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Physico-Chemical Analysis of Industrial Area Soils at Karaikal, India

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Abstract : Soil samples were collected from an industrial area at Karaikal, Puducherry State, India for Physico-chemical analysis. The following parameters such as pH, electrical conductivity, organic carbon (OC), total hardness (TH), and contents of elements like, potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), copper (Cu) and zinc (Zn) were determined. Correlation coefficients are calculated for the soil parameters.
Keywords: Industrial area soils, Parameters, Trace elements, Statistical analysis.

1. Introduction

Soil is one of the important and valuable resources of the nature. All living things are directly and indirectly dependent on soil for day to day needs and 95 % of the human food is derived from the earth. Making plan for having healthy and productive soil is essential to human survival. Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical and mineralogical characteristics. Soil is composed of particles of broken rock that have been altered by chemical and mechanical processes that include weathering and erosion. The most possible sources of soil, water and plant pollutionsare sewage sludge, residues of industrial factories and intensive fertilization. In suburban areas, the use of industrial waste water is common practice in many parts of the world [1, 2] including India [3]. The use of sewage effluents for irrigating agricultural land is a worldwide practice [1]. Industries have taken up so many processes. Due to discharge of effluents, industrial area soils get contaminated. Soil pollution is caused by the presence of xenobiotic and other alteration in the natural soil environment. Usage of pesticides, leakage of storage tanks, oils etc can cause soil pollution. Dumping of waste material can leach the toxic substance and penetrate towards soil [4] and may cause underground water pollution also. Commonly used chemicals for the production, machineries, treatment of petroleum, hydrocarbons, pesticides, lead and other chemicals could cause soil contaminations [5].

2. Material and Methods

2.1. Study area and collection of soil samples

Soil samples were collected from an industrial area near Karaikal Port at Karaikal, Pondicherry State, India using standard procedures [6]. The geological formation of the soil of the area is sandy loam of Karaikal in Pondicherry State, India. Fig. 1 shows the location of sampling area (different sites) in the industrial area. Thirty six soil samples were selected for this study using Physico-chemical analysis. Each location is separated by a distance of 100 m approximately. In each site, three samples were collected, one at the surface level, second at 15 cm depth from the surface and the third at 30 cm depth. All 36 samples were dried at room

temperature in open air for two days and stored in black polythene bags. The soil samples are ground well into a fine powder by using an agate mortar. The soil samples were oven dried at 60°C for two hours to remove the moisture content.

Fig.1.

Soil samples were then analysed for various Physico-chemical parameters such as pH, electrical conductivity, organic carbon (OC), total hardness (TH), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), copper (Cu) and zinc (Zn). The above tests were performed as per the standard procedures. Soil test were analysed in Govt. Agriculture and Chemistry, Soil Testing Lab, Perambalur, Tamil Nadu, India.

3. Results and discussion

3.1. Physico-chemical analysis of soil samples

The present investigation aims to assess the status of soil from an industrial area. The Physico-chemical parameters like pH, electrical conductivity, organic carbon (OC), total hardness (TH), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), copper (Cu) and zinc (Zn) contents of soil samples were estimated. The Physico-chemical analysis of soils from four canals at different samples sites (S1-S36).

3.2. pH and electrical conductivity

pH is a measure of the hydrogen ion concentration i.e. acidity or alkalinity of the soil. pH can affect the availability of nutrients and activity of many essential micro-organisms. Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics [7, 8]. pH of all soil samples (I - IV canals) were found to range between 6.2 to 7.8, 6.0 to 8.2, 6.2 to 7.9 and 6.1 to 8.4, respectively, which indicated the slight alkalinity of soils as presented in Tables 1-4. The higher value of 8.4 has been observed in sample S33 at site-2 (30cm depth) of Fourth canal and lower value of 6.0 has been observed in sample S30 at site-1 (surface layer) of Second canal.

The unit of electrical conductivity is µS/cm. Electrical conductivity of soil of 1 – 4 canals ranges between 0.198 to 0.422, 0.245 to 0.545, 0.234 to 0.372 and 0.176 to 0.288 respectively. The higher value of 0.545µS/cm has been observed for S18 sample at site-3 (30cm depth) of Second canal and lower value of 0.176 µS/cm has been observed for S32 sample at site-2 (15cm depth) Fourth canal [9].

