Heavy metals (Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb) status in some selected soils of Peshawar and Nowshera Districts.

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Summary: This study was initiated to investigate the levels of heavy metals Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb in some contaminated or expected to be contaminated by industrial effluents and non-contaminated soils of Peshawar and Nowshera districts. The project also included the determination of physico-chemical properties of the selected soils and their correlation with the heavy metals concentrations. Thirty (30) soil samples from ten (10) different selected soils were collected from 0- 15, 15-30 and 30-45 cm, respectively. Each sample was analyzed for physico-chemical characteristics, using standard analytical techniques and for extractable Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb, using ammonium bicarbonate-diethylenetriaminepentaceticacid(AB-DTPA) as extracting solution.

The textural classes varied from silty loam, sandy-loam to silty-clay-loam. All the soils under study were non-saline having EC values between 0.38 and 2.81 dsm^{-1}. pH value ranged from 7.63 to 8.22 except Pirbala soil which had pH value of 9.11. All the soils were adequate in Zn, Cu, Fe and Mn for most agricultural crops. Higher levels of Ni and Cr near Ghee mills and Tanner Industry, respectively may be harmful for human, aquatic life and agricultural crops. Higher levels of AB-DTPA extractable heavy metals were observed in contaminated than in non-contaminated soils. In majority of the soil samples, the concentration levels of metals decreased with increase in depth. No correlation was found between concentrations of heavy metals and soil physico-chemicl properties, which might be due to the soils collected from different places with different thermodynamic properties.

Introduction

Because of rapid industrialization, soil pollution by heavy metals is becoming a serious problem. Being an ultimate sink for industrial wastes, almost all industrial wastes are dumped into the soil. Heavy metals in the wastes find specific adsorption sites in the soil where they are retained relatively strongly either on inorganic or organic colloids [1].

Some of the heavy metals are essential in trace amounts and play important role in plant and animal nutrition, enzymatic reactions and metabolic processes[2-4]. The metals Cr, Fe, Mn, Zn, Mo, and Co are essential for higher plants while Cu, Fe, Mn, Ni, Mo, Co, and Cr are essential for animals [5,6]. The sensitivity of plants and animals differs strongly for deficiency and excess levels of a particular metal. Even among various species of plants and animals, it is very difficult to establish a single critical value of deficiency or potential toxicity of particular metal [2,7].

The availability of heavy metals depends upon soil properties such as pH, electrical conductivity, lime content, organic matter and texture. Therefore their correlation studies are of utmost importance. The soils of North West Frontier Province (N.W.F.P.) are generally alkaline in nature and produce all types of crops and fruits. But due to poor management practices and insufficient use of fertilizers, the production is not of satisfactory level. Heavy metals levels are necessary to be determined for evaluating the potential effects on crop productivity and toxicity to animals and human being. This study was designed to estimate the levels of heavy metals Cu, Fe, Mn, Zn, Ni, Mo, Co, Cd, Cr and Pb in non-polluted soils and in soils potentially polluted by industrial effluents.

Results and discussion:

Physico-chemical characteristics:

The ranges and average values of physico-chemical characteristics of soils are given in Tables 1,2 and 3.

The textural classes of soils studied varied from silty loam, sandy loam to silty clay loam. (Table

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Table 1: Particle Size Distribution of Soil Samples Collected From Peshawar And Nowshera

