EVALUATION OF THE EFFECTS OF HEAVY METAL EXPOSURE IN AGRICULTURAL SOIL ON SELECTED AREAS OF VIRUTHUNAGAR DISTRICT

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ABSTRACT

Heavy metals enter the soil through anthropogenic activities and industrial discharges. They enter the human body through plants and vegetables. Heavy metals can cause various acute and chronic diseases in human beings. Heavy metal consumption by fishes and other aquatic animals affect aquatic life and also people consuming them as food. Reduction of the developmental growth, deformities, and increase of developmental anomalies are some of the toxic effects of heavy metals on fishes and aquatic invertebrates. Removal of heavy metals from soil is becoming an increasingly important for reducing environmental pollution. The soil samples were collected from different areas (nearby match & sugar industry) of Virudhunagar District. The quality of soil was analyzed by various physiochemical parameters. The survival and growth rate of *Vigna radiata* and *Pennisetum glaucum* plants were also studied in control and test samples. Isolation and Screening of control and polluted soil microorganisms were studied by various Microbiological and Biochemical assays. Finally the control and test soil samples were analyzed by SEM. The study reveals the status of soil along the match and Fire industry where the agricultural activities have been carried out, it shows the lack of essential nutrients in the soil which may ultimately reach to the food chain through plants and leads toxicity to the soil. So addition of natural manure to the concern polluted soil is recommended to enrich the soil nutrients.

Keywords: Physiochemical, SEM, Microorganisms, Polluted soil, Heavy metal.

INTRODUCTION

Bioremediation is an alternative method that offers the possibility to destroy toxic pollutant using natural biological activity. Soils polluted with heavy metals have become common across the globe due to increase in geologic and anthropogenic activities. Bioremediation techniques are typically more economical than thermal and physio-chemical remediation such as incineration. (Robles-González et. al., 2008). Heavy metal toxicity has become a pressing ecological problem that affects the ecosystems through bioaccumulation, representing a serious public health hazard. Many conventional strategies have been developed and applied to decontaminate and restore metal-contaminated areas. However, these conventional approaches are not very suitable and environmentally safe for heavy metal remediation because of their high operational costs, high energy requirements, post-waste disposal problems, and secondary pollutant generation. (Mishraetal S. et.,al 2001).

Recent strategies for bioremediation include in situ bioremediation and ex situ bioremediation. Bioremediation is a natural process and therefore has certain advantages along with some disadvantages. Phytoremediation, on the other hand, is the use of plants and their associated microbes for cleaning up the environment. (Irfan, S. et,.al 2022).

Nowadays, the accumulation of toxic heavy metals in soil and water streams is considered a serious environmental problem that causes various harmful effects on plants and animals. Phytoremediation is an effective, green, and economical bioremediation approach by which the harmful heavy metals in the contaminated ecosystem can be detoxified and accumulated in the plant. Hyper accumulators exude molecules called transporters that carry and translocate the heavy metals present in the soil to different plant parts. The cost-effective and eco-friendly approaches are needed for decontamination of polluted soils. (Yaashikaa, P.R., et al. 2022)

MATERIALS AND METHODS

The soil samples were collected from different areas (nearby match & sugar industry) of Virudhunagar District**.** The soil surface was dig up to 15 cm depth, the soil was mixed thoroughly and it was packed in a zip-locked plastic bag and it was taken to the laboratory for further analysis. Then the soil samples were analyzed by different Physiochemical, Biochemical and Microbiological parameters.

SOIL QUALITY ASSEMENT:

The quality of soil was assessed for Various Physio Chemical parameters.

SCREENING OF HEAVY METAL UTILIZING MICROORGANISMS:

Isolation and Screening of potential heavy metal utilizing microorganism was carried out by following assays. Antimicrobial Sensitivity by Kirby-Bauer method, Oxidase and Catalase Test.

RESULT AND DISCUSSION

The collected soil samples were subjected to various physiochemical parameters testing.

