



Research Article

HEAVY METAL ANALYSIS OF SOIL SAMPLES COLLECTED FROM IN AND AROUND SATNA

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ABSTRACT

The physico-chemical parameters (i.e. temperature, pH, EC, organic carbon) and heavy metal (i.e. Manganese, Iron, Cobalt, copper, Zinc) has been examined in the soil samples of Satna district. The values ranges of different parameters temperature- 22-28 °C, pH- 7.60-8.80, EC- 0.69-3.20, organic carbon- 0.27-2.10, Mn- 16.3-36.8, Fe- 59.7-157.2, Co- 6.54-19.12, Cu-15.19-83.4 and Zn- 45.1-96.2 mg/kg were found in soil of Satna district. Fe and Zn content were found in all the samples are below than the (SQGL) recommended values.

INTRODUCTION

Satna is a town and District in the state of Madhya Pradesh India. It is situated on the Tons River, a tributary of the Ganges. The city is a road and rail junction and an important distribution centre for agricultural products and cloth fabrics. The grain market in the city is one of the largest in the country. Industries include flour and oilseed milling and cement manufacturing; there is a large cement plant and a thermal power-generating station. Satna has several colleges affiliated with Awadesh Pratap Singh University. Satna's surrounding region was part of the kingdom of Kosala and later became part of Vatsa territory. The district of Satna is situated between latitude 23° 12' north and longitude 80° 21' and 81° 23' east in mid northern part of Rewa commissioner's division in Madhya Pradesh State of India. Mostly two type of soils is obtained in Satna district, light black and loam soil. Metals that have been shown to be essential for plants, and lower forms of animal life and even other mammals, but essentiality for humans has not been convincingly demonstrated. The yield of crop depends on fertility and presence of micronutrients and heavy metals in the soil. The soil condition is of great importance, because it is a universal medium for plant growth, which supplies essential nutrients to the plants. Trace heavy metal concentration in the soils is a major concern because of their toxicity and threat to

human life and the environment (Saleh, *et al* 2006). Heavy metal concentrations (Cu, Fe, Mn, Zn and Co) of each fraction was analysed by Atomic Absorption Spectrophotometer. The industries are located very close to human population and clearly indicate decrease in fertility and presence of various metals. The heavy metal soil contamination from mining and smelting creates a wide spectrum of hazards. Adverse environmental impacts from contaminated mining sites include risk to human health, phytotoxicity, contamination of soil, and ecotoxicity (Thakre, *et al.* 2012 Anju, *et al.* 2011; Sonawane, *et al.* 2013). Recent studies have shown that chemicals used in agriculture, industry, households and for personal care are making their way in to the environment and that many of them are suspected endocrine disruptors (Al-omran, *et al.* 2005; Thkre, *et al.* 2012; Patnika, *et al.* 2013; Dwivedi, *et al* 2013; Markey *et al.* 2002; Tripathi *et al.* 2014). The aim of this study was to examine the physico-chemical properties and heavy metals in soil of Satna district with a view to establish the contamination status of the soil as a result of anthropogenic input. Soil samples were collected from crop land area, residential area and Industrial area in various locations of Satna district.

MATERIALS AND METHODS

All the chemicals were used analytical grade reagent (AR), and list of sampling location are shown in Table 1. Fifteen sampling stations were chosen at different site of the study area and

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sampling was done during month of march-2014. Soil samples were collected from different locations in plastics bags, dried at 60 °C for 48 h and fine powder was made with the help of pistil mortar and sieved it with 2mm sieve. Various physico-chemicals parameters were analyzed by different technique (Tendon *et al.* 1993). 0.5 g of soil was digested in 10 ml HNO₃: HCl in the ratio 3:1 and 1ml perchloric acid in culture test tube and incubated at 80°C in a water both. After total digestion and subsequent cooling, the solution was diluted to 50 ml and digested samples were analyzed for heavy metals using Atomic Absorption Spectrophotometer (APHA, 1995).

positive relationships with each parameter expect temperature. All the metals (Mn, Fe, Co, Cu, and Zn) correlate with each other significant positive correlation value will be obtained. The positive significant correlation values will helps in selecting the proper treatments to minimize the contaminations of the soil of Satna District.