3.3. Organic carbon

Soil organic carbon plays an important role as a source of plant nutrients and in maintaining the soil integrity. Organic carbon values of soil samples in all canals have been observed in the range from 0.42 to 1.22 %, 0.32 to 0.63%, 0.58 to 1.10% and 0.42 to 0.96 %, respectively. The higher value of 1.22% has been observed for S6 sample at site-2 (30cm depth) of First canal and the minimum value of 0.32 % is recorded for S16 sample of Second canal (site-3: surface layer) as shown in Tables 1-4.

Table-1 Physico-chemical analysis of industrial area soils in First canal (S_1-S_9)

parameters	Site-1 (0 cm)			Site-2 (100cm)			Site-3 (200 cm)			Desirable limit
	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	
	S1	S2	S3	S4	S5	S6	S7	S8	S9	
pH	6.2	6.5	7.0	7.3	7.1	7.8	6.5	6.8	7.2	5.5-8.0
EC (µS/cm)	0.198	0.215	0.242	0.220	0.232	0.250	0.352	0.380	0.422	Agreeable
OC (%)	0.82	0.97	1.15	1.08	1.20	1.22	0.45	0.42	0.48	2%
TH (mg/l)	150	162	168	120	115	128	142	164	170	300 mg/l
K (Kg/ha)	98.20	120.40	152.3	112.00	165.1	185.10	255.50	264.20	295.00	150-250 Kg/ha
Ca (mEq/l)	0.86	0.90	0.92	0.78	0.80	0.83	0.98	1.05	1.10	7.5 mEq/l
Mg (mEq/l)	0.40	0.52	0.56	0.35	0.38	0.45	0.86	0.89	0.92	4 mEq/l
Na (mEq/l)	2.20	2.35	2.38	3.25	3.32	3.38	4.50	4.54	4.60	2 mEq/l
Fe (ppm)	5.42	5.54	6.28	4.81	4.88	4.92	5.37	5.62	5.90	2.5-4.5 ppm
Cu (ppm)	0.52	0.60	0.65	0.92	0.98	1.15	0.34	0.42	0.48	0.2 ppm
Zn (ppm)	2.15	1.98	1.65	1.20	1.28	1.42	0.80	0.86	0.97	0.4-1.2 ppm

Table- 2 Physico-chemical analysis of industrial area soils in Second canal (S_{10}-S_{18})

Parameters	Site-1 (0 cm)			Site-2 (100cm)			Site-3 (200 cm)			Desirable limit
	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	
	S10	S11	S12	S13	S14	S15	S16	S17	S18	
pH	6.0	6.7	6.9	6.8	6.6	7.0	7.4	7.6	8.2	5.5-8.0
EC (µS/cm)	0.245	0.262	0.278	0.362	0.398	0.420	0.441	0.534	0.545	Agreeable
OC (%)	0.52	0.61	0.63	0.34	0.35	0.36	0.32	0.33	0.36	2%
TH (mg/l)	98	90	102	208	219	231	182	188	199	300 mg/l
K (Kg/ha)	165.20	188.10	232.20	75.40	84.20	98.40	345.50	364.20	386.10	150-250 Kg/ha
Ca (mEq/l)	0.65	0.68	0.72	0.50	0.55	0.56	0.77	0.79	0.83	7.5 mEq/l
Mg (mEq/l)	0.98	1.10	1.23	0.50	0.53	0.55	0.63	0.68	0.70	4 mEq/l
Na (mEq/l)	4.23	4.30	4.35	4.05	4.10	4.13	3.20	3.30	3.35	2 mEq/l
Fe (ppm)	6.30	6.48	6.57	7.10	7.22	7.45	4.28	4.34	4.41	2.5-4.5 ppm
Cu (ppm)	0.96	1.12	1.19	0.62	0.65	0.70	0.80	0.84	0.90	0.2 ppm
Zn (ppm)	0.90	0.96	1.10	2.20	2.42	2.65	1.53	1.62	1.80	0.4-1.2 ppm

Table-3 Physico-chemical analysis of industrial area soils in Third canal (S_{19}-S_{27})

