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REGULAR ARTICLE

BIORECLAMATION OF SUGAR MILL EFFLUENT POLLUTED SOIL USING EARTHWORM AND ITS RESPONSES ON GREENGRAM (*VIGNA RADIATA* L.)

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SUMMARY

Reclamation is an emerging technology that uses to clean up pollutants (metals and organics) from the contaminated soil. In this field of reclamation the utilization of earthworm is a new approach, to remove the metals from the polluted soil. The present work has been carried out for the reclamation of sugar mill effluent contaminated soil with earthworm. The physico-chemical analysis of sugar mill effluent and the polluted soils revealed that they are toxic in nature because they contain higher amount of micronutrients and macronutrients, organic and inorganic chemicals and heavy metals. The presence of pollutants in the soil mainly affected the plant metabolism which leads to growth and yield reduction. In order to enrich the soil quality, earthworm was cultured upto 60 days in polluted soil. After that, the various soil properties were analysed and good percentage of pollutant reduction was observed. Germination studies were conducted in bioreclamated soil and best germination was noticed under bioreclamated soil when compare with polluted soil.

Keywords: Bioreclamation, effluent, earthworm, greengram, biochemicals.

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1. Introduction

Soil pollution is a very important environmental problem. It has been attracting considerable public attention over the last decades. As a matter of fact, increasing widespread pollution has caused vast areas of land to become non-arable and hazardous for both human population and industrialization. Nowadays, all the people consider that the magnitude of the pollution problem in our soil calls for immediate action. Industrialization is the key to the economical development of a nation. During its production, industries generate useless byproducts and waste materials with 1 to 10% of the quality of parent chemicals. Unfortunately all kinds of pollutions were produced from different kinds of chemical industries. The effluent discharging industries are sugar mill, dyeing, textile printing, tanneries, pharmaceuticals, distilleries detergents, chemical factory, paper mills, fertilizer factories etc. Among the industries, sugar mills play a major role in creating pollution of water bodies and soil because the effluent contain higher amount of organic and inorganic chemicals. They

harmfully affect the soil properties when used for irrigation. The effluent irrigation mainly disturbs soil micro and macronutrients like N, P, K, Cu, Zn, Fe and Mg which are very much important for green revolution. In case of contaminated soils they are having lower and higher amounts of nutrients which are unsuitable for plant cultivation. So, there is a need to conduct some kind of experiments to enrich the soil properties and make good source of environment in that way earthworms play a major role in reclamation of contaminated soil [1-4].

Eudrillus eugeniae is an important type of earthworm and it can be used for soil reclamation. It lives in the uppermost 5 cm of the soil layer. It is found in the litter layer feeding mainly on organic, inorganic matter and decaying materials and the soil surface. In that way, the present research work has been carried to find out the efficiency of earthworm (*Eudrillus eugeniae*) for the uses of reclamation of sugar mill effluent polluted soil and the reclamated soil tested with greengram through germination study.

2. Materials and methods

This research was conducted in the Environmental Biology Laboratory, Department of Botany, Annamalai University. Sugar mill polluted soil and effluent were collected from nearby industrial area. The collected polluted soil and effluent were analysed for their various physico-chemical and nutrient contents by using standard method. The earthworm *Eudrillus eugeniae* was obtained from Department of Zoology, Faculty of science, Annamalai University and 90cm×60cm×50cm sized cement tanks were used for the study.

Experimental Method

90 × 60 cm and 50 cm volume cement tanks were filled with polluted soil and some amount of cow dung. The earth worms *Eudrillus eugeniae* were allowed to live in the polluted soil upto 60 days. After that, the earthworms were taken from the treated soil and the various macro and micronutrients were analysed.

Seed Germination With Reclamation Soil

The reclamation soil was tested with greengram (*Vigna radiata* L.) seeds. The reclamation soil filled in earthen pots and greengram seeds were sown and various morphological parameters like germination percentage, seedlings length, seedling dry weight, vigour index were analysed.