Soil Series	Sample No.	Depth (cm)	% Sand	% Silt	% Clay	Textural class
1. Koto	1.	0 – 15	9	52	39	Silt –clay-loam
	2.	15 – 30	10	55	35	//
	3.	30 - 45	11	57	32	//
2. Sadu	4.	0 – 15	9	52	39	//
	5.	15 - 30	6	50	43	//
	6.	30 - 45	6	50	44	//
3. Amangar	7.	0 – 15	14	60	36	//
	8.	15 - 30	17	56	37	//
	9.	30 - 45	18	51	31	//
4. Bandagey	10.	0 – 15	12	57	31	//
	11.	15 - 30	13	56	31	//
	12.	30 - 45	15	55	30	//
5. Pirbala	13.	0 – 15	14	76	10	Silt-loam
	14.	15 - 30	11	81	8	//
	15.	30 - 45	9	80	11	//
6. Thalash	16.	0 – 15	8	78	14	//
	17.	15 - 30	13	74	13	//
	18.	30 - 45	13	73	14	//
7. Nagoman	19	0 – 15	68	26	6	Sand-loam
	20	15-30	64	27	9	//
	21	30-45	63	29	8	//
8. Gul	22	0 – 15	65	24	11	//
	23	15-30	66	24	10	//
	24	30-45	67	19	14	//
9. Hassan	25	0 – 15	19	68	13	//
	26	15-30	17	72	9	Silt-loam
	27	30-45	22	64	14	//
10.Makhey	28	0 – 15	20	62	18	//
	29	15-30	18	62	20	//
	30	30-45	18	66	16	//

Table 2: pH, EC, Lime and Organic Matter of Soil Samples Collected from Peshawar and Nowshera

Soil Series	Sample No.	Depth (cm)	pH	EC	% Lime	% org: Matter
1. Koto	1.	0 – 15	7.91	0.53	13.37	3.41
	2.	15 – 30	8.00	0.56	13.89	1.88
	3.	30 – 45	8.11	0.83	14.04	1.23
2. Sadu	4.	0 – 15	8.03	0.69	13.92	1.32
	5.	15 – 30	8.12	0.80	14.38	1.41
	6.	30 – 45	8.21	0.90	14.38	0.91
3. Amangar	7.	0 – 15	7.63	0.38	7.13	1.76
	8.	15 – 30	7.82	0.44	7.32	1.02
	9.	30 – 45	7.86	0.43	7.35	0.94
4. Bandagey	10.	0 – 15	7.67	0.41	7.20	1.21
	11.	15 - 30	7.77	0.42	7.47	1.11
	12.	30 - 45	7.79	0.37	7.11	0.79
5. Pirbala	13.	0 - 15	9.11	2.81	17.55	1.49
	14.	15 - 30	9.04	2.65	17.41	1.10
	15.	30 - 45	8.82	1.94	17.33	0.18
6. Thalash	16.	0 - 15	8.13	0.78	16.24	1.18
	17.	15 - 30	8.18	0.87	16.19	1.02
	18.	30 - 45	8.21	0.87	16.39	0.92
7. Nagoman	19.	0 - 15	7.70	0.39	10.15	1.12
	20.	15 - 30	7.78	0.39	10.33	0.95
	21.	30 - 45	8.01	0.44	10.92	0.80
8. Gul	22.	0 - 15	8.05	0.73	9.87	0.98
	23.	15 - 30	8.12	0.72	9.53	0.91
	24.	30 - 45	8.15	0.68	9.21	0.57
9. Hassan	25.	0 - 15	8.20	0.88	5.17	1.31
	26.	15 - 30	8.29	0.96	5.68	0.87
	27.	30 - 45	8.29	0.90	5.78	0.31
10.Makhey	28.	0 - 15	8.19	0.72	4.43	1.19
	29.	15 - 30	8.26	1.03	4.64	0.82
	30.	30 - 45	8.33	0.97	4.88	0.63

