

# **Assessment of Soil Characteristics and Heavy Metal Contamination in Agricultural Field around Explosive Industry Dhaulpur, Rajasthan, India**

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**ABSTRACT:** The purpose of the study to assess the soil quality and heavy metals (Pb,Cu,Cd ) contamination in agricultural soil around explosive manufacturing industry Dhaulpur, Rajasthan. Fifteen soil samples were collected from different agricultural fields randomly and analysed for PH, EC, Organic carbon and heavy metals (Pb, Cu, Cd) by digital pH meter, digital conductivity meter, walkley &black method and atomic absorption spectrophotometer respectively. The results were compared with WHO and Indian standards. In summer and rainy season Pb concentration ranged from 454 to 694mg/kg, Cu value varied between 253 to 325 mg/kg and Cd concentration ranged from 4.03 to 7.75 mg/kg. In winter season soil sample collected from agricultural field showed Pb concentration from 504 to 687 mg/kg, Cu concentration ranged from 247 to 307 mg/kg and Cd value ranged from 3.54 to 7.53mg/kg. Most of the soil samples showed higher concentration of heavy metals in summer season than winter season and exceed the permissible limit.

**KEYWORDS:** soil quality, contamination, explosive, heavy metal

## **I. INTRODUCTION**

This world has only 4% of freshwater. India is the second highest populated country in the world. There is huge demand of water in India because most of food production depends upon the agriculture [1]. Rapid industrialisation and urbanisation is creating a lot of problems in diverse manners, lack of infrastructure and planning wreaks havoc on the environment. The impact of anthropogenic activities on water bodies has been so extensive that they have lost their self purification capacity to a large extent [2] domestic sewage, industrial effluent and agriculture runoff are the major anthropogenic factors causing water pollution. Lack of appropriate infrastructure to manage these wastes is a major contributor in deterioration of water quality across our country. Safe potable water is enormously essential for life and ground water is one of the important sources for human consumption in both urban as well as rural areas. Ground water is formed from rain water, which reaches the earth surface and percolates into the ground [3]. The ground water quality is a function of natural process as well as anthropogenic activities. Manmade activities, agricultural and industrial use of ground water increased day by day resulting in shortage of ground water. Ground water due to percolation of domestic and industrial waste water and runoff from agricultural land are among the most vulnerable water bodies to pollution. Minor or trace elements are essential for good health if they come from organic or plant source. In contrast if they come from an inorganic or metallic source they become toxic. However it is very important to monitor the level of toxic metals in soil due to environmental concern so the purpose of the study was to determine the physicochemical parameter and heavy metal concentration in soil samples collected from different agricultural field.

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## II. LITERATURE SURVEY

Soil contamination is a severe problem in industrialized and developing countries due to human activities through agriculture, mining, industrial, domestic, traffic, etc [4-5]. These sources contributed to heavy metal contamination in soil. Absorption of heavy metals in soil depends on various factor such as pH, organic matter, season and presence of heavy metal in soil [6] Some metals are essential and non essential. Essential metal for human life are-Mn, Cu, Fe, Zn in appropriate concentration but in excess they become toxic, non essential metals are also at low concentration may pose health hazards to human being. Elevated concentration of heavy metals in soil may decrease soil productivity and also inhibit plant growth. Heavy metals uptake by plants and accumulated in human tissue and biomagnifications through food chain can cause chronic and acute ailments even death. [7-12] Heavy metal adversely affect microbial community, biochemical properties and also inhibits enzymatic activity of soil microbes, change soil microbial profile. [13-15].

## III. METHODOLOGY

**Study Area** Dholpur District formed 15 April 1982, Dholpur (district) of Rajasthan carved out of Bharatpur district. Dholpur district with an area of 3034 sq. km is located in easternmost extremity of the state Rajasthan and is situated within latitude 26°21'19" and 26°57'33" North and longitude 77°13'06" and 78°16'45" East. . The RECL industry manufactured detonator, gunpowder and fuse. Detonator is the primary explosive and formed with lead azide, lead styphnate and fuse head (copper wire).

