Research Article

Proportional Physico-Chemical Analysis of Control Soil, Silk Dyeing Effluent Contaminated Soil and Biotreated Effluent Soil

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ABSTRACT

The physical and chemical parameters were explored for control soil in fresh water, 75% of silk dyeing effluent and biotreated effluent conditions as pot study. The biofertilizer, Pseudomonas fluorescens was mixed with crude effluent and biologically treated. The physical parameter such as the pH and EC of biotreated soil were within the standard limits similar to the control. The soil texture was equivalent throughout the study. The results also indicated that the biotreatment progresses the micronutrient status of the soil within the optimal range. It is due to the influence of biofertilizer in the biotreated soil that had improved the levels of Calcium, Nitrogen, Phosphorus and Potassium from 105, 76, 4, 137 ppm in the effluent treated soil to 110, 200, 14.5, 390 ppm respectively in the biotreated effluent soil. The micronutrients Iron, Manganese, Copper and Zinc ranges from 1.2, 10, 0.4, 0.2 ppm of effluent treated soil to 6.1, 26.22, 2.26, 2.13 ppm respectively in the biotreated effluent soil. Thus it was clear that the impact of effluent on the soil nutrients was encountered by the biofertilizer. The biotreatment had improved the macro and micronutrients of the effluent contaminated soil and can be amended as cost effective and ecofriendly to sustain the productivity of the green leafy vegetable crops.

Keywords: Pseudomonas fluorescens, pH, EC, Calcium, Potassium, Nitrogen, Phosphorus, Iron, Manganese, Copper and Zinc.

INTRODUCTION

Microorganisms which crumblethe organic pollutants through cometabolism in natural water and soil environment[13]. Wastewater discharged from the silk industry is the cradles of aesthetic pollution associated to color pollute the soil. The salt and the heavy metal in the wastewater are toxic to aquatic life. Some of the dyes are carcinogenic and thus cause severe health problems[2]. Bacterial degradation of dyes is frequently initiated under static / anaerobic conditions by an enzymatic transformation reaction[7]. Biodegradation is a biologically mediated cessation of chemical compounds. When this progression gets completed it is called mineralization i.e. the total breakdown of organic molecules into water, carbon dioxide and any other inorganic end products [8]. These methods have the potential to mineralize dyes to harmless inorganic compounds like carbon dioxide, water and the formation of a small quantity of relatively insignificant amount of sludge. The attractive features of biological treatment or biodegradation are low cost, renewable and regenerative activity without any secondary hazard [3].

Soil pH (refers to its acidity or alkalinity) and Soil electrical conductivity (EC) that correlates with soil properties is a measurement that affect crop productivity with the effluent's interference show differences in the composition and the structure, materials will endure at different rates, affecting soil's texture [5].

The Calcium and Nitrogen after absorption from the soil in plant growth is to provide structural support to the cell walls and other cellular constituents of plants and hence it is required for their proper growth and development, when plants are physically or biochemically stressed they change in their contents[10]. Phosphorus and Potassium serves several significant functions in growth and metabolism, storage and transfer, a component of critical cell constituents, promotion of root development and tillering and facilitating proper maturation [8].

Iron is one of the major abundant minerals in the soil and is unavailable for direct assimilation by plants or microorganisms[1]. Copper is a vital micronutrient for plants, humans and animals as it has a role in many vital biological functions and as a compound in amino acids and proteins. Zinc is a critical micronutrient to plants and animals. Zinc uptake in plants is a rather common phenomenon and as zinc is phototoxic the effects will most likely be correlated with reduced crop yield and soil fertility degradation[11]. Iron, Copper and Zinc can be lost in the soil due to the soil contamination with silk dyeing effluent.

MATERIALS AND METHODS

Collection of silk dyeing effluent

The silk dyeing effluent was collected from the effluent disposal site of small scale silk dyeing industry in airtight plastic containers, located at Seelanaickenpatti in Salem district.

Collection of Biofertilizers

The Biofertilizer *Pseudomonas fluorescens* was collected from the Tamil Nadu Agricultural University,Coimbatore.

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Soil preparation for the study

The red soil and the sand were mixed at the ratio of 3:1. Each pot was filled with 7 kg of soil. In Phase 1 and Phase 3, five GLVs were grown with four replicates. In phase 2, three pots for each of the four different concentrations (25%, 50%, 75% and 100%) were used. The biofertilizer, *Pseudomonas fluorescens* was mixed at the rate of 5 tonnes ha^{-1} with crude effluent and used in Phase 3. The bacterial concentration of the biofertilizer was 10^8 Colony forming units (CFU ml^{-1}).

