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Heavy Metals Status in Soil Samples Grown Leguminous Crops Around Industries in Singrauli (M.P.)

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ABSTRACT

Evaluation of heavy metals content were perfumed in samples of five leguminous crops Soy bean (*Glycine max*), Beans (*Phaseolus vulgaris L*), Chick pea (*Cicer arietinum*), Pea *(P. sativum),* Lentils (*Lens culinaris*) were grown soil around the industries in Singrauli Madhya Pradesh for the two sequential experimental duration of 2020-2021 and 2021-2022. Station I (Mahan Super Thermal Power)), Station II (Chitrangi Power Plant) and Station III (Mahan Super Thermal Power). There was following heavy metals Cd, Cr, Pb, As, Cu, and Zn were studied in soil samples, in all three stations collected samples conventional analytical methods were employed to determine the heavy metals were analysed by atomic absorption spectrometry. The average concentration of all the metals in each farm also gave the trend Station I > Station > and Station III. The findings indicate the presence of heavy metals in all the farms but only Zn was above the FAO/WHO standards.

Keywords: leguminous crops, heavy metal contents, industries, Singrauli region, acid digestion, AAS

I. INTRODUCTION

Heavy metals like Pb, Cd, As and Cr occur naturally in the environment and could serve as plant nutrients depending on their concentrations. Pb, Cr, As, Cd Cu, Zn etc are indirectly distributed as a result of human activities could be very toxic even at low concentrations [1]. Those most commonly found at contaminated sites are Pb, Cr, As, Zn, Cd, Cu, and Ni [2]. Heavy metals are extremely persistent in the environment because of their non-biodegradable nature, thermal stability and potential to accumulate to toxic levels, even at low concentrations. These metals can pose a significant health risk producing damaging effects on man and animals because there is no good mechanism for their elimination from the body [3,4]. There is a growing concern about the possibility of agricultural soil's contamination by heavy metals resulting in uptake by plants and their introduction in vital food chains affecting food safety [5]. The contamination is often a direct or indirect consequence of anthropogenic activities from urban and industrial wastes, mining and smelting of non-ferrous metals and metallurgical industries [6,7]. Other ways of metal accumulation in soil is by irrigating farmland with poor quality water, weathering of rocks, transportation and disposal of high metal waste on farmland and leaching from refuse dumpsite [8]. Soils may also become contaminated by the accumulation of heavy metals and metalloids from leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, coal combustion residues, and spillage of petrochemicals [9,10]. Knowledge of the total metal concentration provides limited information about their potential mobility and bioavailability [11].The movement and availability of the important micronutrients such as Mn, Fe, Zn and Cu change due to soil conditions which are controlled by plant species and a number of soil parameters like the nature of complexes in which the metal is present in soil [12]. Region of Singrauli known for evolving industrial pollution, main discharge consist heavy metals. The current study focuses on the industrial setting and the surrounding agricultural area. Heavy metals are released by industries after being disposed of. It is crucial to periodically evaluate the quality of food items in this region by metal analysis due to the significance of these metals for humans and the associated threat they cause, as well as a growth in environmental contamination. The evaluation will increase public knowledge of the dangers related to eating food that contains significant amounts of heavy metals and provide information on the degree of metal contamination and, consequently, the effect on food safety standards and consumer risk.

II. MATERIAL AND METHODS

In general, soil sampling strategies can be grouped into three major categories: random, systematic and stratified sampling methods. The random sampling strategy is the simplest of the three, where soil samples are collected randomly and stochastically independently across the site of interest. Soil samples were collected from a depth of 10 to 15 cm, from the surface as described [13]. From each farmland, ten soil samples were collected from ten different spots, which were pooled together to form a composite of each individual sample. They were placed in clean dried polythene bags, labelled and transported to the laboratory for analysis. The soil samples were air dried, disaggregated with porcelain pestle and mortar and finely powdered to pass through 2 mm mesh sieve for homogeneity.

