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REGULAR ARTICLE

PHYSICO-CHEMICAL CHARACTERISTICS OF SOIL AND FLY-ASH AROUND CHANDRAPURA THERMAL POWER STATION: A COMPARISON

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SUMMARY

Fly-ash and native material (soil) were evaluated for physico-chemical properties and trace elements in their lechates as an essential requirement for environmentally safe disposal and improvement for soil fertility. Fly-ash and soil samples were randomly collected from Chandrapura Thermal Power Station (Bokaro, Jharkhand, India) and brought to Central Institute of Mining and Fuel Research, Dhanbad. Fly-ash and soil samples were leached with deionized water and lechates were analyzed following the methodology by ASTM (American Society for Testing Material) to determine the pH, EC, Ca, Mg, OC, Om, P and K. The extract of DTPA for micronutrients was determined. Characterization of native material (soil) and fly-ash result show that the pH of fly-ash was neutral in comparison to soil. And found that the large number of macro nutrients (K, P, Ca, Mg and Macro nutrient (Fe, Zn, Cu, and Mn) in fly-ash which are responsible for improvement of soil fertility. Results of this study allow the possible utilization of fly-ash for agriculture purposes.

Keywords: **A**griculture, fly-ash, leeched, macronutrients, micronutrients.

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1. Introduction

Fly-ash is one of the major wastes produced by burning of coal in thermal power stations. It annual production all over the world is 300-500 million tones through combustion of 3000 million tones of coal (1). In India produce about 110 x 106 tones of fly-ash per annum from 85 thermal power plants.

Enormous volume of fly-ash remains unutilized and its dumping has passed a threat to environmental problem to heavy metal content (2, 3). The potential adverse affects of fly-ash a) leaching of potential toxic substances from ash into soil and ground water. b) Changes in plant elemental composition c) Increased cycling of these toxic elements through food chain (4, 5) and d) Respiratory problems to human beings.

Depending on the source of the coals fly-ash contain various levels of trace elements such as arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, mercury, and selenium (6, 7, 8). This means that fly-ash contains most elements required for plant growth and metabolism. In India fly-ash is utilized as (i) Raw material in cement, cellular concrete, lime bricks, gypsum block, and building tiles (ii) Admixture in cement concrete and in products made of timber substitutes; (iii) Aggregate in concretes, roads and building blocks, (iv) Pozzolana in lime mortars and plaster and Portland cement (v) A stabilizer for soil and for road construction, (vi) A filler in consolidation of ground land and mine filling (9, 10), (vii) Soil conditioner and source of plant nutrients in agriculture and fishery. The other applications of fly-ash include metals extraction, creation of cenospheres and waste-water treatment (11). In controlled doses fly-ash has proposed as an amendment for agricultural soil due to its potential to improve physical and chemical texture of problematic soils. Similarly, at 100-1000 times dilution, it does not affect the soil micro flora or enter the food chain (4, 12).

2. Material and Methods

Study area

Chandrapura thermal power station is locacated in the Bokaro district of Jharkhand state (Figure 1). It is 50 km from the Dhanbad and 1 km from the Chandrapura railway station and situated at Dhanbad –Bokaro roadway. Chandrapura located 23o46'11'on the North and 86o7'12'E. The capacity of thermal power plant was 750 mw. The power plant covers an area of a about excluding the ash pond area. The maximum temperature is usually experienced during the month of May with temperature approximately 450C, whereas during the winter in the month of December-January. It is as low as 70 to 90. The mansoon season start in the early June and continue till September. The experiences 80% to 85% annual rain fall. Relative humidity of the area has maximum of 87% and minimum of 55%.

Sampling and analytical works:

Fly-ash and soil samples was collected from dumping sites of Chandrapura thermal power station, Chandrapura (Bokaro) Jharkhand , India , in large plastics bags and brought to the field laboratory CIMFR, Dhanbad. Fly-ash and soil sample were air dried and sieved with 2mm mesh size.

