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Chemical Characterization And Heavy Metal Analysis Of Soils From Villages Adjacent To Industrial Area Of Rewari District

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Abstract- Soil is a natural habitat for diverse microbial and faunal communities and a medium for regulating various cycles and processes that supports the plant growth. The present study investigates the soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), phosphorus (P), potassium (K) sodium (Na) and heavy metal concentrations of soils in four villages adjacent to Bawal industrial area. Soil samples collected from three distinct agricultural lands of each village at a depth of 10 cm. Results reflects the normal to slightly alkaline nature and low organic carbon content of studied soils. Soil nutrient analysis revealed N, P, K contents in the range of 13 to 18, 15 to 21, and 16 to 20 mg/kg respectively. Soil pH is reported to show a strong negative correlation with EC (r= -0.86501), moderate negative with OC and positive correlation with N(r= 0.424826). A significant positive correlation observed between OC and P(r=.0.64327). The heavy metal concentrations of soils exhibited the order Fe> Zn > Cu>Ni> Cr> Pb> Cd. As these soils are irrigated with groundwater, levels of heavy metals are in compliance with the maximum allowed concentrations established by WHO.

Keywords : Heavy metals, Nutrients, Correlation, Agricultural Land.

Introduction-

Soil profile changes with the region, climate, industrialization, type of vegetations, amount of precipitation received and groundwater profile.[1] Soil texture or soil structure is determined by the percentage of soil particles in the form of clay, sand, and silt and it varies region to region and with time and type of rocks. [2] India is a country of diverse culture, climate, language, and geography. In this country of diverse climatic conditions, different types of crops are grown, depending on the soil structure and profile. In order to have knowledge about soil profile, analysis of soil parameters is primary necessity. Soil parameters are the reflection of the state of the soil ecology and its shape and structure, which controls the fertility and other soil functions like buffering and filtering. The soil profile, depth, reaction, soil texture, quantity and quality of decaying organic material, available nutrients, and concentration of surface material are of significant importance. All these soil parameters perform a vital role in providing detailed information about the soil quality. [3]

Strength of a particular kind of soil, to function according to its capacity within natural or managed ecosystem boundaries, to maintain human habitation, air and water quality and to sustain plant and animal productivity can be termed as soil quality [4,5] Soil testing is an effective tool to analyse the requirement of soil for better production of crops. Optimal use of nutrients, and increase crop productivity could be achieved by characterization of soil for its physical and chemical properties. [6] Soil parameters concentration should be in required range. Deficiency and excess of nutrients, both are not good for soil

health. Soil rich in organic carbon and nutrients generally considered good for soil health but it enhances parasite populations that could be injurious to crop, in that case it is not suitable for crops.[7,8]

Available N deficiency can cause a change in the colour of leaves that become light green and become narrow, short, and sometimes yellowish. Dark brown necrotic spots appear on the tips of leaves due to deficiency of Available K and leaves become dark brown in case of severe deficiency of K. [9] High concentration of N in the form of ammonium may become toxic to plants and can reduce iron uptake of plants. Increased levels of K can affect the nutrient uptake of the soil. Unbalanced NPK concentration in soil imparts negative effects on the plants. The overuse of NPK fertilizers causes nutrient-limited microbes to rapidly decompose the soil organic matter, which results in decreased water-holding capacity of soil and ultimately greater runoff and groundwater pollution. [10] All type of organic manure are reported to increase N, P, K contents of soil in addition to Soil organic matter, Calcium and Magnesiun concentrations in soil [11] It had been reported in many studies that excessive and continuous use of inorganic fertilizers to the agricultural soil may increase the crop yeild but reduces the crop quality by declining the nutrient availability in the grains.[12,13] Over application of N could leads to leaching of nitrate and increase the nitrate concentration in groundwater. [14]

Heavy metals concentration in soil has become the matter of great concern in this era of industrialization and development. Most of the heavy metals are necessary at trace amounts such as Fe, Zn, Mn, Cu, Co, and Ni for the growth and normal functions of plants and animals but excess of any of them may cause acute or chronic toxicity.[15] In the present study, we have tried to analyse the soil of four villages situated near the industrial area of Rewari district for its chemical parameters and heavy metals. We aims to characterize the soil of selected area and find the effect of industrialization on it , if any.

