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Analysis Of Heavy Metals (Cr, Cd, Cu, Pb, Ni, Zn) In Agricultural Soil Near Dolvi, Alibuag

Tanvi Patil[1], Kamini Thakur[2], Akash Patil[3]

[1,2] Assistant professor, Dept. of Environmental Science, SIES (Nerul) College of Arts, Science and Commerce (Autonomous), Maharashtra, India.

[3]Senior Environmentalist and Compliance Manager, Sairaj Enterprises, Maharashtra, India.

Email ID: *tanvip@sies.edu.in[1], kaminit@sies.edu.in[2], patilakash987051@gmail.com[3].*

Abstract

This study shows the concentration of heavy metals in the agricultural soil of Dolvi Village, Raigad, Maharashtra, India. The area is categorised by notable industrial activity, like steel and cement plants. Soil samples were collected from six different rice fields using a random sampling method at a depth of 15 cm, with composite sampling to ensure representative data. The analysis concentrated on six key heavy metals: Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Nickel (Ni), and Zinc (Zn). The result shows varying concentrations of contamination of heavy metals across the study area. With sample 3 exhibiting the highest concentration of Cadmium (12 mg/kg), Chromium (138 mg/kg) and Copper (115 mg/kg). The lowest concentration of Cadmium was observed in sample 5, i.e. (5mg/kg). The study highlights that the proximity of rice fields to iron and steel industries contributes to heavy metal accumulation in the soil, posing a risk of bioaccumulation in the crop. Such contamination could cause a risk to food security and human health. The finding features the urgent need for an industrial pollution control system and the implementation of remedial strategies to safeguard the soil health and agricultural productivity of the region.

Keywords: *Heavy Metal, Soil Contamination, Rice Field, Bioaccumulation, Dolvi.*

1. Introduction

Soil is one of the crucial natural resources supporting agricultural and various ecological services. It serves as a medium for plant growth, a supply of nutrients, and a regulator for water and biogeochemical cycles. Anthropogenic activities are significantly altering soil quality, particularly near industrial areas. Industrialisation often places significant pressure on surrounding agricultural land [1]. One of the most urgent environmental issues affecting agricultural soil is heavy metal contamination. Agriculture is the backbone of the Indian Economy, but its productivity is hindered by degraded and nutrient-deficient soil. (M. S. Sirsat 2017). Because heavy metals are non-biodegradable or thermodegradable, they are highly persistent in the environment and easily build up to hazardous levels. (Rajesh Kumar Sharma et al. 2007). The accumulation of trace elements such as Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb) beyond permissible limits triggers a dangerous pathway of bioaccumulation. When these metals are integrated in the soil and plant system, they can be absorbed by the rice crop and eventually enter the food chain [2]. This process of biomagnification can cause acute and chronic health risks to humans, including renal dysfunction, neurological problems, and respiratory complications. (Tchounwou et. al. 2012) [3].In the Dolvi village of Raigad district, Maharashtra, the intersection of intensive rice cultivation and heavy industrial activities provide a critical case study of assessing the risk. This study aims to quantify the concentration of key heavy metals in agricultural soil to evaluate the extent of industrial impact and risk to local food safety [4].

1.1.Study Area

The samples were taken from Dolvi village near Alibuag in Raigad District. The samples were taken from the Rice fields which are located near industries. There are cement and steel industries near Dolvi, Alibuag. The Rice fields from which the samples are taken to study heavy metal concentration are located near industries. Most of the rice fields near Dolvi have a loamy soil type.

2. Sample Collection and Storage

The six samples are taken from six different rice fields. A random sampling method was used to take samples from rice fields. The samples are collected in the clean zip-lock plastic bags. The Rice field soil was dug up to a depth of 15 cm. In each Rice field, 6-8 different spots are located to take samples. These 6-8 samples are collected from 6-8 spots in the Rice field. They are mixed thoroughly to get one single sample, which will represent the whole Rice field soil. The collected six samples are stored in clean zip-lock bags to avoid contamination that is shown in table 1.

Table 1. Location of Samples

SAMPLE	LATITUDE	LONGITUDE
Sample 1	18.705032	73.048153
Sample 2	18.697460	73.047930
Sample 3	18.696361	73.048431
Sample 4	18.686526	73.054635
Sample 5	18.679938	73.059739
Sample 6	18.679072	73.057279

2.1.Methodology

The soil samples were collected from six different rice fields. Each soil sample weighs about 1 kg. The samples are air dried for 1-2 days. The dried soil samples are crushed and pass though 2 mm sieve. The heavy metals analysis was carried out using an Atomic Absorption Spectrometer. The soil samples were prepared by acid digestion using HCl, HNO3 and HClO4. After preparation of soil samples, they are injected into the Atomic Absorption Spectrometer. The concentration of heavy metals in soil samples is determined using standard calibration curves.