In the present investigation the temperature ranged between 22 °C to 28 °C, the highest temperature (28 °C) was recorded in (SR₂) Bardhadeh residential area of Satna District while the

Table 1. List of sampling location

S. No.	Sampling Location	Sampling Area	Depth in cm.	Description of Sampling Location
1	Satna Cement Plant (Birla) (SI ₁)	Industrial area	15cm	Satna Cement Plant (Birla)
2	Baricalan Crop Land (SC ₁)	Crop land area	15cm	Behind 1.5 km High School
3	Village Biricalan (SR ₁)	Residential area	15cm	Gernal Store of Ramkumar
4	Universal Cabil Ltd (SI ₂)	Industrial area	15cm	Universal Cabil Ltd.
5	Bardadeeh Crop Land (SC ₂)	Crop land area	15cm	Behind of the UCL
6	Bardadeeh (SR ₂)	Residential area	15cm	Kaima Road Bardadeeh
7	Kamal Spanj (SI ₃)	Industrial area	15cm	Sagma Plant
8	Kaima crop land (SC ₃)	Crop land area	15cm	Behind 1.5 km Sagma Plant
9	Kaima Village (SR ₃)	Residential area	15cm	Near Talab
10	Babupur Jaypee Cement Plant (SI ₄)	Industrial area	15cm	Jaypee Plant Babupur
11	Sakaria Crop Land (SC ₄)	Crop land	15cm	Near Railway Fatak
12	Sakariya Village (SR ₄)	Residential	15cm	In Side Village
13	Prism Cement Plant Mankahari (SI ₅)	Industrial area	15cm	Prism Cement Plant
14	Mankahari Crop land (SC ₅)	Crop land area	15cm	Near Mankahari
15	Mankahari Village (SR ₅)	Residential area	15cm	Near High School Mankahari

RESULT AND DISCUSSION

In the present study soil samples were collected from different part of Satna District. Soil samples were subjected for the analysis of physical and chemical parameters, like as temperature, pH, electrical conductivity, organic carbon, and heavy metal (manganese, iron, cobalt, copper zinc). Analysed samples data and statistical data with SQGL values of the metal are shown in table-2 and table-3, and graphical representations of the data are shown in figure 1 to 5. The mean values of temperature, pH, EC, O.C, Mn, Fe, Co, Cu, and Zn are recorded to be 25.27 °C, 8.214 m moh, 1.745, 0.819, 23.19, 95.45, 10.09, 40.74 and 63.97 mg/kg respectively. S.D values was found slight deviation in Fe, Cu, Zn, Co, Mn and Temperature which is 33.23, 20.13, 3.37, 6.04, 1.53 mg/kg, respectively. A very little deviation was found in pH, EC, and O.C. percent variation values of temperature (6.06), pH (4.59), EC (56.32), Mn (26.07), Fe (34.82), Co (33.39), Cu (49.42) and Zn (23.88) Showed wide fluctuation between station to station. While percent variation values of organic carbon (80.94) showed significant variation from one station to another. Present study deals with the various relationship derived statistically by calculation r among the physico-chemical characteristics. The r value was negative five times and positive thirty nine times this showed that positive relationship in the present soil studied. Temperature showed significant positive relationship with EC, and Mn and negative relationship with pH, OC, Fe, Co, Cu, and Zn. pH showed significant positive relationship with all the Parameters except temperature, Similarly EC and O.C. Showed

lowest value (22 °C) was observed in (SI₄) Babupur cement plant. The pH of all the soil samples varied from 7.60 to 8.80, the highest pH was observed 8.80 at sampling location (SI₃) Sagma iron plant and the minimum value 7.60 (SR₃) Caima residential area. (Tripathi *et al.* 2014) Studies of Physico-chemical characteristics of soil in Shahdol District of Vindhya platue and reported temperature ranges 28.64 °C to 42.28 °C and pH was observed from 6.4 to 8.4. The electrical conductivity of soil depends upon the concentration of ions and its nutrient status. In the present investigation of the electrical conductivity ranges from 0.69 to 3.20 m mhos cm⁻¹, the highest electrical conductivity was recorded in (SI₁) Birla cement plant. Organic Carbon of the soil samples varied from 0.27 to 2.10 mg/Kg. Tripathi, *et al* 2014, reported the organic carbon ranged between 0.06-3.19 mg/kg. The maximum concentration of manganese, cobalt and copper are observed to be 36.8, 19.12 and 83.4 mg/kg respectively. Values of manganese, at sampling stations Kima crop land (22.4), Biricalan (21.9), Kima (24.8), Mankhari (20.5), Birla cement plant (36.8), Universal Cabil Ltd (28.6), Kamal Spanj (31.2), Babupur Jaypee Cement Plant (29.4) and Prism cement plant Mankhari (25.3) is higher than the prescribed SQGL value. Cobalt value at Kaima crop land (15.56), Sakaria crop land (19.12), Villeage Biricalan (12.45), Sakaria village (8.47), Mankhari Village (9.82), Birla cement plant (10.37), Universal cabil Ltd (9.05) Kamal sapanj (9.01), Babupur Jaypee cement plant (15.06) and Mankhari cement plant (11.21) were also higher than the prescribed SQGL value. Copper values at sampling station Satna cement plant (69.5), Babupur Jaypee cement plant (83.4) and Mankhari Prism