Parameters	Site-1 (0 cm)			Site-2 (100cm)			Site-3 (200 cm)			Desirable limit
	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	
	S19	S20	S21	S22	S23	S24	S25	S26	S27	
pH	7.7	7.5	7.2	6.2	6.4	6.7	7.0	7.5	7.9	5.5-8.0
EC (µS/cm)	0.310	0.284	0.325	0.351	0.364	0.372	0.250	0.234	0.265	Agreeable
OC (%)	0.96	0.98	1.10	0.58	0.69	0.73	0.85	0.87	0.90	2%
TH (mg/l)	146	132	120	118	129	138	125	144	156	300 mg/l
K (Kg/ha)	124.00	128.10	137.20	440.00	456.00	462.10	200.00	212.20	225.50	150-250 Kg/ha
Ca (mEq/l)	0.96	0.99	1.06	1.15	1.18	1.22	1.68	1.75	1.85	7.5 mEq/l
Mg (mEq/l)	0.54	0.56	0.58	0.60	0.65	0.67	0.43	0.47	0.50	4 mEq/l
Na (mEq/l)	3.75	3.78	3.82	3.90	4.10	4.20	1.68	1.75	1.80	2 mEq/l
Fe (ppm)	5.65	5.70	5.78	6.18	6.25	6.35	3.23	3.45	3.70	2.5-4.5 ppm
Cu (ppm)	1.05	1.10	1.17	0.65	0.68	0.73	1.15	1.20	1.24	0.2 ppm
Zn (ppm)	3.64	3.87	4.06	0.60	0.67	0.72	2.78	2.85	2.96	0.4-1.2 ppm

Table-4 Physico-chemical analysis of industrial area soils in Fourth canal (S_{28}-S_{36})

Parameters	Site-1 (0 cm)			Site-2 (100cm)			Site-3 (200 cm)			Desirable limit
	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	Surface layer	15 cm depth	30 cm depth	
	S28	S29	S30	S31	S32	S33	S34	S35	S36	
pH	6.6	6.8	7.3	7.8	8.0	8.4	6.1	6.4	6.7	5.5-8.0
EC (µS/cm)	0.262	0.278	0.288	0.187	0.176	0.195	0.231	0.235	0.240	Agreeable
OC (%)	0.42	0.44	0.47	0.51	0.53	0.58	0.88	0.92	0.96	2%
TH (mg/l)	202	236	248	91	112	123	169	178	184	300 mg/l
K (Kg/ha)	86.10	88.10	96.20	124.20	135.50	141.00	422.10	428.20	435.00	150-250 Kg/ha
Ca (mEq/l)	0.43	0.52	0.55	0.87	0.95	1.02	0.75	0.95	1.07	7.5 mEq/l
Mg (mEq/l)	0.56	0.60	0.62	0.51	0.54	0.60	0.55	0.58	0.61	4 mEq/l
Na (mEq/l)	4.05	4.10	4.17	3.30	3.35	3.42	3.25	3.28	3.40	2 mEq/l
Fe (ppm)	5.20	5.35	5.42	6.10	6.18	6.25	6.98	7.25	7.50	2.5-4.5 ppm
Cu (ppm)	0.55	0.60	0.63	0.98	1.04	1.10	0.92	0.98	1.05	0.2 ppm
Zn (ppm)	3.20	3.08	2.95	4.00	4.35	4.22	1.02	1.25	1.36	0.4-1.2 ppm

3.4. Total hardness

The hardness values are shown to range from 115 mg/l to 170 mg/l, 90 to 231 mg/l, 118 to 231 mg/l and 91 to 248 mg/l as presented in Tables 1-4. The maximum TH value of 248 mg/l has been observed in S30 sample at site-1 (30cm depth) of Fourth canal and lower value of 90 mg/l has been observed in of S11 sample at site-1 (15cm depth) of Second canal.

3.5. Potassium (K)

Potassium is an essential nutrient; it has an important role in the growth of plants. Potassium values of soil samples in the canals have been observed in the range between 112 to 295 kg/ha, 75.4 to 386.1 kg/ha, 124 to 462.1 kg/ha and 86.1 to 435 kg/ha, as presented in Tables 1-4. The higher value of 462.1 Kg/ha has been observed in S24 sample at site-2 (30cm depth) of Third canal and lower value of 123 Kg/ha has been observed in S13 sample at site-2 (surface layer) of Second canal [10].