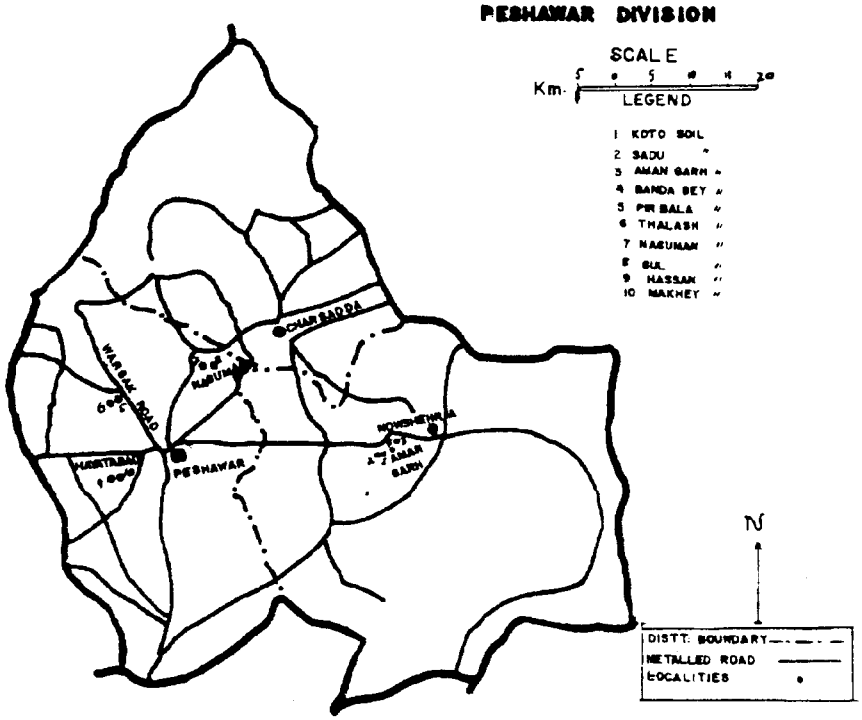
Table 3: Ranges and Average Values of Physico-Chemical Properties of Soil Samples Collected from Peshawar and Nowshera

Physico chemical characteristics	Units	Topsoil (0-15cm)	Sub Soil (30-45cm)
PH	–	7.63-9.11 (8.06)	7.79-8.82 (8.18)
EC	dsm^{-1}	0.38-2.81 (0.83)	0.37-1.94 (0.83)
$CaCO_3$	%	4.43-17.55 (10.50)	4.88-17.33 (1075)
Organic matter	%	0.98-3.41 (1.5)	0.18-1.23 (0.73)
Sand	%	8-68 (23.8)	6-57 (24.2)
Silt	%	24-78 (55.5)	19-80 (54.4)
Clay	%	6-39 (21.7)	8-44 (21.4)

1). The variation in texture might be due to parent material and the kind of loess deposition that might have taken place at their respective sites. The distribution of sand content was not consistent. Silt was the dominant fraction of most of the soils. The majority of the soils are either silty-clay loam or silty-loam. In majority of the soils, silt content decreased with depth. The clay content varied depth wise and in most cases, it increased with depth which indicates clay migration downward.

The pH value in surface soils (0-15 cm) ranged from 7.63 to 9.11 with an average value of 8.06. In sub-soils (30-45 cm), the pH value ranged from 7.79 to 8.82 with an average value of 8.18. The pH value in all soils increased with depth except soil samples collected from pirbala site which had higher pH values of 9.11 and 9.04 in the 0-15 and 15-30 cm and 8.82 at 30-45 cm.This site having higher pH values in the surface is affected by activities of marble industry. The relatively low pH values of the surface soils in all other sites could be associated with microbial activities.

The EC value in surface soils (0-15 cm) varied from 0.38 to 2.81 with an average value of 0.83 dsm^{-1}. In sub-soil (30-45 cm), the EC value ranged from 0.37 to 1.94 with an average value of 0.83 dsm^{-1}. The EC value slightly increased with depth, which indicated the downward movement of salts. The highest values of 2.81, 2.65 and 1.94 dsm^{-1} observed in soil No. 5, located near marble industry might be due to deposition of dust fall containing salts. However, all the soils were non-saline and will present no problem to agricultural crops except soil No. 5 which may create slight salinity problem over a longer period of time [8].



Appendix-1 Map showing the different Soil sites.