Soil analysis

The soil which was treated with freshwater for the growth of the GLVs served as the control soil. The crude effluent soil treated with 100% of the crude silk dyeing effluent without dilution and the effluent biotreated soil is the soil treated with the biotreated effluent. The analysis of control soil, crude effluent soil and effluent biotreated soil samples in the initial stages of treatment was carried out.

The reference for methodology and the appendix number for the measurement of soil pH and electrical conductivity are given in Table 1.

RESULTS AND DISCUSSION

The soil analysis revealed that the pH of the soil used in this study was within the optimal range and found to be a sandy loamy type of soil. The electrical conductivity was also found to be within the optimal range and lay under salt free condition.The calcium and the nitrogen contents of the present study were below the prescribed optimal range. The phosphorus level in soil was about 10 kg/ha which was in the minimum level of phosphorus as referred by Antonio *et al.* (2013) in the general guide for crop nutrient and limestone recommendation by Lowauniversity. The potassium level was found to be within the optimal range.

Physical analysis of the control, silk dying effluent contaminated soil and Biotreated soil

Table 1 depicts the levels of physical parameters in the control soil,silk dying effluent contaminated soil and Biotreated soil.

Table 1: Physical analysis of the control, silk dying effluent contaminated soil and Biotreated soil

Parameter	Optimal range in Normal soil*	Control soil (C)	Effluent soil (E)	Biotreated effluent soil (by *Pseudomonas fluorescens*) (EB)
pH	6-7.5	7.1	8.1	7.5
EC	<1.0	0.1(Good condition)	1.2	0.2
Texture	-	S1 –Type sandy loam (Red soil: sand) (3:1)	S1- Type sandy clay loam (Red soil: sand) (3:1) with Dyeing effluent	S1- type sandy clay loam (Red soil: sand) (3:1) with effluent and biofertilizer (*Pseudomonas fluorescens)*

* The optimal range in normal soil was taken from 'Soil Test Interpretation Guide', EC 1478, Oregon State University, 2011.

Analysis of the soil contaminated with silk dyeing effluent

Table 1 represents the physicalparameter analysis of silk dyeing effluent treated soil. The pH (8.1) and EC (1.2) noticed in effluent soil was above the standard limits. Similar results were also reported in the soil sample collected in the sanganer region in the month of august [12].

The soil texture was observed to be S1- type sandy clay and loam. All the macronutrients (N, P, K and Ca) and micronutrients (Fe, Cu and Zn) except manganese in the effluent soil were detected to be lower than the optimal range. The results indicate that the effluent reduces the level of both the macronutrients and micronutrients below the optimal range. Calcium can be lost from the soil in contaminated water and its deficiency symptoms contain death at the growing point, abnormally dark green foliage, weakened stems, shedding flowers[10]. Nitrogen deficiency in the soil affects the cellular metabolism and may lead to dwarfism of the plant, decrease of chlorophyll content of the cells and finally may lead to plant death [15]. The alkaline pH of the effluent medium bath can also be the cause of low level of copper, as heavy metals are precipitated as their salts at high pH and are deposited as sediments [14].

Thus from this study, the effluent treated soil will not be able to provide the macronutrients and micronutrients for the growth of the GLVs. According to the study with reference[16], the application of industrial effluent affects the physico-chemical properties of the soil as well as the fertility of soil.

Physico-chemical analysis of the biotreated effluent soil

Biofertilizers are the products containing living cells of different types of microorganisms that enrich the nutrient quality of the soil. The availability of nutrients for plants utilized from the soil is regulated by the rhizospheric microbial activity [9] comparetively depicts with the levels of macronutrients and micronutrients in biotreated soil, treated with *Pseudomonas fluorescens*.

Similar to the control, the pH and EC of biotreated soil were within the standard limits. The soil texture was

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same throughout the study. The results also indicated that the biotreatment improves the micronutrient status of the soil within the optimal range. It is due to the influence of biofertilizer in the biotreated soil that had improved the levels of Ca, N, P and K from 105, 76, 4, 137 ppm in the effluent treated soil to 110, 200, 14.5, 390 ppm respectively in the biotreated effluent soil. It was observed that the application of biofertilizers improved the available N, P and K contents in the soil as well as in the plant[6]. The micronutrients Fe, Mn, Cu and Zn ranges from 1.2, 10, 0.4, 0.2 ppm of effluent treated soil to 6.1, 26.22, 2.26, 2.13 ppm respectively in the biotreated effluent soil.