Table -1 Soil Analysis Report

S. No	Nutrients	Control	S1(Kayathar)	S2(Sivakasi)	S3(Sattur)	S4(Akilandapuram)
1.	Colour	Black	Black	Black	Black	Black
2.	PH	8.3	8.5	8.3	8.1	8.3
3.	Texture	Clay loamy	Clay loamy	Clay loamy	Clay loamy	Clay loamy
4.	EC(m mhos	0.16	0.25	0.14	0.39	0.16
5.	Calcium carbonate(%)	High	High	High	High	High
6.	N(kg/hec)	80	56	49	78	83
7.	P(kg/hec)	3.2	1.8	2.7	2.7	1.8
8.	K(kg/hec)	217	210	205	210	217
9.	Fe(mg)	1.29	0.69	1.54	1.11	0.76
10.	Mn(mg)	9.29	4.94	5.54	7.25	5.87
11.	Zn(mg)	0.39	0.29	0.37	0.57	0.40
12.	Cu(mg)	0.52	0.76	0.45	1.97	0.48

Soil Analysis Report

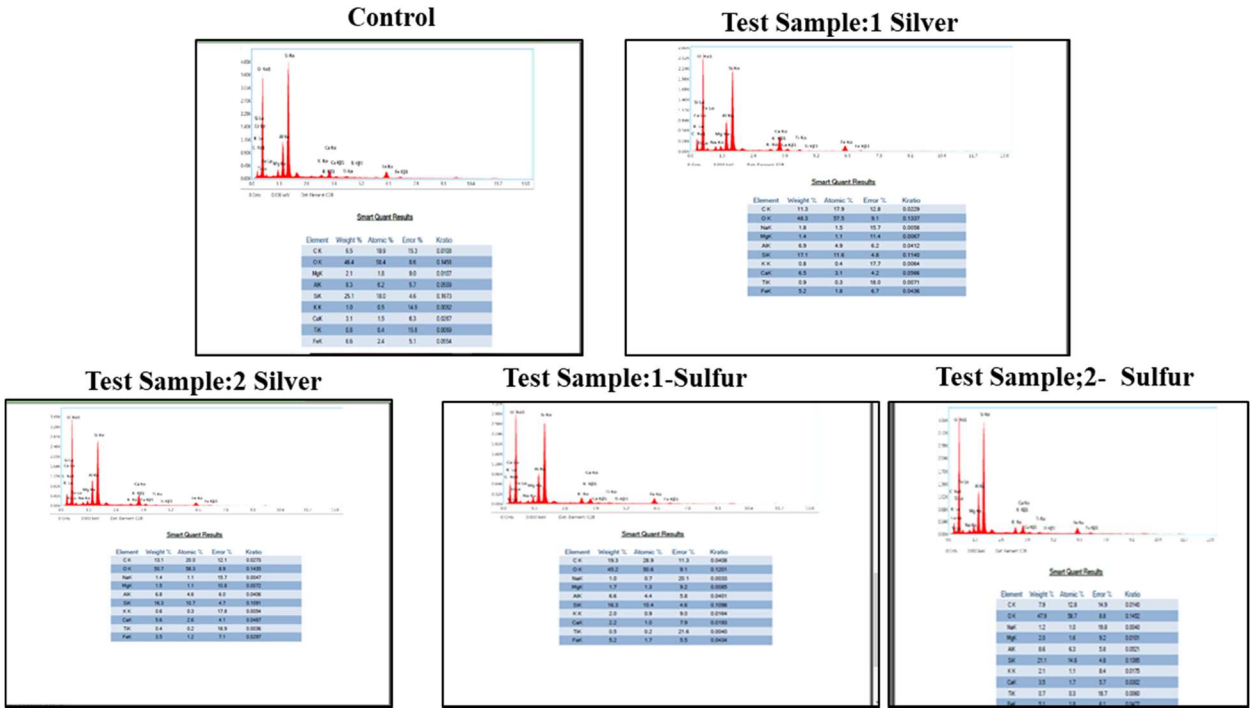
A-Control, B-Kayathar, C-Sivakasi, D-Sattur and E-Akilandapuram