### Sampling and Analysis

15 soil samples were collected at surface level (0-15 cm depth) from various agricultural fields around RECL industrial area. Samples were stored in polyethylene bags, labelled, properly tied and transported to the laboratory for physicochemical and heavy metal analysis. The soil sample was oven dried at 105<sup>o</sup>c for 24 hrs and sieved using to remove stones, plant roots to uniform the particle size of soil samples. 2 gm oven dried sieved soil sample were taken in 250 ml glass beakers and digested with 8 ml of aqua regia on a sand bath for 2 hr. after evaporation to near dryness, the samples were dissolved with 10 ml of 2 % Nitric acid filtered through Whatman's No.1 filter paper and then dilute with deionized water to give final volumes depending on the suspected level of metals[16].

### Physicochemical And heavy metal analysis

The collected soil sample were analysed for pH, EC and organic carbon. The standard techniques and methods were followed for physical and chemical analysis of soil samples. pH and EC determined by digital pH meter, digital conductivity meter and organic carbon by walkley&black method. Heavy metals (Pb, Cu, and Cd) were analysed by AAS (atomic absorption spectrophotometer).

## IV. RESULT AND DISSCUSION

Results from present and previous studies demonstrated that contaminated soil contains different amount of heavy metals in different soil samples in different seasons. Table -1 shows the soil characteristics and heavy metal concentration in winter season in different soil samples.

**TABLE-1 STUDY OF VARIOUS PARAMETERS IN DIFFERENT SOIL SAMPLES IN WINTER SEASON**

soil samples	Parameter					
	pH	Ec(μs)	org.carbon (%)	Pb(mg/kg)	Cu(mg/kg)	Cd(mg/kg)
S1	8.5	0.38	0.34	687	307	7.53
S2	8.4	0.36	0.31	664	283	7.51
S3	8.45	0.35	0.28	655	292	7.02
S4	8.36	0.34	0.3	608	302	7.14
S5	8.31	0.31	0.33	593	288	6.96

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S6	8.2	0.29	0.36	574	278	6.83
S7	8.18	0.3	0.4	485	269	6.76
S8	8.14	0.26	0.43	544	273	6.53
S9	8.11	0.2	0.46	425	259	6.45
S10	8	0.22	0.52	533	266	6.47
S11	8.04	0.24	0.61	469	256	5.85
S12	8	0.18	0.65	511	247	3.54
S13	7.8	0.18	0.67	504	254	3.86
S14	7.86	0.17	0.67	473	258	4.57
S15	7.7	0.2	0.7	484	274	5.16
min	7.7	0.17	0.28	425	247	3.54
max	8.5	0.38	0.7	687	307	7.53
avg	8.13	0.24	0.48	547.26	273.73	6.14
std.dev	0.241±0.058	0.07±0.01	0.15±0.46	77.08±20.60	17.95±4.63	1.28±0.33
standard	7-9	-	-	250-500	190-270	3-6

In winter season pH varies from 7.7 to 8.5, Ec ( $\mu$ s) ranges from 0.17 to 0.38, organic carbon (%) ranges from 0.28 to 0.7, Pb(mg/kg) varies from 425 to 687, Cu(mg/kg) 247 to 307 and Cd(mg/kg) 3.54 to 7.53.