Soil sample preparation To facilitate the dissolution and subsequent analysis of heavy metals in soils, drying, sieving and grinding of the soil samples are usually required. The collected soil samples were oven-dried to remove moisture. For non-volatile heavy metals, such as Cd, Cu, Pb and Zn, the soils can be air- or oven-dried at temperatures between 50 and 105^{o} C. After drying, the soil samples are usually sieved to remove coarse debris and rubble (>2.0mm). A non-metallic sieve is used to avoid contamination.

Procedure of Digestion

The digestion procedure used for determining heavy metals was as recommended by AOAC, [14]. 1g of the dried pulverized samples was weighed each and poured into a 100ml beaker. 10 cm3 of concentrated nitric acid was added to sample and heated at 40 0C. After the evolution of brown fumes, heating was continued until a clear solution was obtained. Deionized water was added at intervals to prevent drying of the digest. The clear solution was diluted to 40 cm3 and filtered with a whatman filter paper No. 41 into a 100 cm3 volumetric flask. The beakers were rinsed thoroughly and then the solution was made up to the mark with de-ionized water [15,16]. It was poured into a 100 cm^3 polypropylene bottles and stored in the refrigerator at 4 ^{0}C for analysis. 1000 ppm stock solutions were prepared from the salts of the metals under investigation and deionized water. Standard solutions were also prepared by serial dilution of the 1000 ppm stock solution of each metal.

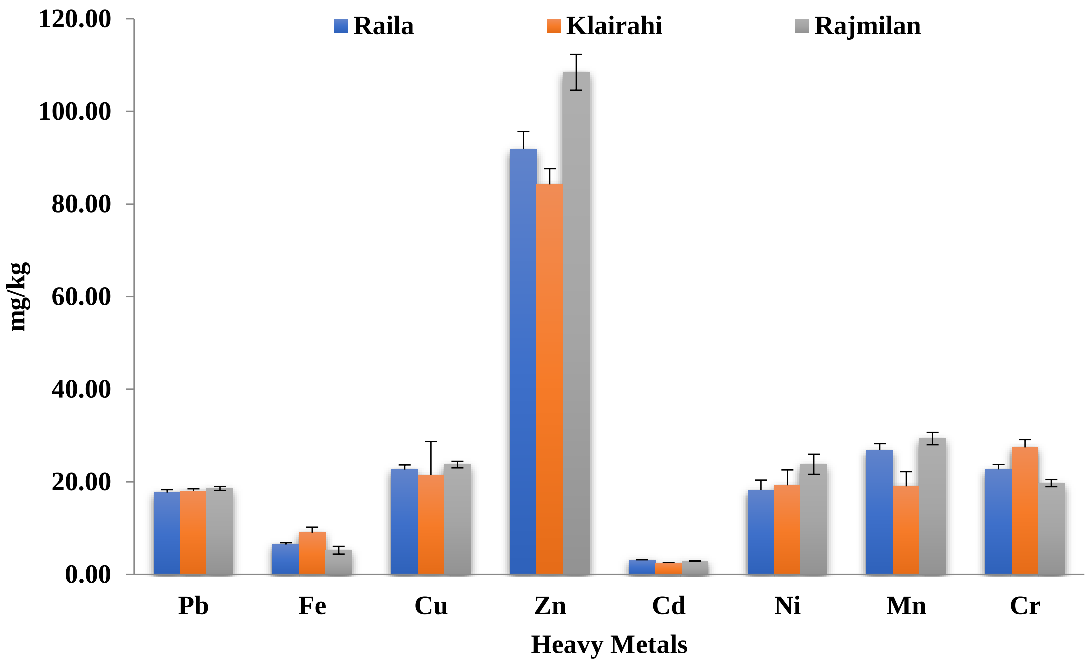
All metals were determined with a Thermo Scientific ICE 3000 series atomic absorption spectrophotometer. Each sample solution was run in triplicate and the result was corrected by subtracting the blank reading from the value for each metal.