PH range of 6 -7 is generally most favorable for plant growth because most plant nutrients are readily available in this range. The reason for slightly high pH of industrial area could be due to discharged of effluents from the industry. Industrial emissions of contaminants are released into the atmosphere which is finally deposited on soil or dumping of industrial wastes on disposal land could be the reason for it. The lowest pH in the soil along match and fire industry where agricultural activity is carried out could be due to applications of fertilizer such as crushed sulfur and some ammonium based nitrogen fertilizers that lower pH and make soil more acidic.

Arshi Iram and TI Khan (2018) reported that the pH of all soil samples were found to be ranged in between 7.04 to 8.3 which indicate the slight alkalinity of soils. Electrical conductivity of soil samples range between 0.026 to 1.967m mhos, in most of the samples except some hilly soil samples moisture content was in proportionate level between 7.02percent to 25.71 percent; moisture content varies in different season. Organic matter was varied widely among the various cultivated soils horizons selected for the study from 0.188 to 3.14percent. Chloride is generally mentioned as a hydrological and chemically inert substance. Chloride concentration in soil generally shows the salinity of soil, chloride concentration in soil samples ranged from 3.52 to 24.14mg/100gm. Most important factor which decide the soil productivity is N: P: K ratio. Available nitrogen found in soil samples between 13.8 to 218.60 kg/ha. Phosphorus considered as micro nutrient, is utilized by plant in the form of H2PO4- & HPO4-2 species. Appropriate concentration of phosphorus (P) is necessary for maintaining a balance between the other plant nutrients and ensuring the normal growth of the crop.

In the present study there was a significant decrease in NPK content of test samples were observed. The result obtained from the study indicates the clear differentiation in the values of the parameter in four different areas of Virudhunagar District. Also the values at different locations differ from each other due to the various industrial activities carried out around that area. Certain parameters exceeded the desirable limit while some parameters show less content as compared to their desired value range in the soil. The high level of phosphorous content could be due to application of fertilizers .The best way to increase the phosphate content is to increase the organic and humus. Abundance of organic matter, excessive application of fertilizers can increase the potassium content in agricultural soil. The above results showed that most of the micro nutrients in different soils were insufficient due to industrial activity and imp roper maintenance of soil.

HEAVY METAL CONCENTRATION IN SOIL



Heavy metal concentration was anslysed by SEM EDAX

The presence of these metals were confirmed by growth of sulfur and Lead resistance bacteria. The SEM EDAX report also showed that our test samples possesses more concentration of Sulfur and Silver metal.

Isolation and Screening of potential heavy metal utilizing microorganism:

The more the microbial activity in the soil, the more good is soil condition. The microorganism activity in soil depends on many factors like soil moisture content, temperature, texture, availability of nutrients etc., Soil microorganisms are vital for the continuing cycling of nutrient and for driving above ground ecosystems.

According to the report of Neethimohan Malaieswari et al., 2007 the fungal strains of *Curvularia* sp. DMTMME01, *Aspergillus* sp. DMTMME02, *Fusarium* sp. DMTMME03 and *Peniciilium* sp. DMTMME04 were isolated from the heavy metal contaminated site having the great potential to survive and remove the contaminants. Among the isolates, *Curvularia* sp.

DMTMME01 proves that it has potential to the remove heavy metals from fireworks industries. These fungal isolates can be used as bio-remediating agent *in situ*.