3.6. Calcium, magnesium and sodium

Calcium is an important nutrient required for organism. Calcium concentration of soil samples in all canals have been observed in the ranges between 0.80 to 1.10 mEq/l, 0.50 to 0.83 mEq/l, 0.96 to 1.85 mEq/l and 0.43 to 1.07 mEq/l, as presented in Tables 1-4. The maximum value of 1.85 mEq/l has been observed in Third canal, S27 sample at site-3 (30cm depth) and lower value of 0.43 mEq/l has been observed in Fourth canal, S28 sample at site-1 (surface layer). Calcium and magnesium are directly related to hardness. Magnesium concentration of soil samples in individual canals have been observed in the ranges between 0.35 to 0.92 mEq/l, 0.50 to 1.23 mEq/l, 0.43 to 0.67 mEq/l and 0.51 to 0.62 mEq/l as presented in Tables 1-4. The higher value of 1.23 Meq/l has been observed in Second canal, S12 sample at site-1 (30cm depth) and lower value of 0.35 mEq/l has been observed in First canal, S4 sample at site-2 (surface layer). Sodium concentrations of soil samples in all canals were found in between 2.20 to 4.60 mEq/l, 3.20 to 4.35 mEq/l, 1.68 to 4.20 mEq/l and 3.25 to 4.17 mEq/l, respectively as presented in Tables 1-4. The higher value of 4.35 mEq/l has been observed in Second canal, S12 sample at site-1 (30cm depth) and lower value of 1.68 mEq/l has been observed in Third canal, S25 sample at site-3 (surface layer) [7, 8].

3.7. Iron, copper and zinc

Iron is essential for chlorophyll and protein formation, photosynthesis, electron transfer oxidation and reduction of nitrates and sulphates and other enzyme activities. Iron content in individual canal of soil samples (S1-S36) varies from 4.81 ppm to 5.90 ppm, 4.28 ppm to 7.22 ppm, 3.23 ppm to 6.355 ppm and 5.20 ppm to 7.50 ppm respectively, as presented in Tables 1-4. The higher value of 4.12 ppm has been observed in Fourth canal, S36 sample at site-3 (30cm depth) and lower value of 3.23ppm has been observed in Third canal, S25 sample at site-3 (surface layer). Copper content in all soil samples (S1-S36) varies from 0.34 ppm to 1.15 ppm, 0.62 ppm to 1.19 ppm, 0.65 ppm to 1.24 ppm and 0.55 ppm to 1.10 ppm. The higher value of 1.24 ppm has

been observed in Third canal, S27 sample at site-3 (30cm depth) and lower value of 0.34 ppm has been observed in First canal, S7 sample at site-3 (surface layer) [7, 8].

Zinc content in all soil samples (S1-S36) varies from 0.80 ppm to 2.15 ppm, 0.90 ppm to 2.65 ppm, 0.60 ppm to 4.06 ppm and 1.02 ppm to 4.35 ppm respectively, as presented in Tables 1-4. The higher value of 4.35 ppm has been observed for Fourth canal, S32 sample at site-2 (15cm depth) and lower value of 0.60 ppm has been observed in Third canal, S22 sample at site-2 (surface layer) [7, 8, 11]. The mean and standard deviation and the relative distribution of parameters in soil samples of four canals are shown in Table 5.

Table-5 The mean and standard deviation of industrial area soils of four canals

Parameters	First canal		Second canal		Third canal		Fourth canal		F value	p value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
pH	6.933	0.490	7.022	0.638	7.122	0.591	7.122	0.792	0.183	0.907NS
EC (µS/cm)	0.279	0.083	0.387	0.111	0.306	0.051	0.232	0.040	6.495	0.001S
OC (%)	0.866	0.335	0.424	0.126	0.851	0.161	0.634	0.220	7.727	0.001S
TH (mg/l)	146.556	21.302	168.556	55.973	134.222	12.775	171.444	54.222	5.246	0.003S
K (Kg/ha)	183.089	72.294	215.478	123.620	265.011	145.552	217.378	159.518	0.610	0.613NS
Ca (mEq/l)	0.913	0.111	0.672	0.116	1.316	0.346	0.790	0.237	13.935	0.000S
Mg (mEq/l)	0.592	0.233	0.767	0.268	0.556	0.080	0.574	0.037	3.550	0.004S
Na (mEq/l)	3.391	0.972	3.890	0.466	3.198	1.101	3.591	0.392	1.246	0.310 NS
Fe (ppm)	5.416	0.492	6.017	1.308	5.143	1.291	6.248	0.846	2.189	0.009S
Cu (ppm)	0.673	0.279	0.864	0.200	0.997	0.240	0.872	0.216	2.887	0.050S
Zn (ppm)	1.368	0.480	1.687	0.639	2.461	1.420	2.826	1.311	3.738	0.021S

S- Significant, NS-Not Significant

One way ANOVA method for parameters for soils of four canals was performed. While comparing the soil samples of four canals, it is maintained that the probability of dependence will be significant when 'p' values are less than 0.05. The Figs. 2 shows the relative distribution of parameters in soil samples I to IV canals in a bar diagram. For the soils of four canals, the parameters like pH, EC, OC, TH, and content of potassium, calcium, magnesium, sodium, iron, copper and zinc were observed by using Physico-chemical method. Table 5 shows that the parameters, namely EC, OC, TH, calcium, magnesium, iron, copper and zinc are significant at 0.001 levels; but the remaining parameters (pH, potassium and sodium) are not significant [12-14].