The pH of fly-ash and soil sample was measured with a digital pH meter (CONSORT C831) in a soil/ fly-ash distilled water at ratio of 1:2.5 Electrical conductivity (EC), expressed in µS/cm of soil/ fly-ash samples deionized water ratio of 1:2.5 was determined following in 60 minutes equilibration in a mechanical shaker a digital conductivity meter (CONSORT C831). Organic carbon values of fly-ash and soil samples were determined by oxidation with potassium dichromate in acid (13), to lots of 5 g of air dried and fly-ash /soil samples, aliquots of 10 ml of 1 N K_2CrO_7 solution, 20 ml of 12 N H_2SO_4 and 1.25% $AgSO_4$ were added followed by addition of 10 ml phosphoric acid (85%) and 1ml of phenyl amine and titrated against 1Nferrous ammonium sulphate. DTPA (Diethylen Triamine Penta Acetic acid) extractable fraction was obtained by mechanical shaking with 40 ml of 0.5 M DTPA, 0.01 M $CaCl_2$, 0.1 m TEA (Tri ethanol amine) buffered at pH 7.3 for 2h. All analyses were carried out in triplicates using with Varian Atomic Absorption Spectrophotometer (AAS).

3. Results and Discussions

The physico-chemical characteristic of soil and fly-ash reported in table 1. The moisture contents and bulkdensity of the soil samples were observed 3.901 % and 1.246. The soil was

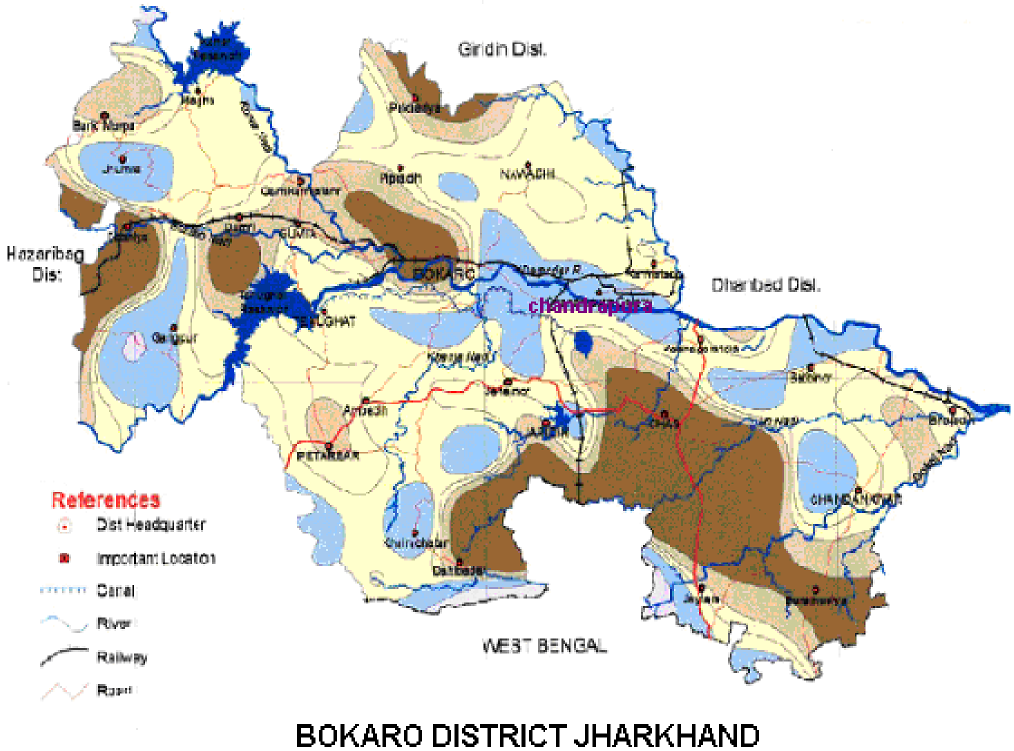

Figure 1. Map of Study areas

slightly acidic in nature (pH 6.3) and its Electrical conductivity (55.41µs/cm)was in the normal range, but its organic carbon content (0.26%) was higher than the normal range in Indian soil is 0.4-0.6% (ICAR, 1996). The organic matter content of soil was 0.46%. The fertility of the soil was poor, as indicated by the low concentration of major and secondary nutrients (mg/kg) for K - 1.264, P - 0.004 (%) and Ca - 2.74 and Mg - 0.62 similarly low concentration of micronutrient were observed (mg/kg) for Cu (2.57), Zn (0.01), Mn (7.02), and Fe (5.75). The contents of the trace and heavy metal were as fallows for Pb (19.4), Ni (4.5), Cr (1.0), Al (0.58), Cd (0.23) mg/kg. The moisture content of experimental Fly-ash was observed greater than soil sample 4.32 % and 1.248 respectively.