In the present study the survival and growth of heavy metal resistance microorganisms were identified by morphological and Biochemical studies. Gram staining, Catalase, Oxidase and Antimicrobial activity assays were carried out for identifying of heavy metal resistance microbial species. Sulfur and lead resistance bacteria was isolated and identified as gram positive bacteria

ANTIMICROBIAL ACTIVITY

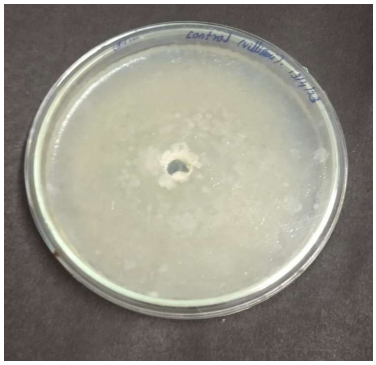


Figure1

CATALASE TEST

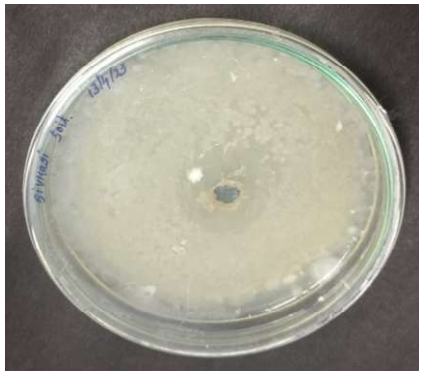


Figure 2

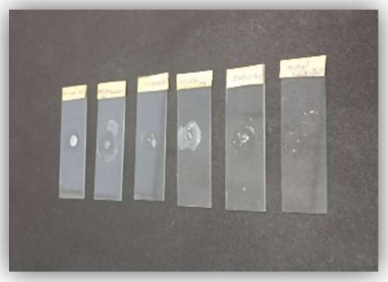


Figure 3

OXIDASE TEST

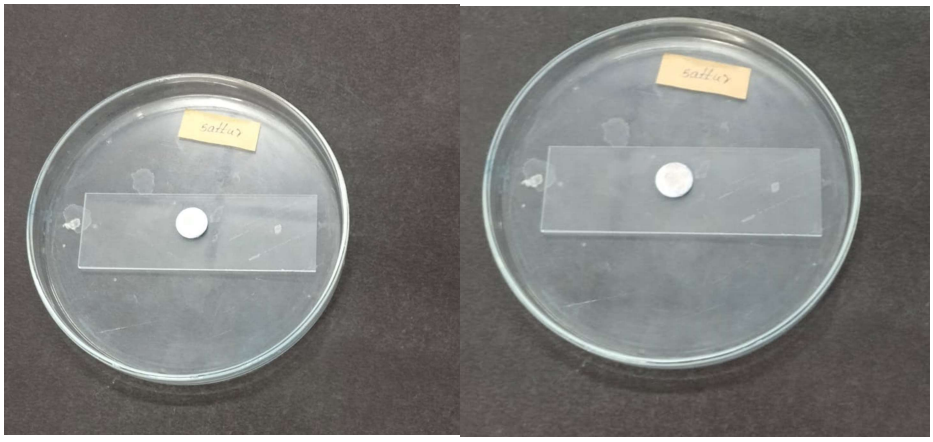


Figure 4

Assessment of Survival and Growth rate of Pearl millet plant

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Figure 5

There was a significant difference observed in test sample (soils collected along the match and fireworks industry) than control. From the above results we conclude that some heavy metals present in agricultural land nearby match & firework industry should be subjected to land reformation process. Strong recommendation given to the farmers to land reformation by applying natural manure & avoid the stagnant of irrigation water.

CONCLUSION

The study reveals the status of soil along the match and Fire industry where the agricultural activities have been carried out, it shows the lack of essential nutrients in the soil which may ultimately reach to the food chain through plants and leads toxicity to the soil .So care has to be taken while growing the plant and regular soil checking has to be done in order to determine the quality of soil. N, P and K are the important nutrient, which has to be present in soil for proper plant growth and Development. So addition of natural manure to the concern polluted soil is recommended to enrich the soil nutrients in order to fasten the growth of plants. Also some other recommendations are given which can be applied to maintain the soil quality especially where the agricultural activities are carried out. The maintenance and improvement of the quality of the soil is a necessity for sustainable environmental growth and development.

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