Table 2. Physico-chemical characteristic of Soil collected from Crop land area, Residential area and Industrial area of the Satna District

Parameters	Crop land area					Residential area					Industrial area					SQGL value			
	SC ₁	SC ₂	SC ₃	SC ₄	SC ₅	SR ₁	SR ₂	SR ₃	SR ₄	SR ₅	SI ₁	SI ₂	SI ₃	SI ₄	SI ₅		Mean	S.D	C.V
TEMP	23	25	25	24	26	25	28	27	26	24	26	26	26	22	26	25.27	1.533	6.06	--
pH	8.20	8.30	8.10	8.35	8.15	7.85	7.85	7.60	7.95	7.70	8.56	8.65	8.80	8.75	8.40	8.21	0.377	4.59	--
EC	0.69	0.94	0.86	0.97	0.67	1.37	1.10	1.65	1.47	1.29	3.20	2.95	2.81	3.06	3.14	1.74	0.982	56.32	--
O.C.	2.10	0.70	0.64	0.70	0.27	0.40	0.30	0.37	0.48	0.33	2.40	1.42	0.49	1.14	0.54	0.81	0.662	80.94	--
Mn	17.6	19.2	22.4	16.9	18.7	21.9	16.3	24.8	18.3	20.5	36.8	28.6	31.2	29.4	25.3	23.19	6.047	26.07	20
Fe	143.7	84.2	85.6	62.5	68.0	81.4	72.4	59.7	67.2	74.2	138.0	99.8	157.2	142.1	95.8	95.45	33.237	34.82	380
Co	7.46	6.59	10.56	19.12	7.24	12.45	7.36	7.64	8.47	9.82	10.37	9.05	9.01	15.06	11.21	10.09	3.370	33.39	8
Cu	49.2	15.19	30.12	22.6	37.4	36.0	28.5	24.6	17.30	34.23	69.5	42.1	55.8	83.4	65.2	40.74	20.135	49.42	63
Zn	62.4	56.8	64.8	62.4	48.2	45.1	72.4	60.7	54.1	55.6	87.1	62.3	46.2	96.2	85.3	63.97	15.277	23.88	200

All the Values are expressed in mg/kg except temperature, pH and EC.

Table 3. Correlation Coefficient 'r' among various physico-chemical parameters in Soil of Satna District

Parameters	TEMP. ^o C	PH	EC m mhos/cm	OC	Mn	Fe	Co	Cu	Zn
TEMP. ^o C	1								
PH	-0.28332	1							
EC m mhos/cm	0.049336	0.647524	1						
OC	-0.32909	0.486903	0.344444	1					
Mn	0.029467	0.607171	0.874888	0.473414	1				
Fe	-0.37778	0.7315	0.563255	0.655511	0.645241	1			
Co	-0.50716	0.290909	0.194472	0.035756	0.096438	0.019346	1		
Cu	-0.33862	0.64904	0.754429	0.506671	0.718354	0.787051	0.251739	1	
Zn	-0.19993	0.383667	0.562958	0.464583	0.431809	0.354476	0.320285	0.66484	1

Fig: 1 Temperature ^oC in the Soil of Satna District.

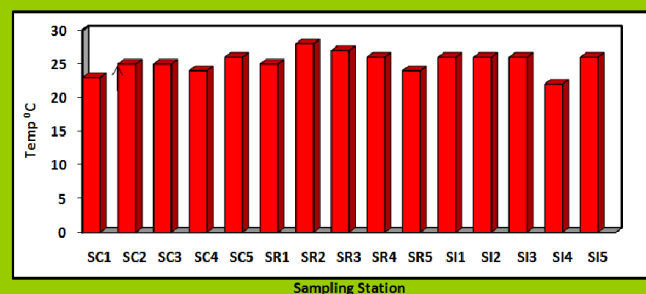


Fig: 2 pH concentration in Soil of Satna District.