Materials and Methods- We have selected four villages near IMT Bawal of Rewari district as study area. Soil samples were collected from three different agricultural lands of each selected village (Jaliawas, Suthani, Banipur and Asalwas) at the depth of 10cm. Total 12 soil samples were collected in clean and dry polythene bags with zip lock. Each sample was labeled properly. In laboratory, these samples were air dried and sieved through a sieve of 2mm pores to remove larger particles, stones, grass and other material. Later these samples were stored in properly labeled glass vials for further investigation. Soil pH, EC, Nitrogen, Phosphorus, Potassium, Sodium, OC% and heavy metal (Zn, Pb, Cd, Cr, Cu, Ni and Fe) concentrations of these soil samples were investigated. Heavy metals estimation was done by using AAS.

Result and Discussion

Results of investigation are reported in table 1 and 2. Sample designated with V11, V12, V13 are taken from Jaliawas village, V21,V22,V23 are from Suthani village, V31,V32, V33 and V41,V42,V43 are from Banipur and Asalwas village respectively. Twelve soil samples were investigated for EC, pH, N, P, K, Na and OC%. Soils from all three sites of each village were mixed for estimation of heavy metal concentrations (mg/kg). Hence total four soil samples were investigated for heavy metals. Heavy metal analysis is reported in table 2. Correlation among soil parameters have been reported in table 3.
Comparative analysis of soil parameters and heavy metals are shown in fig 1 and 2 respectively.

Parameters	V11	V12	V13	V21	V22	V23	V31	V32	V33	V41	V42	V43
pH	7.11	7.05	7.23	6.98	7.45	7.12	7.25	7.17	7.44	7.80	7.67	7.71
EC	0.77	0.802	0.711	0.814	0.713	0.729	0.718	0.705	0.688	0.609	0.696	0.674
P (mg/kg)	20	18	19	19	17	18	20	16	18	21	17	19
OC %	0.231	0.196	0.248	0.24	0.234	0.27	0.304	0.312	0.268	0.194	0.212	0.234
N (mg/kg)	13	15	14	15	13	16	17	15	16	18	14	16
K(mg/kg)	17	19	16	18	19	20	17	16	17	18	18	15
Na (mg/kg)	18	22	19	17	18	20	23	17	24	19	20	23

Table 1: Soil parameters of three different sites of each studied villages

Heavy Metals (mg/kg)	V1	V2	V3	V4
Ni	4.9	6.25	4.47	5.26
Zn	15.44	16.56	14.71	13.84
Cu	6.4	5.8	7.2	5.2
Cd	0.17	0.28	0.19	0.24
Pb	1.02	0.87	0.73	0.61
Fe	489.72	262.56	394.27	321.13
Cr	5.71	4.83	4.69	6.45

Table 2: Heavy metal analysis of soils from different villages

	pH	EC	N	P	OC	Na	K
pH	1						
EC	-0.86501	1					
N	0.424826	-0.57108	1				
P	-0.02687	-0.16307	0.015385	1			
OC	-0.35316	0.00815	0.274846	0.643274	1		
Na	0.286938	-0.20602	0.284057	0.049237	0.04914	1	
K	-0.22713	0.28895	-0.0802	-0.18071	-0.3055	-0.154	1

