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Phytoremediation Treatment of Farm Waste-Water by Selected Aquatic Plants

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Abstract: Wastewater management has a direct impact on the biological diversity of aquatic ecosystems. Disrupting the fundamental integrity of our life support systems. When water bodies receive excess nutrients especially nitrates and phosphates, these nutrients can stimulate excessive plant growth, which causes eutrophication including algal blooms. Eutrophication leads to oxygen depletion, decreased biodiversity, changes in species composition and dominance, and a severe reduction in water quality. Aquatic plants grow profusely in lakes and waterways all over the world and in recent decades their negative effects have been magnified by man's intensive use of water bodies. Eradication of the weeds has proved almost impossible and even reasonable control is difficult. Turning these weeds to productive use would be desirable if it would partly offset the costs involved in mechanical removal. These aquatic plants were growing on the waste-water in different range. Amount of Nitrate, phosphate, EC, TDS, pH changes were estimated and analyzed. Through this experiment 87.5% of Nitrate, 67% of phosphate was absorbed by the aquatic plants and 25% reduction of Ec and TDS was observed and alkaline pH changes to neutral. *Duckweed* and *Water hyacinth* are high pollutant removal efficiency and highest survival among these aquatic plants. *Azolla* performs the considerable reduction than others plants. Whereas *Salvinia* performs the lowest reduction rate compared to other aquatic plants. In addition to that *hydrila* performs the high reduction of water pH. In this study phytoremediated waste-water, which consists permissible level of pollutants can be used for the irrigation of farm plants without any physiological stress.

***Keywords*:** Phytoremediation, Eutrophication, Aquatic-weeds, *Waste*-water treatment.

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Introduction

Wastewater is a combination of domestic, commercial, industrial, and agricultural discharge, which contains pollutants and contaminants, including nutrients, microorganisms, chemicals and other toxins. These pollutants can cause health and environmental problems when wastewater is released into body rivers improperly (Secretariat, 2014). On the other hands, the increase in the concentration of nutrients such as nitrogen and phosphorus in water causes eutrophication of surface water resources.

However, wastewater also contains reusable resources such as water, carbon and nutrients that could be recovered or reused. Therefore, they require appropriate treatments for removal of pollutants to meet the effluent regulatory standards prior to discharge to the environment. Natural treatment systems are not disposal practices, nor are they random applications of waste and wastewater in various habitats (Crawford, 2010).

Natural treatment systems are engineered facilities which utilize the capabilities of plants, soils, and the associated microbial populations to degrade and immobilize wastewater contaminants. Due to the numerous advantages presented by wastewater treatment systems using plants, a new research field has evolved for better understanding of the processes underlying the inter-relations between the different species of plants in effluent treatment. Phytoremediation has been increasingly used to clean up contaminated soil and water systems because of its lower costs and fewer negative effects than physical or chemical engineering approaches (Prasad and Freitas, 2003). The principles of phytoremediation system to clean up storm water includes identification and implementation of efficient aquatic plant systems; uptake of dissolved nutrients including N and P and metals by the growing plants, and the plants creating a favorable environment for a variety of complex chemical, biological and physical processes that contribute to the removal and degradation of nutrients (Billore *et al*., 1998).

Objective

To estimate the performance of nutrient removal from farm waste water by aquatic plants such as Hyacinth, Duckweed, Salvinia, Azolla and Hydrila.

Materials and Methods

Study Area

Kilinochchi is the main Agricultural district in Northern Province of Sri-Lanka. It does not have a single perennial river, seasonal streams and rivers. Traditional water storage was through built irrigation tanks.

The area belongs to the dry zone of Sri Lanka with low annual rainfall, cannot be supported without adequate replenishment of surface water storage. Waste water was selected according to the nutrient

content like pH, TDS, EC also analyzed to stabilize proper condition for plant growth. It has also contributed to nitrate and phosphate contamination which is now-a-days a matter of concern because of ground water scarcity.