III. RESULTS AND DISCUSSION

Heavy metal study in leguminous crops growing soil samples around station I (Mahan Super Thermal Power) during 2020-2021

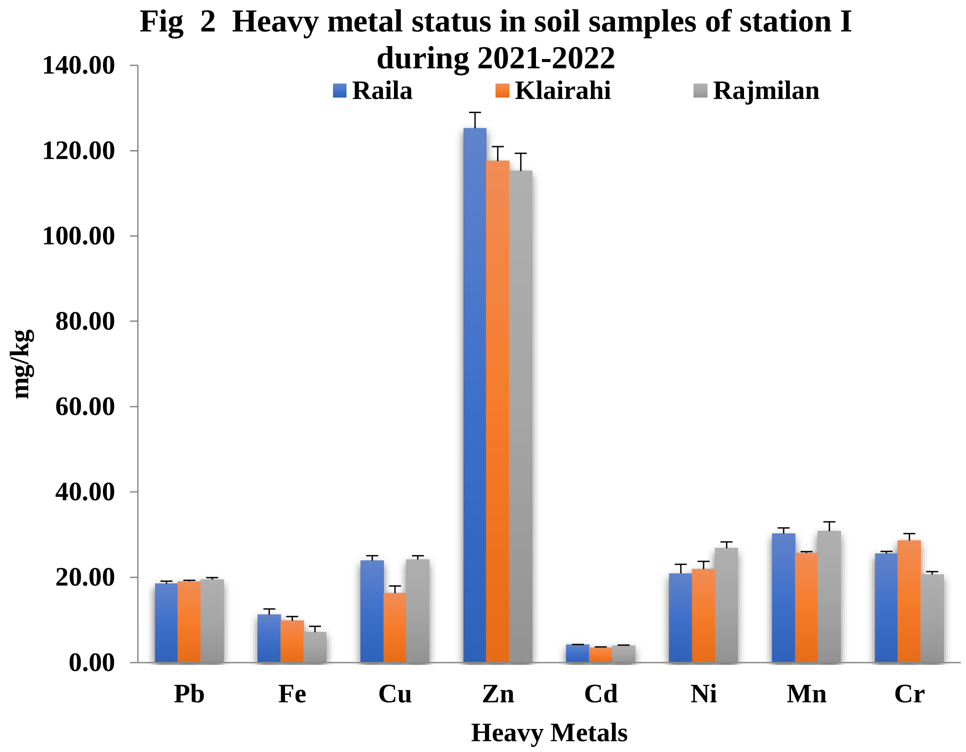
The soil metal analysis of various metals for soil samples taken from several Station I locations revealed varying concentrations in comparison to metallic standards. Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr values for the Raila site for 2020–21 are (17.67 ± 0.63), (6.44 ± 0.38), (22.62 ± 1.02), (91.89 ± 3.75), (3.07 ± 0.08), (18.22 ± 2.14), (26.89 ± 1.35), and (22.67 ± 1.06), respectively. The values of several metals in the Klairahi site exceeded the established limitations. The values for Pb, Fe, and Cu were 18.06 ± 0.43, 9.00 ± 1.20, and 21.46 ± 3.22, respectively. If a comparison analysis is carried out for all three locations, Rajmilan site has the highest Pb level, with a value of (18.56 ± 0.42). In station-III the value of Fe was recorded as (5.22 ± 0.84) Cu (23.71 ± 0.71), and Zn was recorded as (108.44 ± 3.86) (fig. 1).

Fig 1 Heavy metal status in soil samples of station I during 2020-2021



Heavy metal analysis in leguminous crops growing soil samples around station I (Mahan Super Thermal Power) during 2021-22

The following year's study revealed a modest increase in the metal absorption in soil samples taken from several Station I locations. Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr values for the Raila site during 2021–2022 are as follows: 18.50 ± 058), 11.22 ± 1.35, 23.88 ± 1.17, 125.22 ± 3.75, (4.16 ± 0.08), 20.89 ± 2.14, (30.22 ± 1.35), and (25.54 ± 0.52). The value of every metal in the soil at the Klairahi site exceeded the established limitations. The values of Pb, Fe, Zn, Cd, Ni, Mn, and Cr were (19.03 ± 0.25), (9.78 ± 1.02), (16.27 ± 1.69), (117.56 ± 3.40), (3.54 ± 0.13), (25.67 ± 0.33), and (28.58 ± 1.65), in that order. Comparably, the value of metal absorption at the Rajmilan site varied from the year (fig.2).