Table 3: Correlation matrix of soil parameters

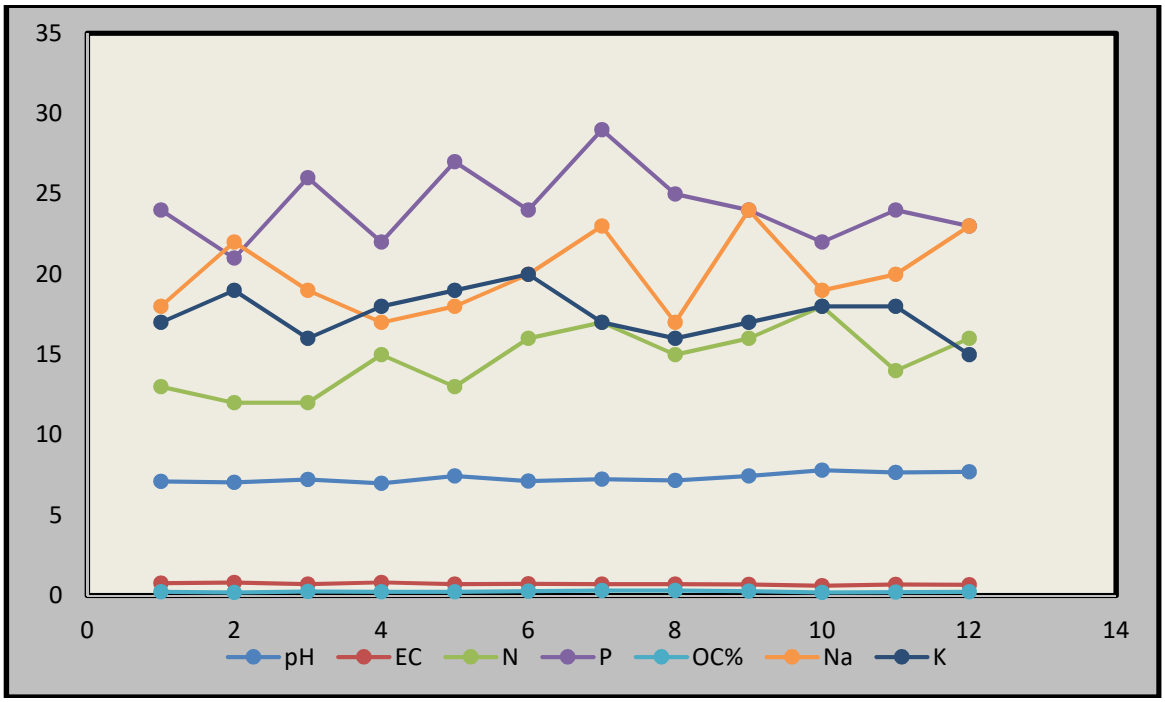

Fig 1: Comparative plot of soil parameters of different villages

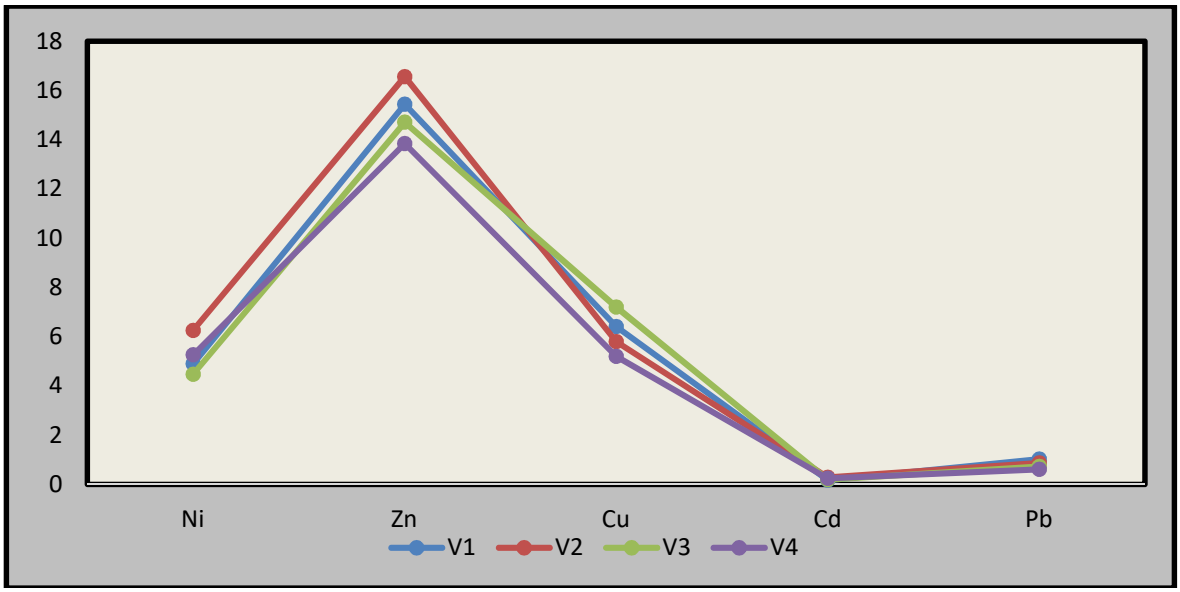

Fig2: Heavy metal concentrations in the soil of different villages

Soil pH is affected by various factors like degree of precipitation, climatic conditions, type of rocks and sometimes by anthropogenic activities.[16] Soil pH controls many biological process like growth of microbial activity and their population, also plays a vital role in availability of nutrient to the plants and influencing other soil parameters. Too much acidic and too alkaline soils are not considered good for crops.[17] Soil pH of all studied sites lie between 6.98 to 7.80, which is almost in the optimum range for crops. It is found neutral to slightly alkaline in nature. Soil pH of these agricultural lands is found to show moderate positive correlation with N and strong negative correlation with EC (table 3). In our previous

study, the soil collected near the industrial sludge in Bawal was found acidic, but presently studied soils pH are found suitable for plant growth. Electrical conductivity values lie in the range of 0.609 to 0.814 mS/cm and it is found to show moderate negative correlation with N.

In our previous investigation, sodium concentrations in the area near industrial sludge had shown very strong positive correlation (r=0.9149) with electrical conductivity and no correlation was observed with the same in agricultural soils. [16] In the present study Na concentrations are found in the range of 17 to 23 mg/kg and shows very weak negative correlation with the EC. These agricultural soils are found low in organic carbon% (in the range of 0.196 to 0.304 %). In the investigation carried out by Datta A. et al. [18], OC % of Rewari district was reported between 0.23 to 0.33 % , irrespective of depth, which is very close to our results. Our investigated area is also under the same district. Organic carbon of these soils is found negatively correlated to pH (r = -0.3531).

In order to meet the requirement of soil for different type of crops, NPK fertilizers are used frequently to increase only N,P,K content of soil. Nitrogen concentration of this area is reported between 13 to 18 mg/kg. It has shown moderate positive correlation (r = 0.4248) with soil pH and weak positive correlation with sodium (table 3). Phosphorus and Potassium concentrations are reported in the range of 15 to 21 mg/kg and 16 to 20 mg/kg respectively. Maximum P and N concentrations are reported in V4 and maximum K is in village V2. Overall random trends of soil parameters are observed in these soils.