**TABLE-2 STUDY OF VARIOUS PARAMETERS IN DIFFERENT SOIL SAMPLES IN SUMMER SEASON**

soil samples	Parameters					
	pH	Ec( $\mu$ s)	Org.carbon (%)	Pb(mg/kg)	Cu(mg/kg)	Cd(mg/kg)
S1	8.4	0.38	0.19	694	325	7.75
S2	8.4	0.35	0.16	685	300	7.7
S3	8.39	0.33	0.23	672	310	7.46
S4	8.32	0.31	0.25	643	315	7.28
S5	8.26	0.3	0.24	604	308	7.15
S6	8.2	0.26	0.27	594	295	7.03
S7	8.16	0.28	0.31	496	290	6.96
S8	8.12	0.28	0.32	571	294	6.87
S9	8.05	0.21	0.36	468	281	6.64
S10	7.86	0.24	0.39	554	276	6.72
S11	7.91	0.27	0.43	484	273	6.03
S12	7.94	0.19	0.56	532	261	5.92
S13	7.78	0.21	0.58	515	268	4.15
S14	7.85	0.18	0.62	495	266	4.37
S15	7.76	0.2	0.54	505	287	5.26
min	7.76	0.19	0.19	484	261	4.15
max	8.4	0.38	0.62	694	325	7.75
avg	8.09	0.26	0.36	567.46	289.93	6.4
std.dev	0.23±0.05	0.06±0.01	0.15±0.03	77±19.97	19.25±4.97	1.12± 0.29
standard	7-9	-	-	250-500	135-270	03-06

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Table -2 shows the characteristics and heavy metal concentration in summer season in different soil samples. In summer season pH varies from 7.76 to 8.4,  $E_c(\mu s)$  ranges from 0.19 to 0.38, organic carbon(%) ranges from 0.19 to 0.62, Pb(mg/kg) varies from 468 to 694, Cu(mg/kg) 261 to 325 and Cd(mg/kg) 4.15 to 7.75.

**TABLE-3 STUDY OF VARIOUS PARAMETERS IN DIFFERENT SOIL SAMPLES IN RAINY SEASON**

Soil samples	Parameters					
	pH	$E_c(\mu s)$	Org.carbon (%)	Pb(mg/kg)	Cu(mg/kg)	Cd(mg/kg)
S1	8.2	0.4	0.31	692	320	7.69
S2	8.24	0.37	0.29	681	296	7.58
S3	8.1	0.35	0.25	668	306	7.37
S4	8.08	0.36	0.28	631	308	7.48
S5	8.05	0.33	0.3	607	312	7.09
S6	7.91	0.31	0.32	587	290	6.91
S7	7.84	0.3	0.36	478	277	6.83
S8	7.81	0.25	0.39	565	285	6.74
S9	7.77	0.28	0.44	454	275	6.6
S10	7.6	0.29	0.48	542	270	6.66
S11	7.84	0.3	0.59	480	267	5.97
S12	7.61	0.25	0.61	527	253	5.86
S13	7.5	0.28	0.62	513	260	4.03
S14	7.68	0.26	0.64	490	259	4.18
S15	7.54	0.25	0.68	502	278	5.39
min	7.5	0.25	0.25	454	253	4.03
max	8.2	0.4	0.68	692	320	7.69
avg	7.85	0.30	0.43	561.13	283.73	6.42
std.dev	0.24± 0.06	0.04± 0.01	0.15± 0.03	79.26 ±20.46	20.93 ±5.40	1.13± 0.29
standard	7-9	-	-	250-500	135-270	3-6

Result of table -3 presented the values of different parameters in rainy season in different soil samples. In rainy season pH varies from 7.5 to 8.2,  $E_c(\mu s)$  ranges from 0.25 to 0.40, organic carbon(%) ranges from 0.25 to 0.68, Pb(mg/kg) varies from 454 to 692, Cu(mg/kg) 253 to 320 and Cd(mg/kg) 4.03 to 7.69.

Graphically representation of various parameters is as follows:

**pH**- Absorption of heavy metals is strongly dependent on pH. Sorption increase with increase pH [17].

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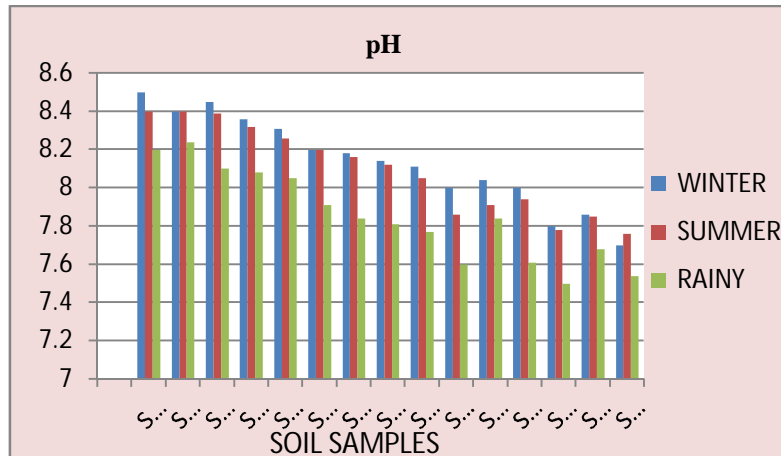