Fig.2 shows that pH is high in Third and Fourth canals of soil samples and low in Second and First canal samples. The electrical conductivity (EC) is high in Second canal and moderate in Third canal samples, when compared to other two canals (First and Fourth) of soil samples. The organic carbon is in higher concentrations in First and Third canal samples and in moderate amount in Fourth canal samples, when comparatively in smaller amount in second canal. The total hardness values of soils are at maximum for Second and Fourth canals and at minimum in First and Second canals. The potassium is present in higher amount in Third canal samples. Moderate amounts were observed in soils of Second and Fourth canals and potassium was present in smaller amounts in First canal soil samples. Calcium is present in higher amount in Third canal samples and in smaller amounts in soils of First, Second and Fourth canals. Magnesium is present in maximum amount in Second canal and in minimum amount in soils of First, Fourth and Second canals. Element sodium is present in predominant amount in samples of all four canals [12].

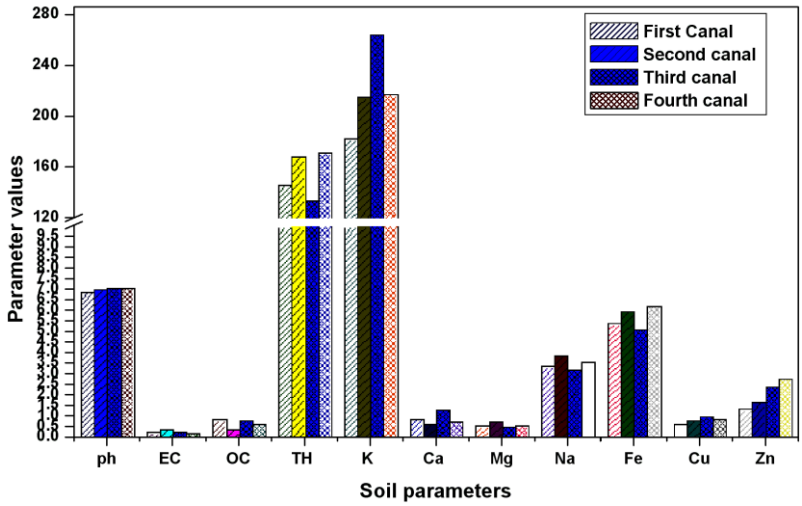

Fig. 2.

Heavy metals, like, iron is in higher amount in soils of Fourth and Second canal samples and in smaller amounts in Third and First canals. Copper is present in maximum amount in soils of Second, Third and Fourth canals and in minimum amount in First canal. Zinc is in higher concentration in Fourth and Third canal samples and has lower concentration in Second and First canals [15].

Table 6 Correlation matrix for industrial area soil parameters of four canals (S1-S36)

Parameters	pH	EC	OC	TH	K	Ca	Mg	Na	Fe	Cu	Zn
pH	1.000										
EC	-0.250	1.000									
OC	-0.098	-0.543	1.000								
TH	0.061	0.032	-0.837	1.000							
K	0.814	0.126	0.099	-0.403	1.000						
Ca	0.352	-0.187	0.774	-0.911	0.689	1.000					
Mg	-0.329	0.847	-0.847	0.535	-0.242	-0.679	1.000				
Na	-0.165	0.488	-0.955	0.882	-0.387	-0.916	0.870	1.000			
Fe	0.165	-0.071	-0.792	0.991	0.336	-0.854	0.432	0.817	1.000		
Cu	0.890	0.166	-0.149	-0.141	0.963	0.473	-0.087	-0.150	0.074	1.000	
Zn	0.954	-0.515	-0.003	0.139	0.634	0.276	-0.489	-0.206	0.264	0.714	1.000

The correlation matrix for physico-chemical elemental content of soils for four canals of the industrial area at sites (S1-S36) is given in Table 6. The result shows that the correlations between the pair of soil parameters observed. In pH with TH, K, Ca, Fe, Cu and Zn there is a positive correlation when compared to other parameters. The parameters of EC, OC, Mg and Na have negative correlation. In EC, there is a positive correlation among the parameters like TH, Ca, Mg, Na and Cu. The parameters of OC, Ca, Fe and Zn show a negative correlation. In OC with K and Ca there is a positive correlation. The parameters of TH, Mg, Na, Fe, Cu and Zn have negative correlation. In TH, there is a positive correlation among the parameters like Mg, Na, Fe and Zn, when compared to other parameters. The parameter of K, Ca and Cu has negative correlation. In K with Ca, Cu and Zn, there is a positive correlation and negative correlation like Mg, Na and Fe. In Fe with Zn. In Mg and Na with Fe, there is a positive correlation when compared to other parameters Cu and Zn. The parameters of Cu with Zn have positive correlation [16].