The lime content in surface soils (0-15 cm) varied from 4.43 to 17.55 with an average content of 10.50% while in sub-soils (30-45 cm), it ranged from 4.88 to 17.33 with an average value of 10.75%. In majority of soils, the lime content increased with depth which might be due to $CaCO_3$ precipitation in subsoils. Higher value of 17% in pirbala soils suggests the effect of dustfall deposition produced by marble industry. All the soils are moderate to highly calacareous which can influence the solubility and bioavailability of trace elements to plants due to sorption/ chemosorption processes [2]. Generally the lime content of NWFP soils ranges between 3.85 to 24. 2% [9].

The organic matter content in surface-soils (0-15cm) varied from 0.98 to 3.41% with an average value of 1.5%. The organic matter content in sub-soils (30-45cm) ranged from 0.18 to 1.23% with an average value of 0.73%. The organic matter content showed a reverse trend to that of pH, EC. $CaCO_3$ and clay content i.e. organic matter content decreased with depth which showed organic matter accumulation on surface soils due to addition of organic material from the industrial/municipal wastes or addition of crop residues. The highest value of 3.41% observed in the surface soil (0-15cm) samples in Koto site could be associated with addition of farm yard manure.

AB-DTPA extractable heavy metals concentrations:

The ranges and average values of AB-DTPA extractable heavy metals Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb in soils are presented in Tables 4,5 and 6.

The AB-DTPA Extractable Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb ranged from 3.45-10.56, 4.18-39.86, 12.30-28.10, 8.25-26.80, 0.03-0.09, 0.71-7.11, 0.90-20.64, 1.00-4.40, 1.00-6.20 and 0.43-2.20 mg/kg with the average values of 7,18.09,20.61,17.39,0.06,2.40,5.71,2.63,2.06 and 1.19 mg/kg respectively in surface soils (0-15cm). In the sub-soils (30-45 cm), the concentrations of Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb ranged from

Table 4:: AB-DTPA Extractable Concentrations of Cu, Fe, Mn, Zn and Cd (mg/Kg) soil samples collected from Peshawar and Nowshera

Soil Series	Sample No.	Depth (cm)	Cu	Fe	Mn	Zn	Cd
1. Koto	1.	0 – 15	8.53	39.86	19.39	9.27	0.08
	2.	15 – 30	8.28	42.52	18.68	8.05	0.06
	3.	30 – 45	6.38	41.88	18.00	7.57	0.06
2. Sadu	4.	0 – 15	4.65	38.71	18.77	9.30	0.07
	5.	15 – 30	4.39	37.04	17.08	7.35	0.05
	6.	30 – 45	4.39	37.00	16.93	7.22	0.03
3. Amangar	7.	0 – 15	6.98	19.22	20.69	9.90	0.07
	8.	15 – 30	5.19	19.00	24.70	9.69	0.05
	9.	30 – 45	5.00	18.57	24.90	6.86	0.02
4. Bandagey	10.	0 – 15	5.30	19.04	25.15	8.25	0.05
	11.	15 – 30	4.52	18.31	24.35	7.03	0.05
	12.	30 – 45	4.31	18.30	24.30	6.49	0.01
5. Pirbala	13.	0 – 15	10.56	17.11	28.45	21.35	0.04
	14.	15 – 30	10.00	16.97	30.00	20.64	0.03
	15.	30 – 45	9.35	16.00	27.30	18.45	0.03
6. Thalash	16.	0 – 15	10.21	16.66	28.10	18.31	0.03
	17.	15 – 30	9.83	16.49	28.65	15.80	0.02
	18.	30 – 45	9.61	15.83	29.67	14.30	0.02
7. Nagoman	19.	0 – 15	9.41	12.06	18.70	26.80	0.09
	20.	15 – 30	9.40	10.69	16.37	26.31	0.11
	21.	30 – 45	8.54	10.71	14.99	23.85	0.03
8. Gul	22.	0 – 15	6.91	9.50	12.30	23.75	0.06
	23.	15 – 30	8.84	7.76	12.50	23.35	0.03
	24.	30 – 45	8.85	7.71	13.71	22.50	0.02
9. Hassan	25.	0 – 15	4.03	4.60	17.65	26.00	0.08
	26.	15 – 30	3.75	3.63	16.52	26.05	0.06
	27.	30 – 45	3.55	3.29	14.44	24.78	0.05
10. Makhey	28.	0 – 15	3.45	4.18	16.87	20.97	0.07
	29.	15 – 30	2.72	3.89	16.66	21.13	0.03
	30.	30 – 45	2.12	3.18	16.54	19.82	0.01