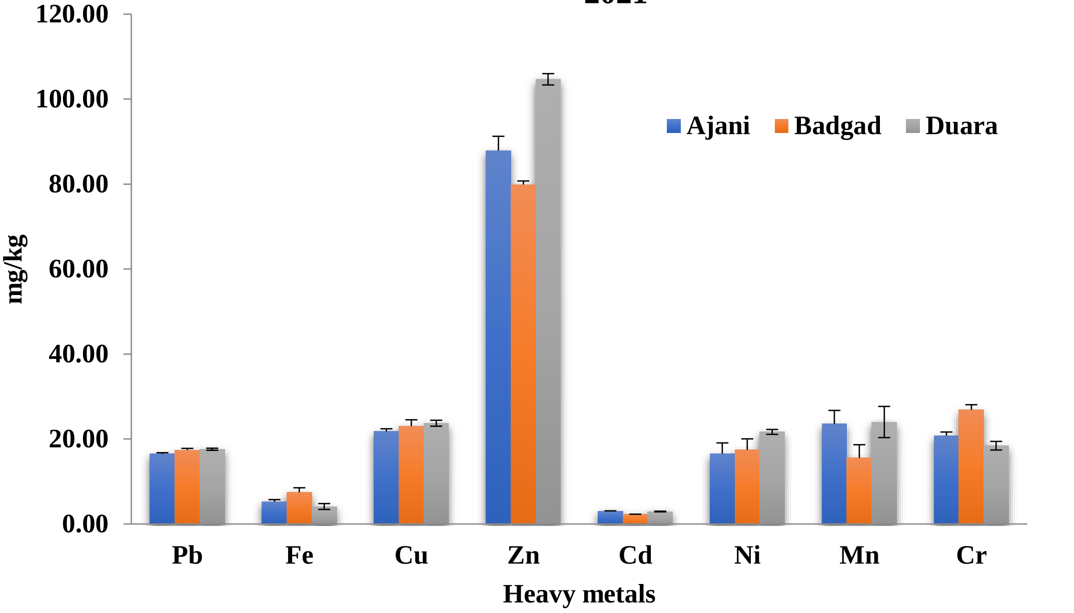


Heavy metal analysis in leguminous crops growing soil samples around Station II Chitrangi Power Plant during 2020-2021

Heavy metal status in soil samples of station II during 2020-2021

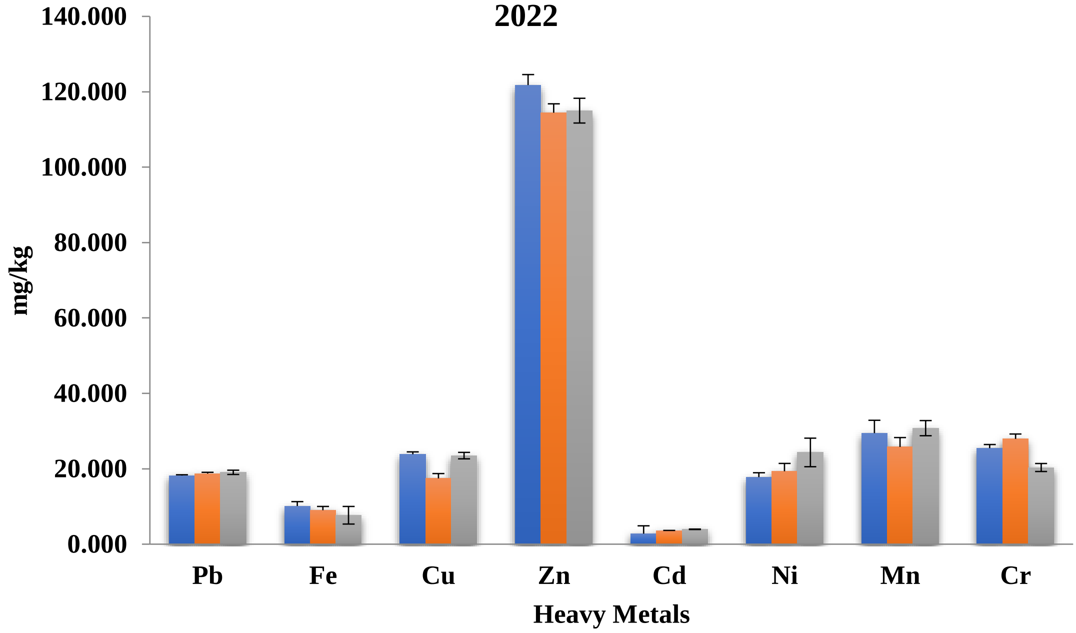
When soil samples from several Station II locations were analysed for metal content, the results showed varying levels when compared to metallic standards. Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr values for the Ajani site for 2020–21 are (16.47 ± 0.29), (5.22 ± 0.51), (21.77 ± 0.63), (87.89 ± 3.36), (2.96 ± 0.13), (16.56 ± 2.52), (23.56 ± 3.17), and (20.79 ± 0.85), respectively. The values of several metals at the Badgad site differed from those at the Ajani site, which was the previous location (fig. 3). Pb, Fe, and Cu values for the Ajani site were (17.39 ± 0.39), (7.44 ± 1.07), and (23.03 ± 1.50), in that order. In comparison to the Ajani and Badgad sites, the Duara site had the highest value of Pb, Cu, Zn, Ni, and Mn metals. In concern to Duara site the value of heavy metals (Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr) accounted as (17.58 ± 0.25), (4.11 ± 0.69), (23.71 ± 0.71), (104.67 ± 1.33), (2.93 ± 0.08), (21.67 ± 0.58), (24.00 ± 3.67), and (18.42 ± 1.01) (fig. 3 and 4).