Nitrate Sedimentation, surface-floating of solid-substances also avoided from the filtration of large particle food industry waste water, farm waste water, food packaging center waste waters also possible for the treatment. In select farm waste water as a waste water resource because of its essay availability in research place. Criteria is used in selecting Macrophytes, adaptability to local climate, tolerance to adverse climatic conditions, tolerance to adverse concent ration of pollutants, pollutants assimilative capacity, high rate of photosynthesis, high oxygen transport capability, resistance to pests/diseases, ease of management harvesting. Based on these criteria, the macrophytes were selected in the study water hyacinth (*Eichhornia crassipes*), duckweed (*Lemna spp.* and *Spirodela polyrrhiza,* W. Koch), salvinia (*Salvinia minima* baker), Azolla (*Azolla caroliniana*) and hydrilla ((*Hydrilla verticillata*).

Experimental set-up, Data Collection and Parameters Analysis

The raw farm waste water was collected from a nearby animal farm in water cans. Chemical parameters were measured pH, TDS, EC, nitrate, phosphate contents were measured by pH meter, calorimeters and spectrophotometer. After the propagating of the aquatic plants 4 days interval samples are collected and the measurement of pH, TDS, EC were done in the laboratory of department of Agricultural Engineering faculty of Agriculture. Further analysis in the water board located in Jaffna for nitrate measurement APHA4500-NO3-E, Adopted method and for phosphate measurement APHA 3500-P E Adopted method were adopted. Plant samples are Shoot (above-water plant part) and root tissue samples were oven dried at 38 °C for 48h, ground, and total NPK measurement was done.

Total Dissolve Solid, pH, Electrical Conductivity Measurements

The water samples were collected in 2 days intervals for sampling immediately. After sampling the rods of the HACH meter dipped in the samples with conical flask. The reading was recorded in the 2 days interval. A graph of the standards was plotted. The concentration of the unknown was driven from the graph. Potassium concentration of the each and every sample was calculated. Whereas the maximum growth, nutrient and COD removal efficiency of duckweed was observe at EC 1,000 µS cm-1 (*Jamshaid Iqbal* , 1999).

Results and Discussion

Results of water quality parameter changes during the phytoremediation of waste water were explained below.

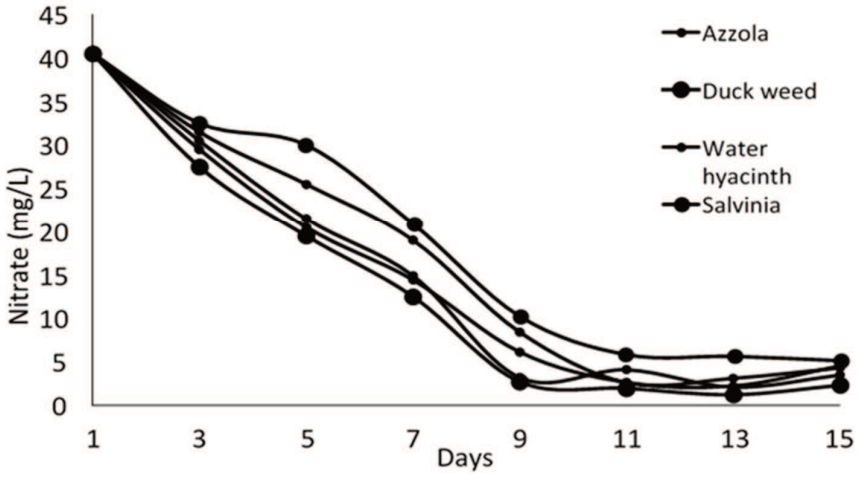

Figure 1: Variation in the nitrate content of the waste water in the time of remediation

Variation in the nitrate content of the waste water through the time of remediation process was shown in the Figure 1. Among the aquatic plant Duckweed performs the highest nitrate reduction rate and Salvinia perform lowest reduction rate. In addition to that water hyacinth also performs at the lowest reduction rate. Through the experiment efficient removal of nitrate content was reduced and ranged from 40mg/L to 5mg/L.

