

Physico - Chemical Analysis of Macro & Micro Elements of Soils of Various Sites around Cement Industry in Rae Bareli District, UP, India

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ABSTRACT- The study undertaken during the year 2021–2022 (July to April), deals with thorough chemical investigation of soil samples collected from different study sites around cement industry in varying seasons, located in Raebareli District. Samples estimated in a regular interval of 3 months (July, Oct, Jan & April) for seasonal variations. The dust emitted from the Cement Company, located in Raebareli, gets deposited in course of time over the soil, leaves and forms a grey cover on the surrounding soils. The concentration of micro nutrient Fe, Cr, Zn, Cu is very high in most of the sampling sites. Extremely high concentration of Fe (60 to 200 ppm) and Cr (72 to 99 ppm) reported almost in all seasons. pH showed highly alkaline (8.2 to 11.3) nature of soil.

KEYWORDS- Soils, Cement, Dust, AAS (Atomic Absorption Spectrophotometer), pH, Heavy metals

I. INTRODUCTION

The three most significant things in our life are air, water, and soil which are essential for life and any imbalance of these three cause a big problem in nature. Soil is one of the most common agents in life and supplies us with all the necessities. Portland cement is one of the common types of cement which is used in construction nowadays. But soil can be polluted by cement plants, where cement industries are established. The chemical composition of cement is a mixture of calcium aluminum silicate also, a trace amount of Cd, Pb, Fe, Ti and silica [2]. Soil, as the mother earth, has all the functions of the 'Tridev' of the Hindu mythology. It is at once the 'Brahma', the 'Vishnu' and the 'Maheshwar'. The creator, preserver, and destroyer. Soil is the soul of infinite life. The essence of life in the soil is in its crop producing capacity i.e., the soil productivity. Soil fertility is that component of productivity which primarily deals with nutrient supplying capacity of the soil to the plant [6]. Soil pH is a key parameter for crop productivity. Soil pH affects the soils physical, chemical, and biological properties and thus plant growth. Soil of Raebareli District highly alkaline in cultivated regions. The soil contains significant amount of

Fe, Ca, Mg, Al, Si & S (in form of sulphates). Zn and Cu levels in polluted soils though not present in cement dust, also higher in concentration in polluted soils. Fe and Ca concentration of the polluted soils increases 78% & 26% respectively. The concentration of Al, Cu, & Zn also higher due to cement dust pollution [4]. The micro nutrients (Fe, Zn, Cu, Cr) are essential for healthy plant growth [3]. For better yield of crop, the status of soil constituents, chemistry of availability of water, nutrient supply to the crop and climatic conditions are most important [7]. The macro nutrients (N, P, K & C_{ORG}) are needed in large amounts and Micro nutrients (Fe, Zn, Cu, Mn & B) are needed in smaller amounts [5].

Some heavy metals are necessary for the plant development e.g. Fe, Cu, Zn, Mn and Mo, but their excess can be toxic for plants. Beyond that there are also other heavy metals (Cd, Hg, Pb) which are not associated with plant development and can cause damage to them [15]. The presence of heavy metals in the environment can have a natural (volcanic emission) or industrial (smelters, coal mines, cement factories) origin. Industrial areas are usually highly contaminated where the pollutants can also spread throughout the vicinity (e.g. due to dust emission) consequently influencing cultivated crops therefore arable land should be excluded from agricultural production [17]. The Changes in the agrochemical and other properties of the soil as a result of the cement industry adversely affected the vegetative development of the agricultural plants grown on it, disrupting the growing season and photosynthesis processes and resulting in reduced yields [21]. there are concerning carcinogenic risks by the local human population due to long-term exposure to potentially toxic metals (PTM) Cd, Pb, Co, Fe, Cu, Cr, Mn, Ni, and Zn found in soil surrounding the cement plants [10].

II. MATERIALS AND METHODS

A. Study Area



Figure 1: Location map of the study area in cement Factory, Rae Bareli.

Study site:

- Azmat ulla ganj
- Bargadha
- Chauhanian
- Dighaura
- Gangaganj
- Harchandpur
- Johwasarki
- Kathwara
- Khidirpurkaraundi
- Kundanganj
- Oie
- Padera
- Paharpur kaso
- Rahwa

The Investigation was conducted in various sites of Rae Bareli district, in different seasons. The soil samples were collected from all 8 blocks in regular interval of 3 months during July 2021 to April 2022. Samples are taken from cultivated area of 14 sampling sites (Azmat ulla ganj, Bargadha, Chauhanian, Dighaura, Gangaganj, Harchandpur, Johwasarki, Kathwara, Khidirpurkaraundi, Kundanganj, Oie, Padera, Paharpur kaso, & Rahwa). Samples were brought to laboratory in polythene bags for analysis and spread out on thick brown paper. Coarse, concretion, stones and pieces of roots, leaves and other undecomposed organic residues were removed. Large lumps of moist soil were broken by hand. Soil samples were air dried for 24 hours, then samples crushed gently in pestle & mortar and sieved through 2 mm sieve [1]. This size has been adopted as an international standard because the soil passing this mesh contains almost the whole of the nutritionally important

fraction in the soil. pH of soil samples was determined by pH meter. The higher range of pH in soils is due to high concentration of alkaline salts, particularly carbonates and bicarbonates of calcium. Estimation of nutrients carried out by given methods:

- Organic carbon (Walkley & Black) [1]
- Total Nitrogen (Kjeldahl method) [1]
- Phosphorous (Olsen method) [9]
- Potassium (Flame photometric method) [1]
- Calcium (EDTA Titration method) [1]
- Magnesium (EDTA Titration method) [1]

For estimation of micro nutrients, the soil samples were washed with 0.1 N HCl followed by washing with double distilled water. 0.5 gm. Sample taken into a 100 ml Kjeldahl flask, added 1 ml of 60% HClO₄, 5 ml HNO₃ and 0.5 ml H₂SO₄, swirled gently and digested slowly at moderate heat, increasing later, digested for 10 – 15 min. after appearance of white fumes. It was set aside to cool, diluted and applied modifications for Cd, Pb, Co, Cr, Ni, Zn, Fe, Cu & Mn. the solution was transferred into 50 ml volumetric flask and diluted. Blank sample was analyzed with the help of atomic absorption spectrophotometer (AAS).

III. OBSERVATION

Table 1: Seasonal Variation of pH & macro nutrients in soil samples at selected study sites near cement factory of Raebareli district during July 2021 to April 2022.

S.No	Parameters	July 2021	Oct 2021	Jan 2022	April 2022
1	pH	8.2 ± 11.3	8.9 ± 10.3	8.4 ± 9.6	8.6 ± 11.0

2	Org Carbon	0.9 ± 15.3	0.8 ± 16.4	0.4 ± 10.6	0.6 ± 14.0
3	Total Nitrogen	0.2 ± 1.3	0.9 ± 1.9	0.4 ± 1.6	0.6 ± 2.9
4	Phosphorous	0.2 ± 0.9	0.9 ± 1.3	0.4 ± 1.7	0.6 ± 1.5
5	Calcium	1.4 ± 9.3	1.8 ± 8.3	1.2 ± 7.8	1.7 ± 9.9
6	Magnesium	2.2 ± 7.7	1.9 ± 9.3	2.4 ± 8.6	1.9 ± 7.9
7	Potassium	1.9 ± 6.9	1.3 ± 5.8	1.8 ± 4.9	1.2 ± 3.8

Table 2: Seasonal variation of Micro nutrients in cultivated soil samples at selected study sites of Raebareli district during July 2021 to April 2022

S.No	Parameters	July 2021	October 2021	January 2022	April 2022
1	Pb	0.2 ± 1.8	0.1 ± 2.6	0.4 ± 3.7	0.3 ± 1.7
2	Zn	0.2 ± 98.3	0.3 ± 78.2	0.5 ± 67.0	0.7 ± 82.0
3	Fe	7.0 ± 102.0	6.3 ± 99.0	12.0 ± 109.5	10.4 ± 112.0
4	Cu	± 13.0	0.5 ± 30.2	0.6 ± 39.2	0.3 ± 41.5
5	Cr	6.1 ± 43.0	7.0 ± 60.0	8.1 ± 47.0	5.0 ± 39.2
6	Mn	3.2 ± 34.0	2.1 ± 48.0	1.9 ± 76.0	2.3 ± 39.0
7	B	0.6 ± 5.8	0.4 ± 6.9	0.3 ± 5.8	0.4 ± 4.6

Variation of concentration of macro and micro nutrients represented with the help of bar diagram in Fig 01 and Fig 02. During the study, it has been observed that pH values are in alkaline range (8.2 to 11.2). Organic carbon contents fluctuated strongly. It showed maximum value in October and minimum in January. Total nitrogen showed deficiency in almost all seasons. Phosphorus ranged from 0.2 to 1.7 %. Potassium showed excess in all seasons, ranged from 1.3 to 6.9 %. Excess of Ca & Mg observed in all seasons. The standard and ideal concentration of macro nutrients present in healthy soils, as for organic carbon, total nitrogen, phosphorus, potassium, calcium and magnesium were 0.2 to 10%, 2 to 5%, 0.01 to 0.2%, 0.02 to 2%, 0.1 to 2% & 0.05 to 3% respectively [1].

The Concentration of Pb varied from 0.1 to 3.7 and Zn varied from 0.2 to 98.3 ppm. Fe content ranged from 6.3 to 112 ppm (extremely high). During the period of study, it has been observed that Cu contents showed variation from 0.1 to 41.5 ppm. Concentration of Cr varied from 5.0 to 76.0. Mn contents in soils varied from 1.9 to 76 ppm. Boron contents during the present investigation in sites ranged from 0.3 to 4.6 ppm.