Fig. 3. Heavy metal status in soil samples of station II during 2020-2021



Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr values at the Ajani site for 2021–2022 are as follows: 18.194 ± 0.210), 10.11 ± 1.171), 23.84 ± 0.639, 121.77 ± 2.79, (2.78 ± 2.08), 17.77 ± 1.17), (29.44 ± 3.42), and (25.45 ± 0.97). In a similar vein, the metal study for the two additional sites, Badgad and Duara, showed a different and greater value of metal content than the 2020–21 year. Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr were the heavy metal status for the Duara site, with values of 19.05 ± 0.56, 7.667 ± 2.33, (23.48 ± 0.86), (115.0 ± 3.28), (3.94 ± 0.06), (24.33 ± 3.78), (30.77 ± 2.01), and (20.33 ± 1.06) (fig. 4).

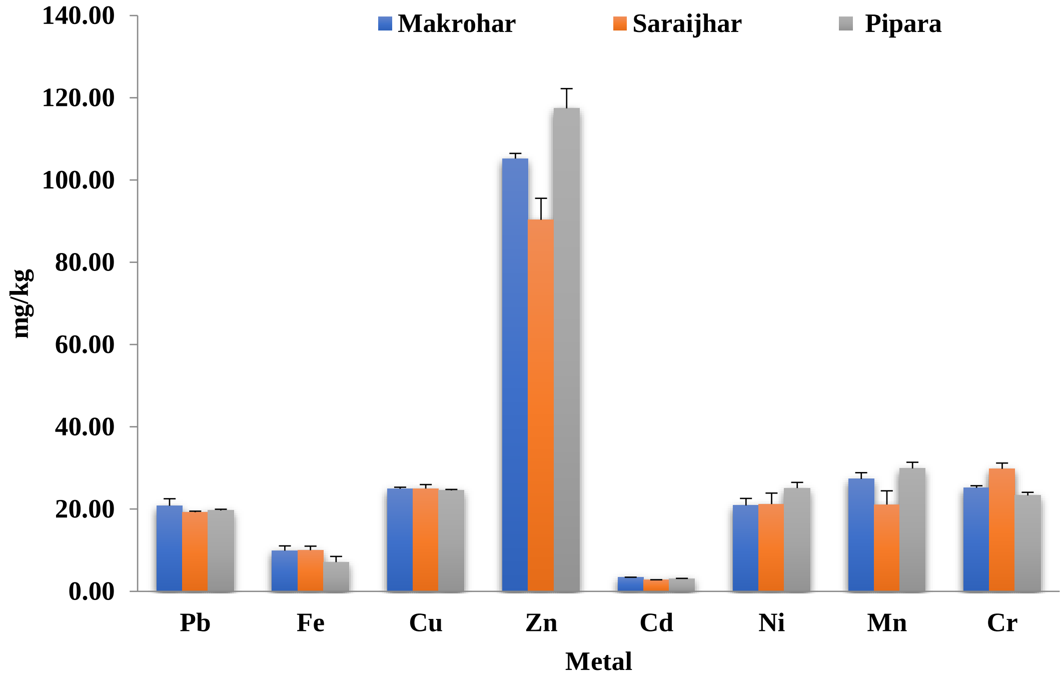
Fig. 4 Heavy metal status in soil samples of station II during 2021-2022