Morphological Analysis

The number of seeds germinated in reclamation soil was counted on the 15th day and germination percentage was calculated by using the formula

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seed sown}} \times 100$$

Seedling length was measured by using a scale and these values were recorded and seedling dry weight was taken by keeping them in a hot air oven at 80°C for 24 hours.

Vigour index of the seedlings was calculated by using the formula proposed [5].

$$\text{Vigour index} = \text{Germination percentage} \times \text{Length of seedlings.}$$

Tolerance index of the seedling was calculated by using formula proposed [6].

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}}$$

Biochemical Anlaysis

Biochemicals like chlorophyll [7], protein [8], amino acids [9] and Sugar [10] were also analysed.

Statistical Analysis

The germination experiment studies were carried out with Completely Randomized Design (CRD). The germination study were analysed with 3 replication and the standard deviation (SD) was calculated. The data were expressed in $X \pm SD$ of 3 replicates.

3. Results and discussion

The results of the physico-chemical analyses of sugar mill effluent are presented in (Table 1). It reveals that it was acidic in nature and yellowish colour. It is rich in total suspended and dissolved solids with higher amounts of biological oxygen demand (BOD) and chemical oxygen demand (COD). A

considerable amount of chloride, sulphate, calcium, magnesium, sodium, potassium and iron were also present in the effluent. The similar nature of effluent was already reported [11-14]. The toxic nature of effluent may be due to the raw materials and chemical used for processes of sugar separation. The toxicity nature of the effluent affects the soil, micro and macronutrients.

Table 1: Physico-chemical properties of sugar mill effluent

S. No.	Parameters	Raw effluent	Tolerance limits for agricultural irrigation prescribed by TNPCB
1.	Colour	Yellow	Colourless
2.	Odour	Decaying molasses smell	Odourless
3.	pH	4.55 – 5.25	5.5 – 9.0
4.	Electrical conductivity	2.23	–
5.	Temperature (°C)	33.0	40.0
6.	Chloride	26	2.0
7.	Total hardness	245	–
8.	Total dissolved solids	1480	200
9.	Biological oxygen demand (BOD)	1850	30
10.	Chemical oxygen demand (COD)	2359	250
11.	Calcium as CaCO3	91	1000.0
12.	Magnesium as Mg	224	–
13.	Sodium	40	–
14.	Iron	42	–
15.	Sulphate	246	2.0

All parameters except colour, odour, pH, EC and temperature are expressed in mg/L.
TNPCB – Tamil Nadu Pollution Control Board

The physico-chemical properties of polluted and bio-reclamation soil is presented in (Figs. 1-5). The polluted soil is having a higher amount of pH, electrical conductivity, nitrogen, phosphorus, potassium, copper, zinc, iron and manganese present in it. At the same time, a considerable amount of nutrient changes was observed in the reclamation soil. It may be due to the intake of nutrients by earthworms, the elements get recycled and changes are brought about in the form of compost [15-17].

Figs. 6-10 show that the response of reclamation soil on germination of greengram (*Vigna radiata* L.). The morphological parameters of greengram like germination percentage, seedling growth, seedling dry weight, vigour index and biochemicals like chlorophyll, protein, amino acid, sugar were observed in both polluted soil and reclamation soil. Among them, all morphological and biochemical parameters were increased. Good germination and biochemical changes were observed in reclamation soil because of the accumulated compost containing a required amount of nutrients [14-1].

Conclusion

The pollutant reduction was observed in reclamated soil and the good germination of greengram was also observed in reclamated soil. After reclamation, the pollutant characteristics will become lower and within prescribed limits. So that work was advised to farmers to give proper treatment to polluted soil and get good yield to crop plants.