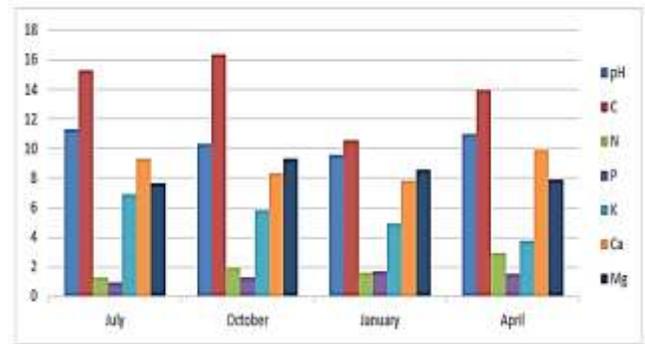


Figure 2: Seasonal variation of Maximum values of pH & Macro nutrients in cultivated soil samples at selected study sites of Rae Bareli district during July 2021 to April 2022

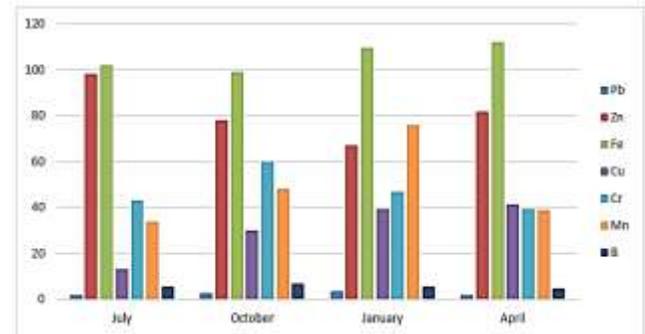


Figure 3: Seasonal variation of Maximum values of Micro nutrients in Cultivated soil samples at selected study sites of Raebareli district during July 2021 to April 2022

IV. DISCUSSION

The values of Physico-chemical parameters obtained were represented in table 01. The soil was alkaline (8.2 to 11.3) throughout the year. Concentration of Pb reported from 0.1 to 3.7 ppm. Maximum value of Zn (98.3 ppm) was noted in July. Available Fe content of soil varied from 6.3 to 112 ppm. Excess of Fe was noted in almost all the seasons. Value of Cu varied from 0.1 to 41.5 ppm, deficiency of Cu pointed in July & April. Concentration of Cr varied from 5 to 60 ppm. Mn status of different soils varied from 1.9 to 76 ppm; excess of Mn was observed in all seasons. The concentration of boron varied from 0.3 to 6.9 ppm. Extractable Zn, Fe, Cu, Mn & B less than 1.2, 8.0, 0.4, 4.0 & 0.5 ppm respectively were considered deficient [1,15]

The soils of the study area fall within the Coastal Group and are reported to have Pb concentrations at some sites higher (75 ppm) than the average Pb in soils of Coastal Group (35 ppm). This could be attributed to the cement industry in which the process and production of cement industry require a substantial amount of energy supplied by burning fossil fuel and traffic activity in the plant. The soils of the study area fall within the Coastal Group and are reported to have Pb concentrations at some sites higher (75 ppm) than the average Pb in soils of Coastal Group (35 ppm). This could be attributed to the cement industry in which the process and production of cement industry require a substantial amount of energy supplied by burning fossil fuel and traffic activity

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Excess of organic carbon reported almost in all seasons, its concentration varied from (0.4 to 16.4 %). The concentration of N could be increase by addition of urea and nitrates of Na, K & Ca in soils. Range of Phosphorus varied from 0.2 to 1.7 %. Low phosphorus status is in 50% & medium in 48% soils. About 48% soils are low to medium in available K & its deficiency is rapidly increasing under intensive cropping & unbalanced fertilizer use [8]. The concentration of P increases, as pH increases, the concentration of K is high due to fixation of soluble K salt at high temperature. Alkaline soil found available N in low category & K in medium [14]. The salt affected soils were low in available N & P and medium in K [13]. The range of K in our investigation varied from 1.2 to 6.9 %. the concentration of Ca ranged from 1.2 to 9.9 % and concentration of Mg varied from 1.9 to 9.3 % respectively. Excess of Ca & Mg reported in all seasons.

V. CONCLUSION

From this study, it is quite evident that Soil of Raebareli district showed alkaline nature. High value of Iron reported throughout the year. Copper also showed excess in majority of our sites, their excess due to fixation of insoluble Cu – complexes by chemical fertilizers. Excess of Mn and Cr reported in all seasons. Boron showed sufficient

concentration except in October, here excess of Boron reported. Organic carbon showed positive correlation with total nitrogen. Excess of carbon due to stabilization of mineral carbon in soil and excess cropping also helpful in fixation of carbon as organic matter in soils. Concentration of phosphorus increases as pH increases. Potassium concentration is high in July due to fixation of soluble potassium salts at high temperature. Excess of Ca & Mg observed throughout the year due to deposition of cement dust from cement industry. Heavy metals are toxic for many plants and humans also, thus its toxic effects should be decreased by applying microbial or Bio-Fertilizers in place of chemical fertilizers. The adequate nutrients & maintenance of proper moisture regime is advocated for better crop production. For proper balancing of these micro & macro nutrients, addition of suitable salts in proper ratio should be applied to minimize leaching of macro nutrients into ground water.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest

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