Heavy metal analysis in leguminous crops growing soil samples around station III (Sasan Ultra Mega Power Plant) during 2020-21

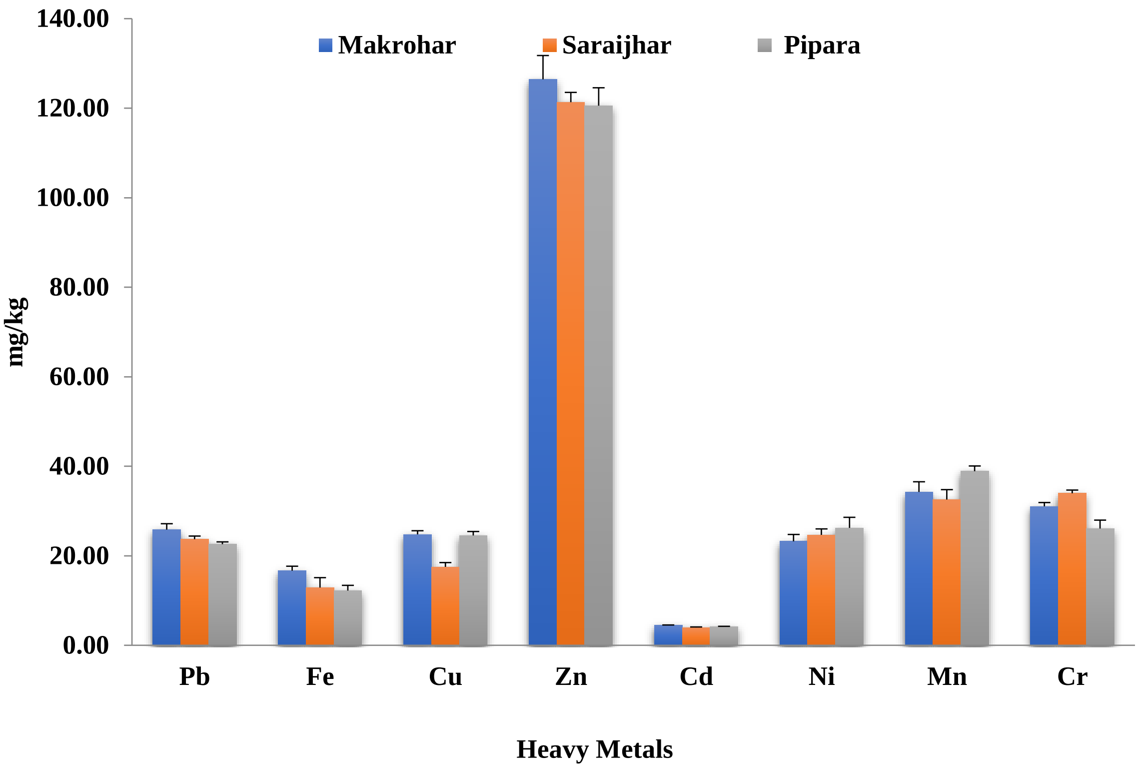
Three soil samples were obtained in triplicate from Station III (Sasan Ultra Mega Power Plant) for metal analysis using different standard metal content parameters in the years 2020-21. Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr statuses are expressed as follows on the Makrohar site: 20.81 ± 1.72, (9.89 ± 1.17), (24.94 ±0.39), (105.22 ± 1.26), (3.41 ± 0.03), (20.89 ±1.71), (27.33 ± 1.53), and (25.17 ± 0.52). In a similar vein, the values of other heavy metals at the Saraijhar site were Pb (19.25 ± 0.25), Fe (10.0 ± 1.0), Cu (25.00 ± 0.98), and Zn (90.33 ± 5.24), in that order. In the third site Pipara, the following values were recorded: 19.67 ± 0.30), (7.11 ± 1.39), (24.57 ± 0.21), (117.44 ± 4.79), (3.12 ± 0.05), (25.11 ± 1.39), (29.89 ± 1.50), and (23.33 ± 0.75) for Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr. The findings showed that there was variation in the standard soil content of every heavy metal in the soil samples that were taken from the three sites that were chosen (fig. 5).

