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Case Study

INFLUENCE OF CEMENT PARTICULATES ON THE SOIL HEALTH: A CASE STUDY OF SOIL IN THE VICINITY OF CEMENT FACTORIES

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ABSTRACT

The present case study reports the alterations in the properties of soil affected from the cement particulates emanating by the surrounding cement factories. The chemical examination was conceded out to appraise the physico-chemical properties of the soil samples collected from the different agricultural lands surrounded by the Cement factories operated in the vicinity of the Gadchandur area of the Vidarbha region of India. The parameters such as pH, electrical conductivity, organic carbon, NPK and other parameters of the soil were evaluated in the soil testing laboratory of the college. Due to the incessant deposition of cement dust particles emerging out from the kiln through the manufacturing of the cement, the pH of the soil has slightly raised in the range of 6.79-7.90. The pH of the soil generally ranged from 5.5 to 7.5. However, the studied area has a slightly alkaline pH. The electrical conductivity of the soil sample has slightly increased and obtained in the range of 0.591-0.493 mili $mhocm^{-1}$ due to unremitting exposer to cement dust. The moisture content of the soil was found to be 8.9% to 9.9 %. The water holding capacity of the soil was found to be 38.1 % to 44.5 %. The organic carbon estimated for the samples in the laboratory was found in the range of 0.33 % to 0.46%. The organic carbon estimated for the samples was found in the range of 0.33 % to 0.46%. The nitrogen (N) estimated by the Kjeldahl method was found to be in the range of 0.14 to 0.29 %. The available Phosphorus (P) content of the soil ranged from 16.1 ppm to18.7 ppm while potassium (K) ranged (206 -259) ppm. From the results obtained, it has been noticed that there were slight alteration in the physic -chemical properties of soil. The influenced soil health was due to the heavy overthrow of particulates pollution onto the soil in the agricultural terrain by the cement factories.

Keywords: Cement particulates, Cement Factories, Physico-chemical properties, Soil health, pH.

1. INTRODUCTION

The ecological balance is the prime responsibility of the living being and most preferably of the human being. The earth vegetation is spread over the vast landscape and however, the soil couldn't be excluded. All the living things are directly or indirectly reliant upon the soil. But human's worthless activities such as extensive land use and management, definitely affects the soil functioning. Thus, it's very important to study the soil processes to retain the ability of soil to regenerate the well balanced eco-system [1].

The soil contains the macro and micronutrients which are vital for the plant growth. The elements which are present in soil with a concentration that exceeds 100 mg/kg are termed as major which includes O, Si, Al, Fe, C, K, Ca, Na, Mg, Ti, N, S, Ba, Mn, P, and perhaps Sr and Zr, in decreasing order of concentration while the remaining elements present are trace elements. The C, N, P and S are macronutrients as they are essential for the life cycle of the organism and required in a significant amount. All other elements comes under the category of micronutrients [2].

Nowadays, the soil is getting devastated due to the contamination with the particulate pollutants which are emitted out from the industries. Among the different pollutants, the dust raised form the cement factories is the main cause of soil pollution. The manufacturing of the cement includes the mining and transportation of the limestone, sand, clay, fly ash, etc. The raw materials are mainly the oxides and carbonates metals. The raw materials are grounded and mixed in fixed proportion to form the cement [3]. During the manufacturing, the Cement Kiln Dust (CKD) spread over a wide geographical landscape, mixed with the soil and hence influences the physico-chemical properties of soil [4]. The CKD consists of major constituents of raw materials. The cement dust produced from the grinding process is composed of lime (CaO), silica (SiO_2), Aluminium

oxide (Al_2O_3), and Iron oxide (Fe_2O_3) [5]. Apart from these, some heavy metals are also emitted such as Cd, Pb, Zn, Cu, Cr, etc. in the CKD [6]. The soil surrounding the cement factories are moderate to heavily contaminated with heavy metals such as Cd, Pb, Cr, Cu and Ni [7]. The cement dust particulates have the most serious environmental stress that influences the soil health significantly. The cement dust may influence the microbial activities and hence soil nutrient contents. If the metals present in the dust such as sodium, potassium, copper, zinc, calcium, magnesium, manganese and iron are in moderate concentration are necessary for the growth of microorganism [8].