Table 6 shows the correlations various soil parameters. Soil parameters have both positive and largely negative correlations with their conjugate parameter; hence, distribution of parameters of the industrial area soil is independent of other parameters and random [16].

4. Conclusion

Physico-chemical analysis is a useful tool for the immediate assessment of materials like soil and etc. Parameters such as pH, EC, OC, TH and contents like Potassium, Calcium, Magnesium, Sodium, Iron, Copper and Zinc were determined with the use of this analysis. From the above results, many useful inferences have been drawn up regarding the variation of chemical compositions. Correlation studies have also indicated the contribution of changes in land use and industrial discharge. The values of correlation coefficients will help in selecting proper treatment to minimize pollution.

References

1. Feign A., Ravina I., Shalhevet J., Irrigation with treated sewage effluent: management for environmental protection. Springer, Berlin. 1991.
2. Urie D.H, The status of waste water irrigation of forest University of Washington Press, Seattle, WA, USA, 1986, 26-40.
3. Singh K.P, Mohan D., Sinha S., Dalwani R., Impact assessment of treated/untreated wastewater toxicants discharged by sewage treatment plants on health, agricultural, and environmental quality in the wastewater disposal area, Chemosphere., 2004, 55, 227-255.
4. Synder C., The dirty work of promoting recycling of America's sewage sludge. Int. J. Occup. Environ. Health., 2005,11, 415-27.
5. Davenport J.R., Milburn P.H., Rosen C.J., Thornton R.E., Environmental impacts of potato nutrient management. American. J. potato. Res., 2005, 82, 321-328.
6. APHA, Standard methods for the examination of water and waste water, 21th edition, American Public Health Association, Washington DC, 2005.
7. Solanki H.A., Chavda N.H., Physico-chemical analysis with reference to seasonal changes in soils of Victoria park reserve forest, Bhavnagar (Gujarat). Life. Scie. Leaflets., 2012, 8, 62-68.
8. Pujar K.G., Hiremath S.C., Pujar A.S., Pujeri U.S., Yadawe M.S., Analysis of Physico-Chemical And Heavy Metal Concentration In Soil Of Bijapur Taluka, Karnataka. Sci. Revs. Chem. Commun., 2012, 2, 76-79.
9. Zaiad G.M., Physico-Chemical Analysis of Soils in Al-Khumscity, Libya. J. Appl. Sci. Res., 2010, 6, 1040-1044.
10. Joshi N., Kumar A., Physico-chemical Analysis of Soil and Industrial Effluents of Sanganer Region of Jaipur Rajasthan. Res. J. Agri. Sci., 2 (2011) 354-356.
11. Akbar K.F., Hale W.H.G., Alistair D., Headley and Mohammad Athar. Heavy metal contamination of roadside soils of northern England. Soil & water Res., 2006, 1,158-163.
12. Kulandaivelu V., Bhat R., Changes in the physico-chemical and biological quality attributes of soil following. European J. Soil. Bio., 2012, 50, 39-43.
13. Ratan R.K., Datta S.P., Chhonkar P.K., Suribabu K., Singh A.K., Long term impact of irrigation with sewage effluents on heavy metal contents in soil, crops and ground water—a case study. Agr. Eco.Envi., 2005,109, 310-322.
14. Yadav R.K., Goyal B., Sharma R.K., Dubey S.K., Minhas P.S., Post irrigation impact of domestic sewage effluent on composition of soils, crops and ground water—a case study. Environ. Int., 2002, 28, 481-486.
15. Sumithra S., Ankalaiah C., Janardhana Rao D., Yamuna R.T., A case study on physicochemical characteristics of soil around industrial and agricultural area of Yerraguntla, Kadapa District, A. P, India. Int. J. Geo. Earth & Environ. Sci., 2013, 3, 28-34.
16. Devi S., Premkumar R., physico-chemical analysis of ground samples near industrial area Cuddalore District – Tamilnadu, India, Int. J. ChemTech Res., 2012, 4, 29-34.

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