Fig. 5 Heavy metal status in soil samples of station III during 2021-2022



The metal analysis in soil sample collected from station III (Sasan Ultra Mega Power Plant) for respective years 2021-22. The Makrohar site processed soil samples represent grade of Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr as (25.83 ± 1.32), (16.67 ± 1.0), (24.78 ± 0.81), (126.44 ± 5.32), (4.45 ± 0.09), (23.22 ± 1.54), (34.26 ± 2.27), and (31.04 ± 0.85). The second Saraijhar site belong to station expressed different status of heavy metals, the Pb (23.69 ± 0.71), Fe (12.89 ± 2.22), Cu (17.52 ± 0.96), Zn (121.33 ± 2.19) respectively. Similarly in Pipara site the value of Pb, Fe, Cu, Zn, Cd, Ni, Mn, and Cr were (22.58 ± 0.52), (12.22 ± 1.17), (24.54 ± 0.89), (120.56 ± 2.10), (4.22 ± 0.02), (26.22 ± 2.36), (38.89 ± 1.17), and (26.08 ± 1.88) 2021-22 (fig. 6).

Fig . 6 Heavy metal status in soil samples of station III during 2021-2022



This result is in agreement with the study on heavy metals in soils from central, Nigeria conducted [17,18]. It is also similar to results of heavy metals analysis of soils of Bijapur taluka in India where out of the ten farms analysed, Ni and Cd were also detected in three stations Distribution of heavy metals in soil is continuously altered due to various soil processes and is under the influence of environmental factors. A large share of general Cd pollution is caused by dumping and incinerating Cd-polluted waste [19,20], these activities may be absent around the farms analysed. Cu metal in agricultural soils absorbed by plants becomes especially important in seed production, disease resistance, and regulation of water. Cu is indeed essential, but in high doses it can cause harms [21,22]. These heavy metals detected in the soil samples were below the moderate limits but the Cd, Pb and Cr, Fe contents of the samples which ranged varied mg/kg that were above the permissible limits.

IV. CONCLUSION

Heavy metals were also detected in the soil samples from all stations investigated. The level of Cd, Cu, Mn Ni were touch the FAO/WHO and EU standards. These heavy metals could be picked up by foodstuffs grown on these stations fields and pose danger to humans as a result of bioaccumulation. The high level of Fe may constitute health hazards due to its toxicity. Routine heavy metals analysis of soil samples of agricultural farmlands should be carried out in order to maintain the quality of crops grown on fields saturated around the established industries of Singrauli (M.P.). Most of these industries were set up without carrying out Environmental Impact Assessment (EIA) and also most do not carry out the mandatory periodical Environmental audits (EA). These industries consequently do not have any clear environmental management policy and environmental management plan. It is imperative that all the industries that generate wastewater that exceed national standards should treat the effluents before discharging into the environment.

V. REFERENCES

[1]. Opaluwa O.D., Aremu M.O., Ogbo, L.O., Abiola, .KA., Odiba, I.E., Abubakar, M.M. and Nweze, N.O. (2012). Heavy metal concentrations in soils, plant leaves and crops grown around dump sites in Lafia Metropolis, Nasarawa State, Nigeria. Advances in Applied Science Research 3(2): 780-784.

[2]. GWRTAC, (1997) Remediation of metals-contaminated soils and groundwater, Tech. Rep. TE-97-01. Pittsburgh, Pa, USA, GWRTAC-E Series.

[3]. Yusuf, K.A. and Oluwole, S.O. (2009). Heavy metal (Cu, Zn, Pb) contamination of vegetables in urban city: A case study in Lagos. Research J of Environmental Sci. 30, 292-298.