Fig. 1. pH analysis of sugar mill effluent polluted soil and reclamation soil, Fig. 2. NPK analysis of sugar mill effluent polluted soil and reclamation soil, Fig. 3. EC analysis of sugar mill effluent polluted soil and reclamation soil, Fig. 4. Copper, zinc and magnesium analysis of sugar mill effluent polluted soil and reclamation soil, Fig. 5. Iron analysis of sugar mill effluent polluted soil and reclamation soil

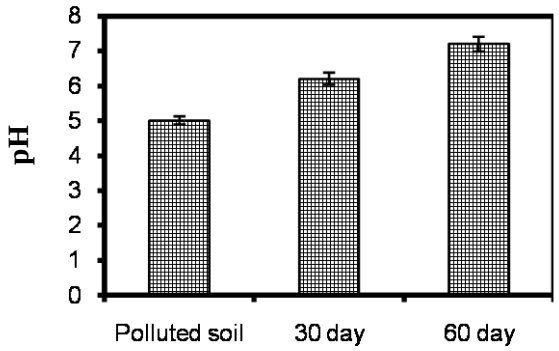
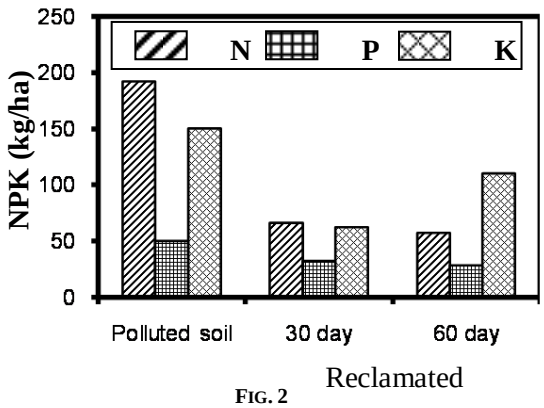


FIG. 1



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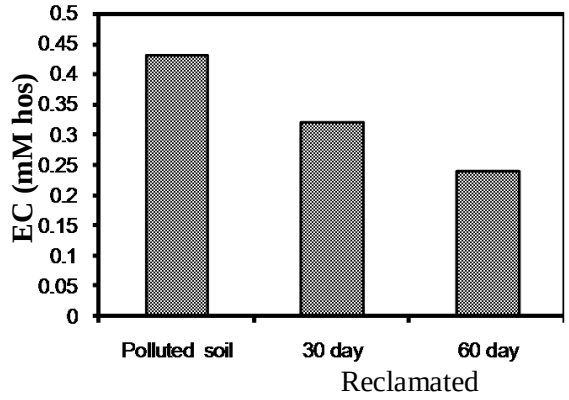

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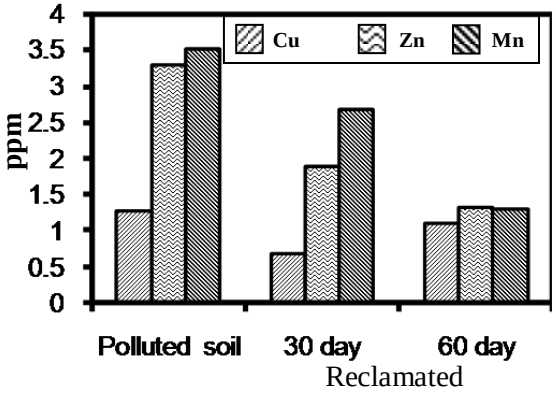

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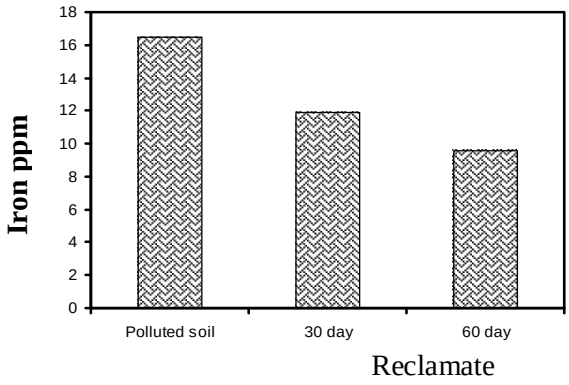