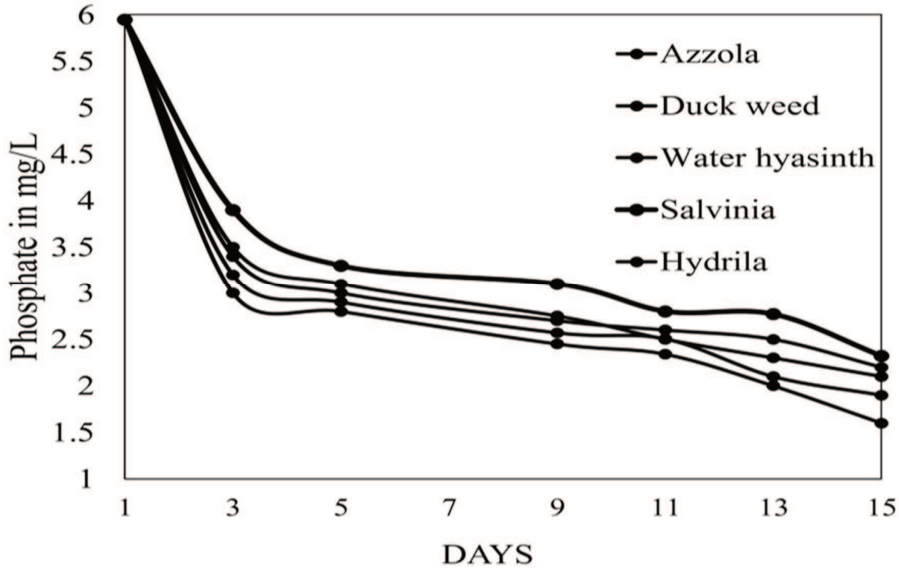

Figure 2: Variation in the phosphate content of the waste water in the time of remediation

Phosphate removal with time was shown in Figure 2. Among the aquatic pants tested Salvinia performed lowest reduction rate whereas the duckweed performed the highest reduction rate. Water hyacinth also performed higher reduction rate. During the absorption process Phosphate content decrease and it ranged from 6 mg/L to 2 mg/L.

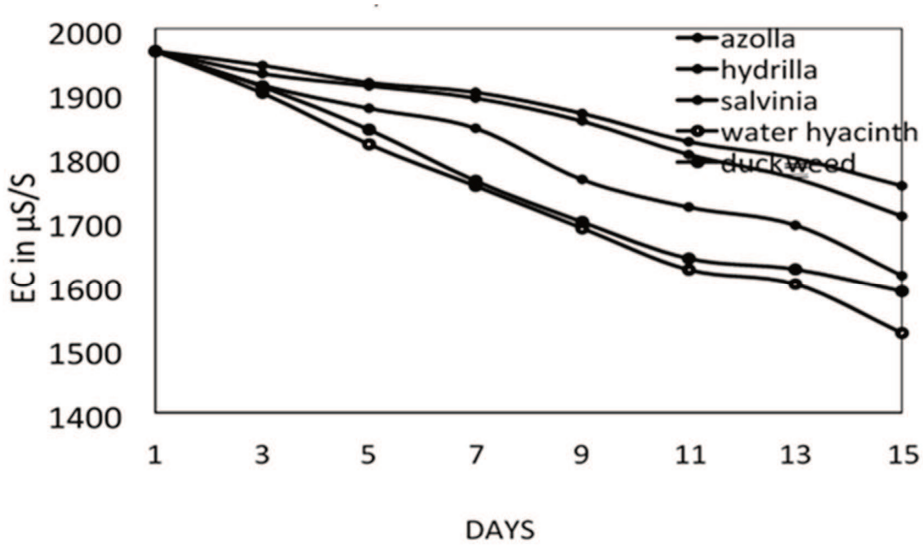

Figure 3: Variation in the electrical conductivity of the waste water in the time of remediation

The profiles of the Electrical conductivity in the phytoremediation process with selected aquatic plants was shown in Figure 3. Among the selected aquatic plant Water hyacinth and duck weed perform highest reduction rate. Whereas Salvinia performs lowest reduction rate compared to other aquatic plants. Study show that duckweed *(Lemna minor*) performed well.