[4]. Pujar, K.G., Hiremath, S.C., Pujar, A.S., Pujeri, U.S. and Yadawe, M.S. (2012). Analysis of physicochemical and heavy metal concentration in soil of Bijapur Taluka, Karnataka. Science Revisions and Chemical Communication 2(1): 76-79.

[5]. Arora, M., Kiran, B., Rani, S., Rani, A., Kaur, B. and Mittal, N. (2008). Heavy metal accumulation in vegetables irrigated with water from different sources. Food Chemistry 111, 811-815.

[6]. McLaughlin, M.J., Parker, D.R. and Clarke, J.M. (1999). Metals and micronutrients – Food safety issues, Field Crops Resources 60: 143-163.

[7]. Singh, B. (2001). Heavy metals in soils: Sources, chemical reactions and forms. In: Smith D, Fityus S, Allman M (ed.): Proceedings of the 2nd Australia and New Zealand.

[8]. Dosumu, O.O., Abdus-Salam, N., Oguntoye, S. and Adekola, F.A. (2005). Trace metals bioaccumulation by some Nigerian vegetables. Centre point (Science Edition), 13(1): 23-32

[9]. Khan, S., Cao, Q., Zheng, Y.M., Huang, Y.Z. and Zhu, Y.G. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China, Environmental Pollution 152(3): 686-692.

[10]. Zhang, M,K., Liu, Z.Y. and Wang, H. (2010). Use of single extraction methods to predict bioavailability of heavy metals in polluted soils to rice. Communication in Soil Science and Plant Analysis 41(7): 820–831.

[11]. Bashir, F., Tariq, M., Khan, M.H., Khan, R.A and Aslam, S. (2014). Fractionation of Heavy Metals and Their Uptake by Vegetables Growing in Soils Irrigated with Sewage Effluent. Turkish J Engineering and Environmental Sci. 38, 1-10.

[12]. Adriano, D.C. (1986). Trace elements in the terrestrial environment, New York, Springer - Verlag, 107-469.

[13]. Agency for Toxic Substances and Disease Registry, ATSDR (1994). Toxicological Profile for Zinc. US Department of Health and Human Services, Public Health Service 205-88-0608.

[14]. ATSDR (2000) Toxicological profile for manganese. U.S. Centers for Disease Control.

[15]. Anhwange, B.A., Kagbu, J.A, Agbaji, E.B. and Gimba, C.E. (2009). Trace metal contents of some common vegetables grown on irrigated farms along the banks of river Benue within Makurdi Metropolis. Electronic Journal of Environment and Agricultural Food Chemistry 8, 1150- 1155.

[16]. Allen, S.E. (ed.) (1974). Chemical analysis of ecological materials. Blackwell, London.

[17]. Sumaila, A. (2014). Assessment of some heavy metals in selected vegetables and soils obtained from farm sites in Paiko, Niger State, Nigeria. Dissertations, Federal University of Technology Minna, Nigeria

[18]. Abbas, M., Parveen, Z., Riazuddin Iqbal, S. and Bhutto, R. (2010). Monitoring of toxic metals (cadmium, lead, arsenic, and mercury) in vegetables of sindh, Pakistan, Kathmandu University. Journal of Science, Engineering and Technology 6, 60-65.
[19]. Troeh, F.R. and Louis, M.T. (2005) Soils and soil fertility. 6th ed. Ames, Blackwell, Iowa.
[20]. Chang, L., Magos, L. and Suzuki, T. (Eds.). Toxicology of Metals. CRC Press, Boca Raton, FL, 1996.
[21]. Muwanga, A. and Barifaijo, E. (2006). Impact of industrial activities on heavy metal loading and their physico-chemical effects on wetlands of the Lake Victoria basin. AJST 7 (1): 51- 63.
[22]. Nabulo, G. and Oryem Origa, H., Nasinyama, G.W. and Cole, D. (2008). Assessment of Zn, Cu, Pb and Ni contamination in wetland soils and plants in the Lake Victoria basin. International Journal of Environmental Science and Technology, 5(1): 65-74.

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