Table 1: Chemical Composition of Cement dust Particulates

Chemical Composition	Dust generated from first grinding process of raw material (%)	Dust generated from second grinding process for cement clinker (%)		
		Stage 1	Stage 2	Stage 3
SiO_2	11.72	20.99	21.56	14.02
Al_2O_3	3.45	3.76	3.44	2.86
Fe_2O_3	1.47	2.66	2.60	1.77
MnO	0.08	0.21	0.23	0.15
CaO	41.77	63.40	65.50	48.09
MgO	0.97	2.01	1.53	1.22
K_2O	0.90	1.70	1.75	8.67
Na_2O	0.26	0.51	0.51	0.71
P_2O_5	0.08	0.16	0.18	0.12
TiO_2	0.19	0.21	0.21	0.15
Loss on Ignition	35.42	1.83	1.35	10.61
Particle size (μm)	3.68	58.78	35.20	7.89

Source. Young-Chull Ahn,et.al., Korean J. Chem. Eng., 2004; ***21(1):*** *182-18.*

The soil parameters like pH and Electrical conductivity show high magnitude while water holding capacity, soil moisture, organic carbon and total nitrogen and phosphorus contents have shown lower magnitude [9]. Meanwhile, the alteration in the physical and chemical properties of soil due to cement dust particulates sometimes confer few advantages for agricultural applications as the dust contains various elements that could provide plants with sufficient amounts of S, Mg, and K [10].

The Gadchandur area of Chandrapur district of Vidarbha region in India is surrounded by the number of cement factories. The huge amount of cement dust is emanating from the kiln and spread over the agricultural land residing close to the factories. Thus, it is necessary to examine the physico-chemical properties of soil. So, the farmers could accomplish requisite deficiency of the soil. Consequently, the soil health can be improved. The present case study is aimed to report the possible influence of the cement dust particulates on the physico-chemical properties of the soil in the vicinity of the cement factories of Gadchandur area.

2. MATERIAL AND METHODS

2.1. Study area

Gadchandur is a city and Municipal Council in Chandrapur district, Maharashtra, India with coordinates 19° 43′ 0″ N, 79° 10′ 0″ E. Gadchandur is surrounded by cement factories, Manikgarh Cement and Ambuja Cement Works and Ultratech cement within the radius of 5-6 KM. The study area is having agricultural land surrounded by the cement factories with seasonal crop production namely cotton and different veggies. The soil of the study area deep grey to black is suitable for the cotton crop. The study was carried out in the winter season in December and January.

2.2. Sampling

The five soil samples were collected from agricultural land surrounded by the three cement factories. Samples A and B were collected within the area of 1 KM from the Manikgarh cement and Ambuja cement works. While other soil samples C, D and E were collected within the area of 4-5 KM from the factories. The samples were collected randomly from depth of 0-20 cm. The samples were air dried, ground and passed

through the 0.2 cm sieve and thus, packed in polyethene for the physico-chemical examination in the soil testing laboratory. The temperature was in the range of 23°C - 27°C during the chemical analysis of soil samples.

Fig.1. Study Area

2.3. Physico-Chemical Analysis

The stock solutions required for the chemical analysis were prepared. The pH and electrical conductivity of the samples were measured suspension of Soil: Distilled water in the ratio 1:2.5 by digital pH meter and Conductivity meter respectively [11, 17]. The total organic carbon was determined by Walkley and Black rapid titration method in the laboratory [12]. The other parameters like bulk density by pycnometer, moisture content and water holding capacity (WHC) were determined by the gravimetric method. The nitrogen was estimated by the Kjeldahl method [13]. The available soil phosphorus was determined by the Oeslen and Mehlic method [14, 18]. Potassium was estimated by flame photometer in the soil testing laboratory while lime requirements and other elements were estimated by different chemical methods [15].