Thus it was clear that the impact of effluent on the soil nutrients was encountered by the biofertilizer.

Influence of fresh water, crude effluent and biotreated effluent on the macronutrients and micronutrient of the soil.

The macronutrients and micronutrients of the soil of different treatments were depicted in the Figure 1, 2, 3 and 4 respectively.

It was clear that the macronutrients such as calcium, nitrogen, phosphorus and potassium and the micronutrients such as iron, manganese, copper and zinc were improved in the biotreated effluent soil compared to the effluent contaminated soil.

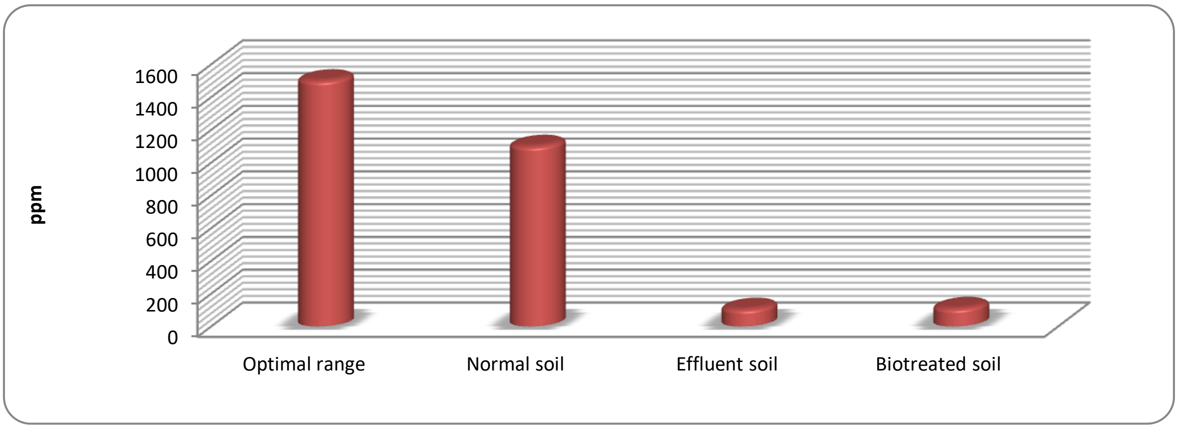

Figure 1: Calcium in the soil of different treatments

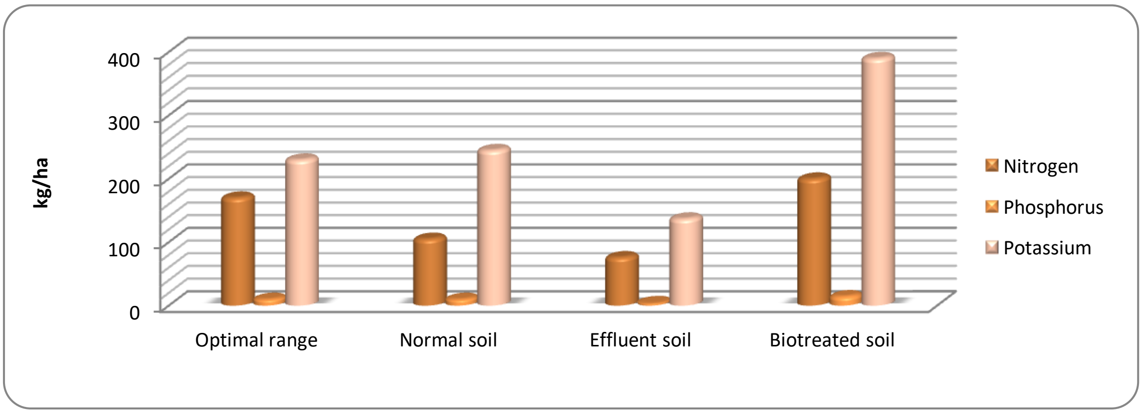

Figure 2: Nitrogen, phosphorus and potassium in the soil of different treatments

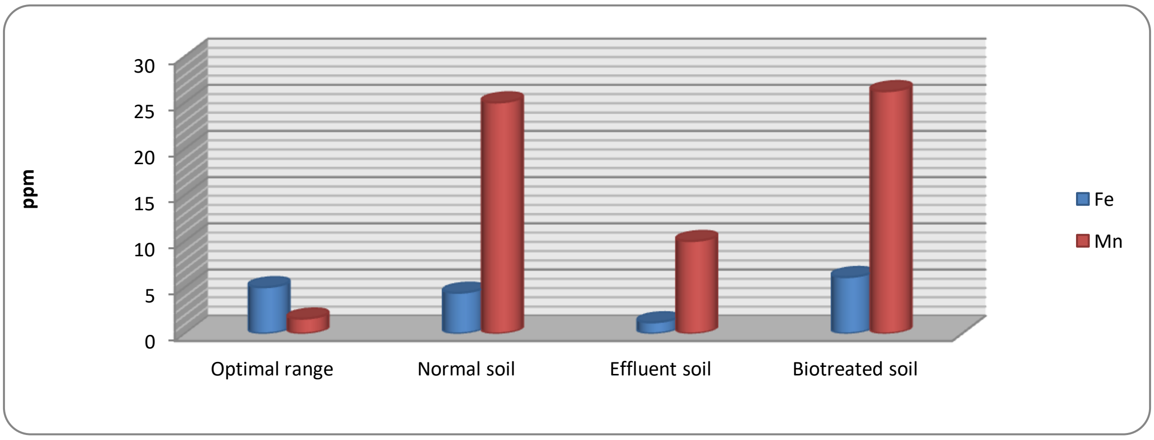

Figure 3: Iron and manganese in the soil of different treatments

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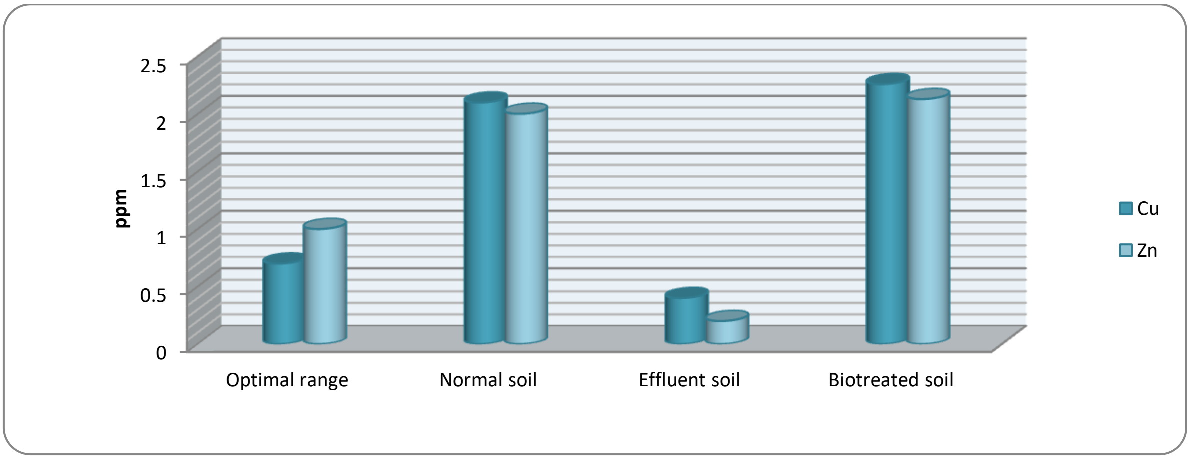

Figure 4: Copper and zinc in the soil of different treatments

Thus it was clear from the present study that the biotreatment had improved the macro and micronutrients of the effluent contaminated soil and can be adapted as cost effective and ecofriendly to sustain the productivity of the green leafy vegetable crops

In the present study, the iron content was found to be 4.4 which was just below the optimal range. The other micronutrients such as manganese, copper and zinc were within the optimal concentration.

CONCLUSION

Thus the experimental soil used for the growth of the selected GLVs was rich in macro and micronutrients in the biotreated soil with *Pseudomonas fluorescens* which in turn would support its growth. A fertile soil with macro and micronutrients with balance of proper nutrients is one that is able to supply the complete dietary needs of the growing plant. Henceforth the biotreatment of silk dyeing effluent can be recommended in the contaminated area of effluents. And this research paper strongly recommends the same.

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