Table 5: AB-DTPA Extractable Concentrations of Co, Ni, Mo, Cr, and Pb (mg/Kg) in soil samples collected from Peshawar and Nowshera

Soil Series	Sample No.	Depth (cm)	Co	Ni	Mo	Cr	Pb
1. Koto	1.	0 – 15	2.60	14.00	1.22	1.47	2.06
	2.	15 – 30	2.20	13.67	1.00	1.19	1.80
	3.	30 – 45	2.03	11.98	0.90	1.03	1.69
2. Sadu	4.	0 – 15	2.24	4.17	1.00	1.30	1.32
	5.	15 – 30	1.99	4.17	0.50	1.05	1.26
	6.	30 – 45	1.49	2.24	0.48	0.91	1.12
3. Amangar	7.	0 – 15	2.00	20.64	4.00	2.02	2.20
	8.	15 – 30	0.44	20.19	2.36	1.72	1.10
	9.	30 – 45	0.41	19.80	2.21	1.57	1.08
4. Bandagey	10.	0 – 15	0.71	4.61	2.33	1.60	0.97
	11.	15 – 30	0.69	2.47	2.00	1.35	0.58
	12.	30 – 45	0.53	2.18	1.77	1.07	0.46
5. Pirbala	13.	0 – 15	7.11	3.40	2.38	1.91	0.65
	14.	15 – 30	5.58	2.66	1.98	1.50	0.41
	15.	30 – 45	5.09	2.18	2.07	2.11	0.40
6. Thalash	16.	0 – 15	2.07	2.07	1.90	1.78	0.43
	17.	15 – 30	2.13	1.99	1.17	1.95	0.39
	18.	30 – 45	2.50	1.42	1.17	2.00	0.37
7. Nagoman	19.	0 – 15	3.00	1.60	2.80	6.02	1.03
	20.	15 – 30	2.70	1.00	1.89	5.59	0.98
	21.	30 – 45	2.10	0.76	1.81	4.98	0.87
8. Gul	22.	0 – 15	2.27	0.90	2.50	2.35	1.09
	23.	15 – 30	2.20	0.60	1.80	2.33	0.08
	24.	30 – 45	2.22	0.50	1.67	2.10	0.08
9. Hassan	25.	0 – 15	0.98	3.15	4.40	1.00	1.19
	26.	15 – 30	0.91	3.08	3.65	0.69	0.55
	27.	30 – 45	0.51	3.01	2.42	0.51	0.53
10.Makhey	28.	0 – 15	1.06	2.59	3.77	1.20	0.99
	29.	15 – 30	0.93	1.82	2.66	0.23	0.45
	30.	30 – 45	0.45	1.55	3.65	0.23	0.44

Table 6: Ranges and Average Values of AB-DTPA Extractable Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb. (mg/kg) soil samples collected from Peshawar and Nowshera

Matel	Topsoil (0-15cm)	Subsoil (30-45cm)
Cu	3.45-10.56 (7.00)	2.12-9.61 (6.21)
Fe	4.18-39.86 (18.09)	3.18-41.88 (17.25)
Mn	12.30-28.10 (20.61)	13.71-29.67 (20.08)
Zn	8.25-26.80 (17.39)	6.49-24.78 (15.18)
Cd	0.03-0.09 (0.06)	0.01-0.06 (0.03)
Co	0.71-7.11 (2.40)	0.51-5.09 (1.73)
Ni	0.90-20.64 (5.71)	0.50-19.80 (4.56)
Mo	1.00-4.40 (2.63)	0.48-3.65 (1.82)
Cr	1.00-6.20 (2.06)	0.23-4.98 (1.65)
Pb	0.43-2.20 (1.19)	0.37-1.69 (0.70)

2.12-9. 61 , 3.18-41.88,13.71-29.67,6.49-24.78,0.01-0.06,0.51-5.09,0.50-19.80,0.48-3.65, 0.23-4.98 and 0.37-1.69 mg/kg with average values of 6.21, 17,25,20.08, 15.18, 0.03, 1.73, 4.56, 1.82, 1.65 and 0.70 mg/kg respectively. In general, the concentrations of extractable heavy metals decreased with increase in depth. This might be due to its adsorption on clay or organic matter or due to inputs from industrial sources.