FIGURE-1 Seasonal variation in pH of different soil samples

The pH of different soil samples ranged from 7.5 to 8.5 in the three seasons. Maximum pH was recorded at  $s_1$  in winter and minimum at  $s_{13}$  in rainy season, which was within the permissible limit prescribed by WHO.

**EC**-The conductivity of soil depends upon the concentration of ions and its nutrient status. The conductivity of soil sample ranged from 0.17 to 0.40  $\mu s$ .

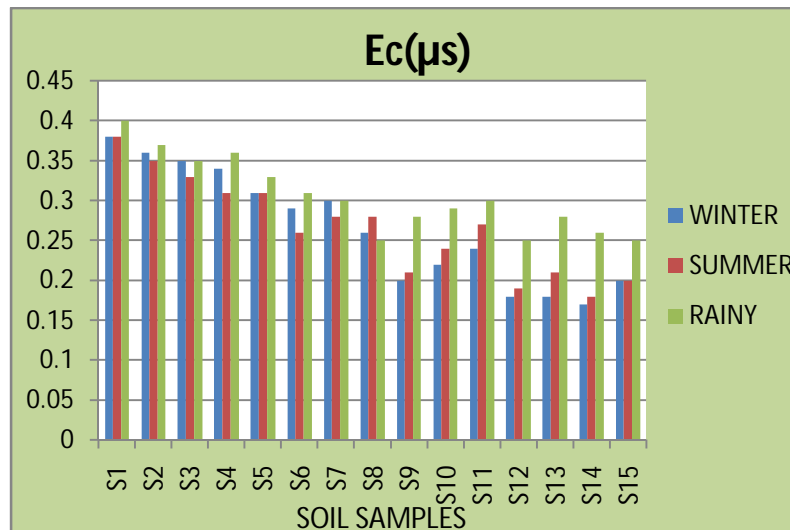


FIGURE-2 Seasonal variation in Ec of different soil samples

Maximum conductivity was recorded at  $s_1$  in rainy season and minimum at  $s_{14}$  in winter season.

**Organic carbon**-Soil organic carbon is the basis of soil fertility. It provides nutrient to plants and improves the structure, biological and physical health of soil. Organic carbon in soil binds with metals and makes complex which reduce the availability of metals to plant.

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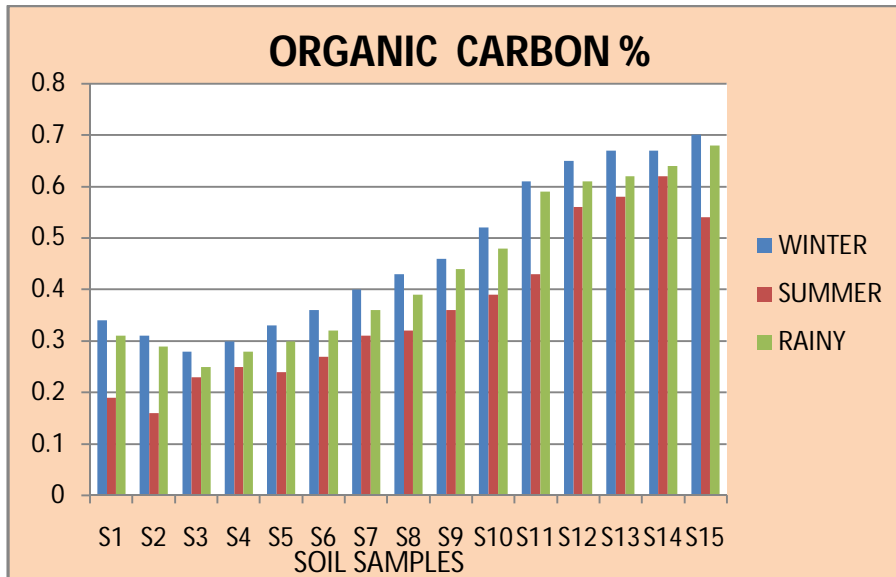