FIG. 5

Fig. 6. Germination percentage of greengram grown under polluted soil and reclamation soil, Fig. 7. Seedling growth of greengram grown under polluted soil and reclamation soil, Fig. 8. Seedling dry weight of greengram grown under polluted soil and reclamation soil, Fig. 9. Vigour index of greengram grown under polluted soil and reclamation soil, Fig. 10. Chlorophyll, protein, amino acid and total sugar contents of greengram grown under polluted soil and reclamation soil

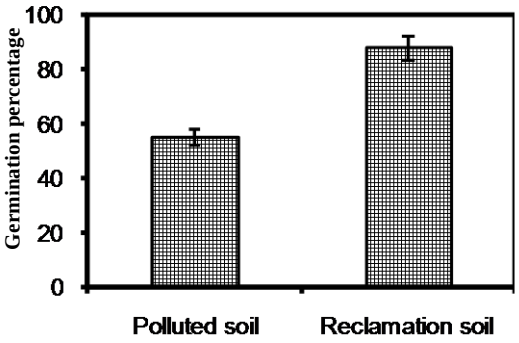

FIG. 6

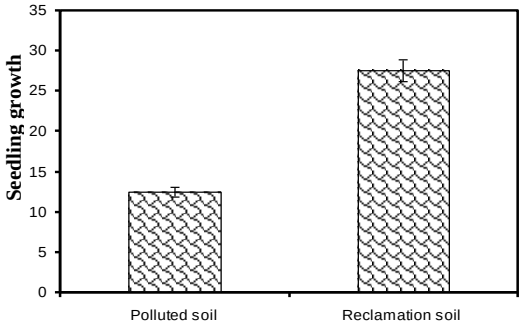

FIG. 7

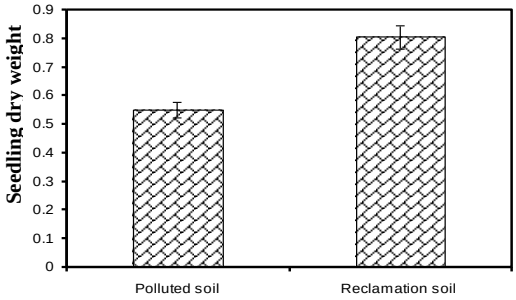

FIG. 8

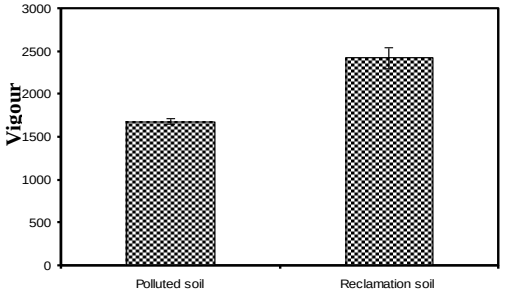

FIG. 9

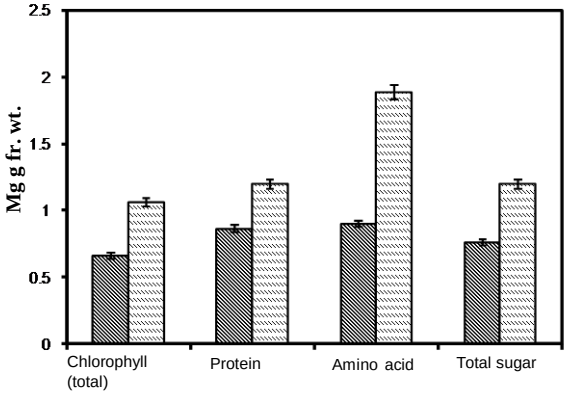

FIG. 10

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