According to the established criteria of Havlin and Sultanpour (1981) [10], all the soils studied are adequate in Cu, Fe, Mn and Zn, in terms of their concentrations for agricultural crops.

The values of Cd are transitional between normal and contaminated soils. The concentration of Cd in typical soils may be less than 0.1 mg/kg [11] and higher value has been reported in contaminated soil [2]. The concentration of Ni was the highest (20.64, 20.19 and 19.80 mg/kg) in soil samples collected from soil No. 3 (Amangarh), located at a

Appendix – II: Name, Location, Cropping Pattern and History of Sampling Fields.

S. No	Soil Series	Location	Cropping Pattern	History of Sampling Field
1.	KOTO	150m, North East of Feroz Sons Labs: Nowshera	Maize, Wheat, Sugar Cane, Recently wheat was harvested	Samples were collected from the field of Iqrar Khan on May 16, 1997. D.A.P., FYM., Urea.
2.	SADU	100m North West of Feroz Sons Labs. Nowshera.	Maize, Wheat, Sugar Cane, Recently wheat was harvested	Samples were collected from the field of Ifthikhar on May 16, 1997. D.A.P., F.Y.M., Urea.
3.	AMANGAR	200m North East of Associated Ghee mills Nowshera,	Maize, Wheat, Grain, Recently wheat was harvested	Samples were collected from the field of Haji Saeed on May 18, 1997. D.A.P., F.Y.M., Urea.
4.	BANDAGEY	400m North of Associated Ghee Mills and 300m South of main Road.	Maize, Wheat, Recently wheat was harvested	Samples were collected from the field of Yasir on May 18, 1997. D.A.P.,F.Y.M., Urea
5.	PIR BALA	100m. South of Avon Marble Industry, Warsak Road Peshawar.	Wheat, Recently wheat was harvested	Samples were collected from the field of Yasir on May 20, 1997 D.A.P., Urea
6.	THALASH	200 m West of Avon Marble Industry, Warsak Road Peshawar	Fodder, Maize, Grasses Recently Grasses were removed	Samples were collected from the field of Gul Amin on May 20, 1997 D.A.P., F.Y.M., Urea
7.	NAGUMAN	50m, East of the tannery industry, Charsadda Road.	Wheat, Recently wheat was harvested	Samples were collected from the field of Haji Anwar on May 23, 1997. D.A.P.,F.Y.M., Urea
8.	GUL	120m, North-East of the Tannery industry, Charsadda Road.	Wheat, Recently wheat was harvested	Samples were collected from the field of Hashim Khan on May 23, 1997. D.A.P., Urea
9.	HASSAN	70m, North East of Hassan PHarmaceuticals and Frontier Cotton Mills, Hayatabad, Peshawar.	Vegetables,	Samples were collected from small orchards of Saleem Khan on May 26, 1997.
10.	MAKHEY	200m, North West of Hassan PHarmaceuticals and Frontier Cotton Mills, Hayatabad, Peshawar.	Un cultivated	Samples were collected from uncultivated fields on May 26, 1997

distance of 300 m from Associated Ghee mills, Nowshera. It could be associated with the effect of industrial effluents of Associated Ghee mills. The higher values of Cr in soil No.7 (6.02, 5.59 and 4.98 mg /kg) and soil No. 8 (2.35,2.33 and 2.10 mg/kg) which are located in the vicinity of Tannery industry could be associated with effect of industrial effluents from Tannery industry. The somewhat high concentration of Pb in soil No.1 and 3 could be associated with aerial dust fall as well as effect of industrial effluents.