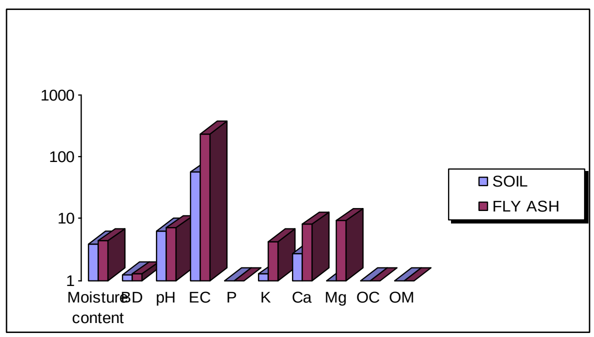

Fig 2. Physicochemical properties of soil and flyash

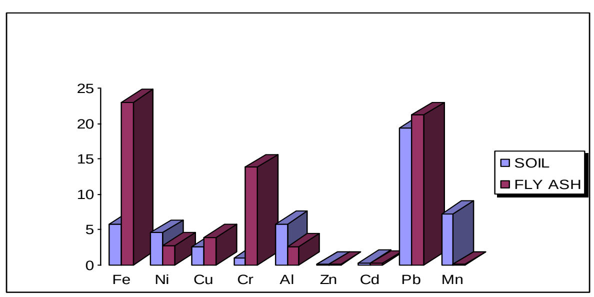

Fig 3. Micronutrients Status in Soil and Fly-ash

The fly-ash characteristic reported that neutral (7.06) and the higher EC (235µs/cm) due to higher concentration of Ca and Mg ions. The organic carbon content of fly-ash was higher (0.28%) than the experimental soil. The content of organic matter (0.48%) was also higher in comparison to soil. The content of secondary nutrient Ca and Mg (8.15, 9.18) were higher than the soil and the values of K and P (4.23, 0.006%) was also higher than the corresponding values in the soil. Similarly concentration of micronutrient were observed (mg/kg) for Cu (3.9), Zn (0.03), Mn (0.05) and Fe (23.0). The contents of the trace and heavy metal were as fallows for Pb (21.19), Ni (2.7), Cr (13.8), Al (2.6), Cd (0.17) mg/kg (Table 1).

Table 1. Physico-chemical properties of fly-ash and soil

	Soil	Flyash	
Moisture content(%)	3.90±0.001	4.32 ±0.01	Siva kumar and Dutta1996.
BD(g/cm3)	1.24±0.001	1.24 ±0.001	
pH	6.35 ±0.1	7.06 ±0.1	
EC(µs/cm)	55.41 ±0.01	235 ±1	
P (%)	0.004±0.001	0.006 ±0.001	
K (mg/kg)	1.26 ±0.001	4.23 ±0.001	
Ca(mg/kg)	2.74±0.0015	8.15 ±0.01	
Mg(mg/kg)	0.62 ±0.001	9.18 ±0.001	
OC (%)	0.26 ±0.01	0.28 ±0.01	
OM (%)	0.46 ±0.01	0.48 ±0.01	
Fe(µg/g)	5.75 ±0.01	23 ±1	47000(mg/kg)
Ni(mg/kg)	4.5 ±0.1	2.7 ±0.1	150(mg/kg)
Cu(mg/kg)	2.57 ±0.1	3.9 ±0.1	100(mg/kg)
Cr(mg/kg)	1 ±0.1	13.8 ±0.1	120(mg/kg)
Al(mg/kg)	5.8 ±0.01	2.6 ±0.1	___
Zn(mg/kg)	0.01 ±0.000	0.03 ±0.000	___
Cd(mg/kg)	0.23 ±0.01	0.17 ±0.01	9(mg/kg)
Pb(mg/kg)	19.4 ±0.1	21.19 ±0.01	35(mg/kg)
Mn(mg/kg)	7.2 ±0.1	0.05 ±0.01	__

BD- bulk density, EC- electrical conductivity, OC- organic carbon, OM- organic matter

Conclusions

On the characterization of native material and fly-ash result shows that the pH of fly-ash was neutral in comparison to soil. It was also found that the large number of macro nutrients (K, P, Ca, Mg and Macro nutrient (Fe, Zn, Cu, and Mn) in fly-ash which is responsible for improvement of soil fertility. Leaching experiment of fly-ash shows that, the content of trace elements is below the permissible limit (Siva Kumar and Dutta 1996).

In this process examination of native material and the fly-ash as a suitable material for not change the physico-chemical characteristic of soil but it also improve the soil fertility for agricultural utility.

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