2.2. Result and Discussion

The analysis of six heavy metals was observed from six different rice fields. These fields are located near industrial areas [5]. From all six rice soil samples, sample 5 has a high concentration of heavy metals. The critical soil total concentration is the range of values that gives concentrations of heavy metals present in soil beyond the range, then it is considered to be toxic to soil as well as the environment. **Cadmium-** The critical soil total concentration for cadmium is 3-8 ppm. The soil samples 2, 4 and 5 are within the limit. The soil samples 1, 3 and 6 are above limits. The concentration of cadmium is maximum in sample 3 (12 ppm). Sample 5 (5 ppm) has the minimum cadmium concentration [6]. **Chromium-** All the soil samples are above the critical soil total concentration of 75-100 ppm. The maximum concentration was observed in sample 3 (138 ppm), and sample 6 (96 ppm) has the minimum concentration of cadmium. **Copper-** The concentration of all six rice soil samples is within the critical limit. The critical soil total concentration range is 60-125 ppm. Sample 3 (115 ppm) has the highest concentration of copper and sample 6 (96ppm) has the lowest concentration. **Lead-** The lead concentration in all six rice soil samples is within 6-11 ppm. All the soil samples lead concentration is within the limit. The critical soil total concentration range for lead is 100-400 ppm. Soil Sample 5 (11 ppm) has the maximum concentration of lead and Soil Sample 2 (6 ppm) has the minimum lead concentration [7]. **Nickel-** The range of nickel concentration in all six rice soil samples is between 43 and 52 ppm. The critical concentration range for nickel is 100 ppm. The maximum concentration was observed in soil sample 5 (52 ppm). The minimum nickel concentration was observed in soil sample 2 (46 ppm). **Zinc-** The range of critical soil total concentration for zinc is 70-400 ppm. All the rice soil

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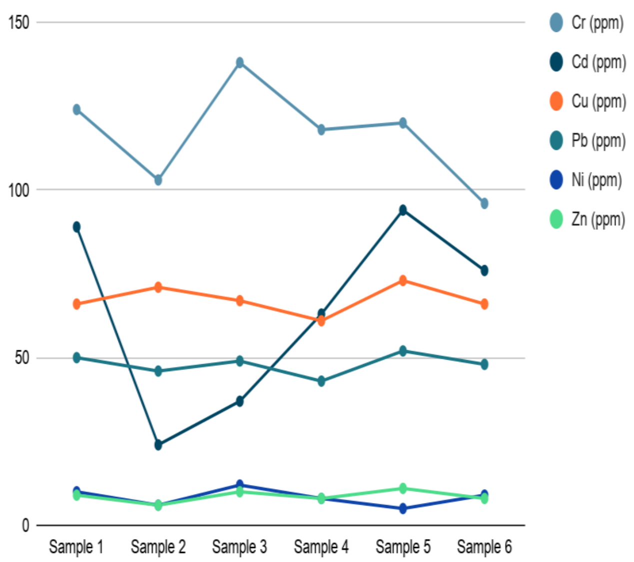
samples concentration is between 66-73 ppm and they are within limits [8]. The zinc concentration in soil sample 5 (73 ppm) is the maximum and minimum in soil sample 4 (61ppm) shown in table 2.

Table 2 Concentration of Heavy Metals in Rice Soil Samples

Sample	Cd ppm	Cr ppm	Cu ppm	Pb ppm	Ni ppm	Zn ppm
Sample 1	10	124	96	9	50	66
Sample 2	6	103	106	6	46	71
Sample 3	12	138	115	10	49	67
Sample 4	8	118	88	8	43	61
Sample 5	5	120	94	11	52	73
Sample 6	9	96	76	8	48	66

Figure 1 Soil Sample Vs Concentration of Heavy Metals in ppm



Conclusion

The presence of heavy metals in agricultural soil causes environmental and health issues. Heavy metals affect crop growth, chlorophyll biosynthesis and inhibit seed germination [9]. There are iron, cement and steel industries near Dolvi, which lead to contamination of heavy metals in Rice field soil. Heavy metals present in soil are uptaken by crops, leading to bioaccumulation. Continuous consumption of these crops can cause biomagnification in humans. Heavy metal toxicity causes various health problems and can build up in the brain, lungs and liver. To reduce heavy metal contamination in agricultural soil various strategies are applied like phytoremediation, bioremediation, use of organic fertilizers or integrated nutrient management. Industries should install pollution control management systems to reduce the dispersion of air pollutants and water pollutants. Soil health cards should be maintained to reduce excessive use of fertilisers and pesticides. Excess use of chemical fertilisers increases toxicity in soil and also affects the quality of crops.

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