, 32.5%, 28.12%, 26.41% by the control respectively at their outlets.

Change in Soil Quality:

Soil nutrients namely percent Soil organic matter, percentage organic carbon, Average available Phosphorus (ppm) and Total nitrogen percent were also found to increase along with the plants growth and increased efficiency in wastewater treatment. The Soil organic matter ranged 4.64 %, 5.23%, 4.86% and 4.64% before plantation in vetiver pond, Common reed pond, mixed pond and Control respectively which after three month showed slight increase in their value as 5.82%, 6.04%, 5.67% and 6.67% for the respective treatment ponds. After six month of plantation, the value showed remarkable increase in soil organic matter as 7.55% for vetiver treatment pond, 6.26% for common reed pond, 6.81% for mixed pond and 6.30% for the control. Similar trend was found for percentage organic carbon, Average available Phosphorus (ppm) and Total nitrogen percent and vetiver pond showed the highest value followed by mixed pond, Common reed pond and lastly control pond.

CONCLUSION:

Growth rate was found greater in the Vetiver than the Common reed though it showed slower development in the mixed pond for the first two months. Decay and rebirth was continuous in Common reed while Vetiver survived 100% though proper hedge development was not seen in the mixed plantation.

Efficiency of vetiver on wastewater treatment by reduction of nutrients and chemicals from the water was found greater than that of Common reed. Mixed pond performed better than the Common reed pond which might be due to the presence of the Vetiver in it planted alternately which played vital role in the reduction of the pollution parameters from the raw wastewater. Mixed pond with both Vetiver and Common reed can be an intermediate solution for an over all good wastewater treatment system for those who donot have access to required number of vetiver saplings for their wastewater treatment.

The soil nutrient in vetiver pond showed remarkable increase in vetiver treatment pond followed by mixed pond, common reed pond and control pond while comparing the values before plantation and after six months of plantation in the treatment ponds. This change could also be observed by the soil texture change which were very rough boulder type building construction wastes refill but after only six months, the soil converted to lusturous and shiny humus contained fertile soil which was supported by the presence of earthworm which aid in making soil more porous and fertile.

On the basis of site observation, experiments and analysis of datas, it was concluded that *Chrosopogon Zinanioides* (Vetiver) performed better than *Phragmited karka* (Common reed) and Mixed plantation (both Vetiver and Common reed) can be an intermediate solution between them in wastewater treatment.