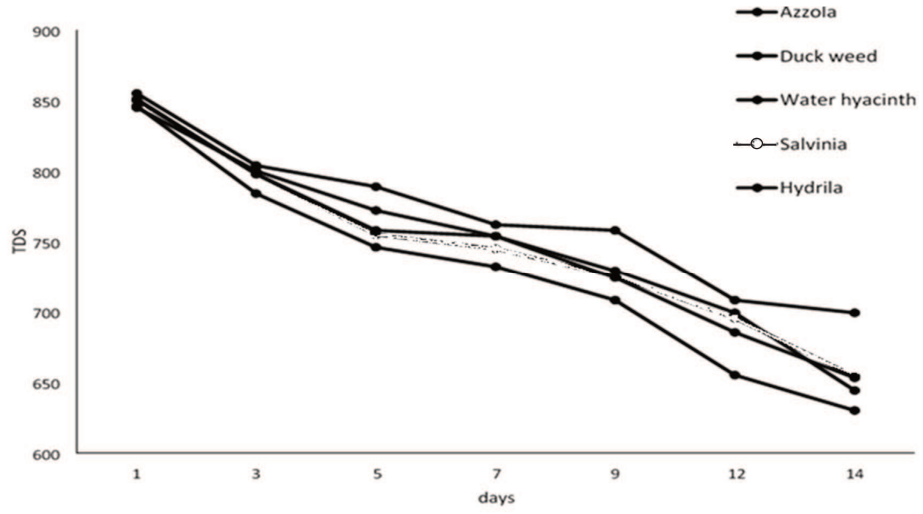

Figure 4: Changes in the total dissolve solid content of the waste water in the time of remediation

Figure 4 explained about the reduction in total dissolve solid content of the waste water. Water hyacinth perform highest reduction rate it ranged between 846 to 630 mg/l. Azola performs the lowest reduction rate than others plants. Duck weed also performs highest reduction than the other three plants. Water hyacinth is the efficient remover of the dissolve solid content among the selected aquatic plant.

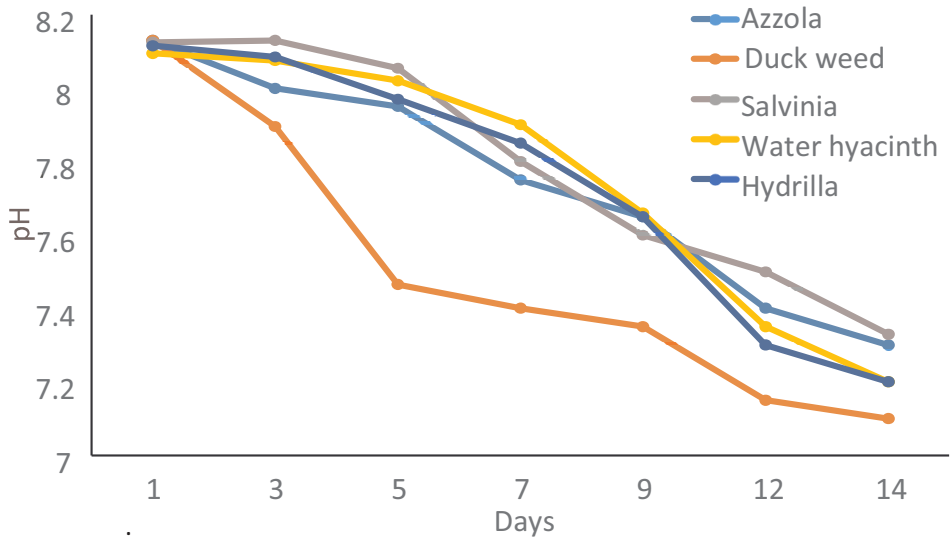

Figure 5: Changes in the pH content of the waste water in the time of remediation process

The pH of the environment has a profound effect on the rate of plant growth. pH affects the function of metabolic enzymes. Figure 5 showed the variation of pH in the phytoremediation treatment through the day. Based on that duck weed performs highest changes in pH, it reflect as near to natural. In addition to that hydrila and water hyacinth also perform the moderate changes. Salvinia perform the minimal change in the pH.

Conclusions

Among the Aquatic plants, Hyacinth, Duckweed, Salvinia, Azolla and Hydrila were purifying the waste-water in different range were estimated and analyzed. All the aquatic plants show better performance in water purification process. Through this experiment 87.5% of Nitrate, 67% of phosphate was absorbed by the aquatic plants and 25% reduction of EC and TDS was observed. Alkaline pH changes to neutral. Duckweed and Water Hyacinth are high removal efficiency and highest performance of survival among these plants. Azola performs the considerable reduction rate than others plants. Whereas Salvinia performs lowest reduction rate compared to other aquatic plants. In addition to that, hydrila performs the high reduction. In this study phyto-remediated waste water, which consists permissible level of pollutants can be used for the irrigation of farm plants without any physiological stress.

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