Heavy metal analysis in the current study reported random trends with respect to the villages. Iron concentration is reported maximum followed by Zn > Cu > Ni > Cr > Pb > Cd. Essential heavy metals (cobalt, nickel, copper, manganese, and iron) are present in the soil in small amounts and are responsible for various biological, chemical and physical processes. Their concentrations are affected by their interaction with binding protein, presence of other non essential heavy metals, various natural and anthropogenic factors.[19] In the present study, zinc concentrations are reported in the range of 13.84 to 16.56 mg/kg, Cu (5.2 to 7.2 mg/kg), Ni (4.47 to 6.25 mg/kg), Cr (4.83 to 6.45 mg/kg), and Fe (262.56 to 489.72 mg/ kg).

Cadmium and lead are naturally occurring non essential heavy metals and anthropogenic activities mainly industrial manufacturing could elevate their concentrations in the soil.[20] Cadmium is soluble in water and can interact with organic and inorganic ligands of toxic metal and can replace various divalent ions of similar ionic radii. It is highly mobile metal and transferred from soil to groundwater more easily than other heavy metals. [21] In current study, Lead concentrations are between the range of 0.61 to 1.02 mg/kg, and Cadmium concentrations are found in the range of 0.17 to 0.28 mg/kg. Lead is also toxic heavy metal and can impart negative effects on human health and plant growth. Both the toxic heavy metals are found within the permissible range of WHO in our studied area.

Conclusion- Soils of studied area are found normal to slightly alkaline in nature and favorable range the plant growth. Soil pH of these agricultural lands is found to show moderate positive correlation with N (r= 0.424826). Low organic carbon percentage is reported in the studied soil samples and OC is found negatively correlated to soil pH (r = -0.3531). N, P, K content are found to follow the order P>K>N. Heavy metal concentrations are found within the permissible range of WHO. No significant contamination has reached to agricultural lands of surrounded villages due to industrialization but improper treatment of waste water and industrial sludge could impart negative effects on the surrounded soils.

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