3. RESULTS AND DISCUSSION

The physico-chemical properties of the soil samples A, B, C, D and E were evaluated by the chemical examination and the results are shown in table 2.

3.1. pH of Soil

The pH of the all the soil sample was determined at the temperature ranged between 23°C-27°C. The normal range of pH of soil should be 5.5 to 7.5 [16]. Sample A to E revealed the pH ranged between 6.79-7.90, which was found to be neutral to slightly alkaline. The pH of soil sample A and B were high as compared to the samples C, D and E. This might be attributed to the presence of high calcium content in soil collected near factory premises (sample A and B) while soil collected from far area (sample C, D and E) have less pH as compared to sample A and B.

3.2. Electrical Conductivity

The suitable range of electrical conductivity of the soil for the growth of most of the plants is 0.25 to 0.75 mili mhocm^{-1} [17]. The electrical conductivity of the soil sample A and B collected from near to the factory site was found to be high in the range (0.591-0.587) mili mhocm^{-1} while for samples C, D and E far from factory site was low in range (0.479-0.493) mili mhocm^{-1} as compared A and B. This could be due to the more contamination of soil surface with cement dust near to factory site. Thus, the electrical conductivity of the soil sample increases near to factory site.

3.3. Moisture content and Water Holding Capacity

The moisture content of the soil and water holding capacity of the soil was found to be significant. The moisture content of the soil was found to be 8.9% to 9.9 %. The water holding capacity of the soil was found to be 38.1 % to 44.5 %. The water holding capacity

near the factory area is high as compared to the soil from far from cement area.

3.4. Organic carbon

The organic carbon estimated for the samples in the laboratory was found in the range of 0.33 % to 0.46%. All the soil samples show low organic carbon content.

3.5. Nutrients content of the soil

The nitrogen(N) estimated by the Kjeldahl method was found to be in the range of 0.14 to 0.29 %. The available Phosphorus (P) content of the soil ranged from 16.1 ppm to18.7 ppm while potassium (K) ranged (206 -259) ppm. The estimated ranges were normal for the growth of plants.

Table 2: Physico-chemical properties of Soil in the vicinity of cement factories

Parameter	Units	Samples				
		A	B	C	D	E
pH		7.90	7.84	6.65	6.74	6.79
Electrical Conductivity	Mili mhos/cm	0.591	0.587	0.479	0.493	0.488
Organic Carbon	%	0.33	0.38	0.42	0.40	0.46
Phosphorus	Ppm	18.7	21.2	17.8	16.5	16.1
Nitrogen	%	0.141	0.156	0.281	0.278	0.291
Potassium	Ppm	259	266	206	214	217
Sodium	Ppm	6.70	7.01	5.99	5.66	6.02
Magnesium	Ppm	740	687	558	598	610
Lime requirement (CaO)	%	7.2	7.7	11.2	10.8	12.8
Water Holding Capacity	%	44.5	41.1	39.7	37.8	38.1
Moisture	%	8.9	8.7	9.1	9.4	9.9

4. CONCLUSION

The results obtained have shown that dust emanating from the cement factories has influenced some physico-chemical properties of the soil. The soil samples collected within the radius of 1 km of the factory have shown significant alteration in some soil parameters as compared to samples collected within the 5 km area from the cement factory. The incessant contamination of the soil by cement particulates has raised the pH. The soil near the cement factory has neutral to alkaline pH. The deposition of the cement dust in the soil results in the addition of the ions in the soil. Thus, the electrical conductivity of the all samples found to be increased when we move near the factory site. The nutrient contents of the soil have normal range so far. However, if the contamination is continued for the coming years the soil health will worsen. The agricultural land will be affected due to heavy contamination due to cement dust.

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