FIGURE-3 Seasonal variation in organic carbon of different soil samples

The organic carbon in soil samples in different seasons varied between 0.16% to 0.70%. Soil samples were found to be maximum in winter season (S<sub>15</sub>) and minimum in summer season (S<sub>2</sub>).

**Pb**- Main source of lead is detonator testing process in RECL industrial area because lead is used in manufacturing of detonators. The concentration of Pb in soil samples collected from different agricultural fields ranged from 484 to 694 mg/kg. In most of the soil samples, the concentration of Pb is higher than Indian standards.

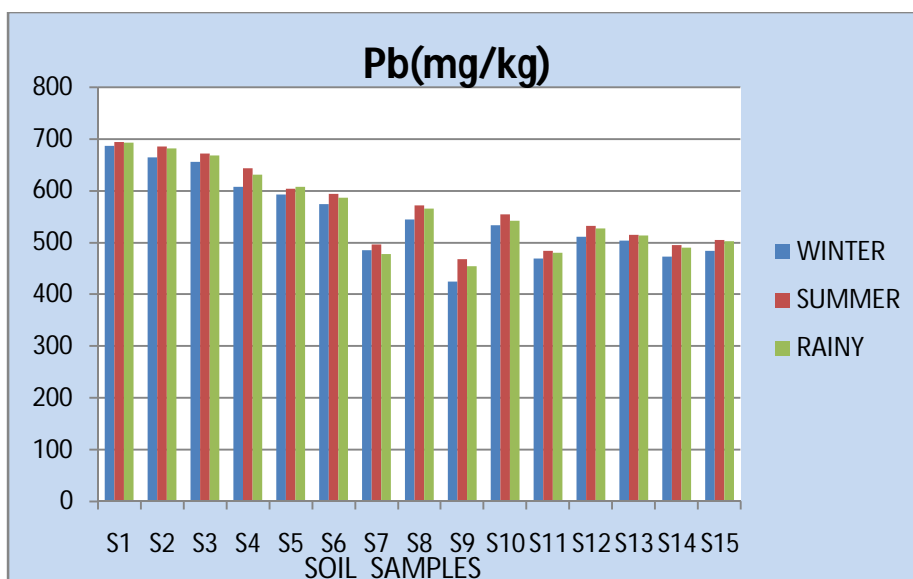


FIGURE-4 Seasonal variation in Pb (mg/kg) concentration of different soil samples

According to Indian standard permissible limit of Pb is 500 mg/kg. The maximum concentration of Pb was found to be in summer season (S<sub>1</sub>-694 mg/kg) and minimum in winter season (S<sub>15</sub>-484 mg/kg).