An effort was made to study the correlation between physico-chemical properties and AB-DTPA extractable heavy metals concentrations. However, no trend was observed between the parameters studied. It might be due to the reason that soils of different areas were collected which have different thermodynamic conditions and it is possible that other geochemical properties and /or anthropogenic factors are controlling the solubility and mobility of these elements in soils [2,12].

Experimental

Collection and preparation of soil samples:

Thirty (30) soil samples, each of about 1kg, were collected by the usual procedure from ten (10) different soils of Peshawar and Nowshera districts. Three samples from depths of 0-15, 15-30 and 30-45

cm, respectively were collected from each soil. Care was taken to select soil which was expected to be affected by industrial effluents and near that another soil was selected which was not affected by industrial effluents. All the samples were collected in the shiny days of the month of may 1997, with the help of a wooden tool to avoid contamination of the soils with any of the element being studied. The name, location, cropping pattern and history of each soil is indicated in Appendix- II. The soil No. 1,3,5,7 and 9 are polluted by industrial effluents while No. 2,4,6,8, and 10 are the non-polluted soils.

Soil samples were air dried in shade, ground with a wooden mortor and sieved through a 2mm nylon mesh size sieve. The samples were then tightly packed in polythene bags and labeled.

Analysis of soil samples:

soil samples were analyzed for soil pH, electrical conductivity (EC), texture, organic matter, lime content and for extractable heavy metals (Table 1-6).

The pH and EC of the collected soil samples were determined in 1:1 soil and water suspension by using pH meter model HI 8418 (Hanna) and conductivity meter model pcm 3 (Jenway) respectively at $25C^0$ [13]. Texture was determined by Bouyoucos hydrometer method using Na_2CO_3 as dispersing agent, as described by Koehler *et al* [14]. Organic matter in each soil sample was determined by Walkley and Black method as recommended by Jackson [15]. The percent organic matter was calculated by using the following formula.

$$\% \text{ organic matter} = \frac{\text{meq } K_2Cr_2O_7 \text{ used} - \text{meq } FeSO_4.7H_2O \text{ used}}{\text{Wt : (g) of soil sample}} \times 0.03 \times 100 \times f$$

Where "f" value of 1.3 is derived from the assumption that only 75% of the organic matter is oxidized.

Lime content was determined by the acid neutralization method according to Black [16]. The percent $CaCO_3$ was calculated by the following formula.

$$\% CaCO_3 = \frac{\text{meq HCl used} - \text{meq NaOH used}}{\text{Wt : (g) of soil sample}} \times 0.05 \times 100$$

Extractable heavy metals in each soil sample were estimated with the help of atomic absorption spectrophotometer model Perkin Elmer 2380 USA, by using NH_4HCO_3-DTPA extracting solution, as described by Halvin and Sultanpour [10].

Preparation of soil sample solution:

20ml NH_4HCO_3-DTPA extracting solution was added to exactly 10 g weighed air dried soil sample and shaken for15 minutes. After shaking, the suspension was filtered through whatman filter paper No. 42. The filtrate was then analyzed for extractable Cu, Fe, Mn, Zn, Ni, Mo, Co, Cd, Cr and Pb, using atomic absorption spectrophotometer.

Conclusion:

1. All the soil samples understudy were adequate in Cu, Fe, Mn and Zn which are essential for agricultural crops.
2. Relatively higher concentrations of the extractable heavy metals were found in contaminated soils than in non-contaminated soils.
3. The high concentrations of Ni in soil No. 3 and Cr in soil No.7 may cause potential hazard for some agricultural crops as well as animals grazing on these soils, over longer period of time.
4. The distribution of AB-DTPA extractable heavy metals decreased with depth i.e. maximum on the topsoil and minimum downward.
5. No correlation or very poor correlation was found between the AB-DTPA extractable concentrations of heavy metals and soil properties.

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