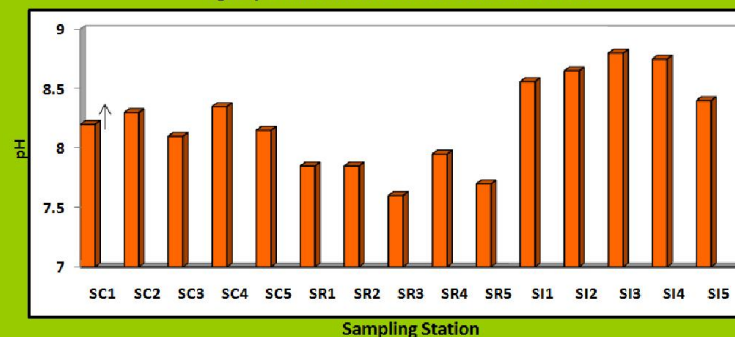


Fig: 3 EC presented in Soil of Satna District

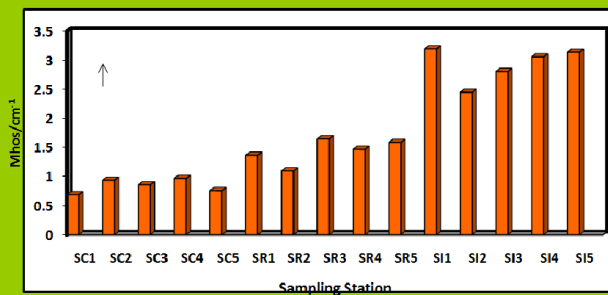


Fig: 4 OC is presented in Soil of Satna District

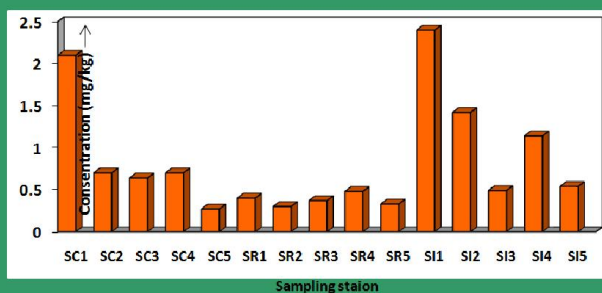
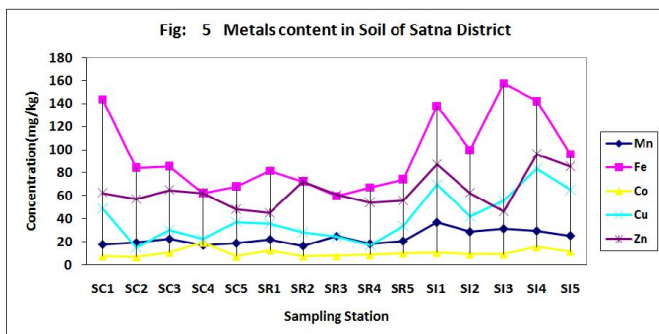


Fig: 5 Metals content in Soil of Satna District



cement plant (65.2)mg/kg are higher than the SQGL (Govil *et al.* 2008) recommended level. Tripathi *et al.* 2013, also reported copper concentration between 0.25-87.20 mg/kg at different location of Satna district soil samples. Iron and Zinc concentration were observed from all the sampling station below the (SQGL) recommended level. Shivakumar *et al.* 2012, studied physico-chemical profile of soil along the banks of Amaravati River banks in Karur areas of Tamil Nadu and reported Iron content range between 9.85-6.14mg/kg.

Conclusion

Soil samples collected from fifteen different sampling stations and analysed for the physico-chemical properties and heavy metals content in it. The maximum temperature (28°C) was recorded at sampling station SR₂ (Bardadeh) during a study period and maximum pH concentration found to be 8.80 at sampling stations SI₃ (Kamal Spanj). The maximum electrical conductivity (3.2) was recorded at Birla cement plant Satna (SI₁). Organic Carbon in these soils is very poor and ranging from 0.27 to 2.40. The Iron and Zinc of all the soil samples were below than the (SQGL) recommended level. While Manganese, Cobalt, and Copper were found more than the SQGL recommended value at sampling stations SR₁, SR₂, SI₁,

SI₂, SI₃, SI₄ and SI₅. Atmospheric deposition of contaminated dust and industrial discharge in the study area may be the cause of heavy metal contamination in Soil. It is concluded that the Soil quality of the Satna District is not encouraging. Therefore, suitable protective measures were suggested for Soil health.

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