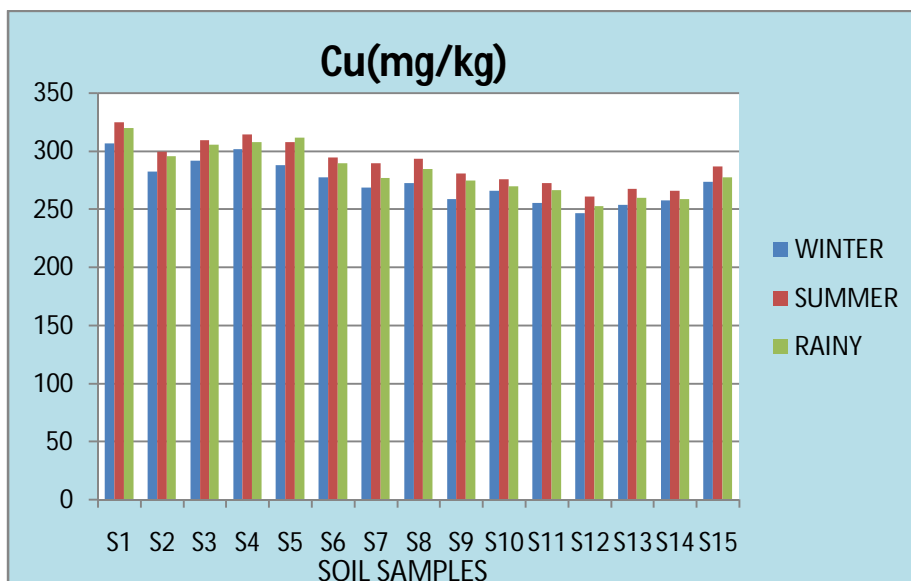
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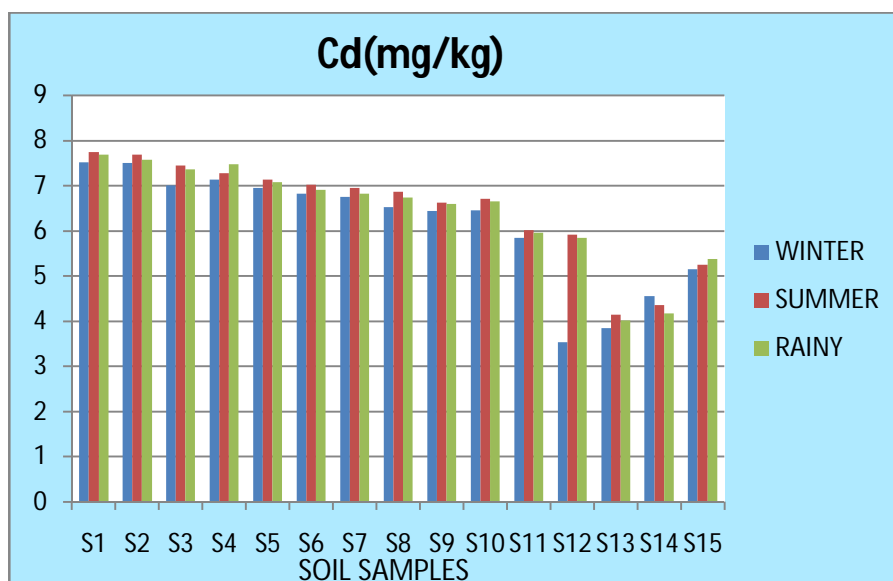
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**Cu**-The concentration of Cu ranged between 253 to 325 mg/kg. The permissible limit of Cu in soil is 190-270mg/kg. The maximum concentration was revealed in  $s_1$  in summer season and minimum concentration was recorded at  $s_{12}$  in rainy. Nine out of fifteen soil samples were exceeding the permissible limits for Cu.



**FIGURE-5** Seasonal variation in Cu (mg/kg) concentration of different soil samples

**Cd**- Cadmium is also used in manufacturing of detonator and contributes to environmental pollution due to leachate process. The maximum permissible of Cd ranged between 3-6 mg/kg. The concentration of cadmium in soil samples in different seasons ranged from 3.54 to 7.75 mg/kg. The maximum concentration was found to be at  $s_1$  in summer and minimum at  $s_{12}$  in winter.



**FIGURE-6** Seasonal variation in Cd (mg/kg) concentration of different soil samples

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## V. CONCLUSION

The results show that the pH value of all the soil samples is within the permissible limit prescribed by WHO whereas value of the electrical conductivity in the collected soil samples are found to be average. Organic carbon in different soil samples showed variability in some soil sample show high organic carbon content whereas some soil sample indicate less organic matter. The concentrations of heavy metals (Pb, Cu, and Cd) were found to be higher than permissible limits in most of the soil sample in summer season. In summer season due to high decomposition rate. Organic matters decompose easily in soil and reduce the capacity to bind the metal with organic carbon which increase the metal ion concentration in soil solution and easily absorb by plants.

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