A study on the beneficial utilization of fly ash from power plant in bio reclamation, Jharkhand, India.

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ABSTRACT: Indian coal being high in ash content of about 35- 45%. In the process of thermal power generation the country is producing high amount of fly ash. Due to high volume of fly ash generation in the thermal power plant, it creates a serious problem of disposal in relation to environmental problems. In addition to fly ash contains many nutrients for plant growth. It has also shown to correct increase the nutrient uptake by crops grown in earthen pot. The present paper discusses the utilization of fly ash of Bokaro Thermal Power Station, Jharkhand in bio reclamation of coal mine spoils. *Pisum sativum* has been selected for this research work. *[Arvind Kumar Rai, Biswajit Paul, Gurdeep Singh A study on the beneficial utilisation of fly ash from power plant in bio reclamation, Jharkhand, India*. **Researcher. 2010;2(12):37-41]. (ISSN: 1553-9865),,**http://www.sciencepub.net.

Key Words: Power plant**,** Fly ash, Bulk density, Available phosphorus.

INTRODUCTION

Power is generated from different sources like thermal power, nuclear power and power from fossil fuel and other non conventional resources. Energy generation through thermal power plants is very normal now days. The coal used in India generally low grade high ash content. This produces very large amount of fly ash all over the world. The power grade coal in our country is mostly mined by opencast method. In India, about 79% of the electricity is generated by coal based thermal power plants (Singh and Siddiqui,2003), leads to 110 million tones fly ash per year (Jamwal,2003) and it will surpass 140 million tons by year2020 (Kalra et al.,1997). Ash is a residue resulting from combustion of coal in Thermal power plants. About 80% of total ash is finely divided form which is carried away with flue gases and is collected by Electrostatic precipitator. This is called dry fly ash or hopper ash. The 20% of the ash gets collected at the bottom of the boiler and is commonly known as Bottom ash. When fly ash and bottom ash is carried to storage pond in the form water slurry and deposited, it is known as pond ash (Paul, 2001). Fly ash contains many nutrients for plant growth. It has been shown to correct nutrient deficiency or increase nutrient uptake by crops. Fly ash amendments in soil have resulted in increased plant production (Adriano et al., 1980). Klein and Russell, 1973 have been shown that soils and plants around a coal burning power plant were enriched in some trace metals caused by fall out fly ash from stack of the power plant. Several studies indicates that wider potentials of fly ash to increase the productivity and convert the problematic soils into agricultural land or revegetation of many plants (Ram et al, 2006). Indian fly ash is mostly rich in available major and secondary nutrients, where weathered fly ash has more organic content (Kandahar et al, 1993). Coal ash contains various trace elements, where B, Cd, Pb, Mo, Ni, Se and Zn are present in higher concentration than soil (Ram et al., 2005). These elements are beneficial for many crops or plants.

MATERIALS AND METHODS

Study area

Bokaro Thermal Power Station (BTPS) is located between $23^0$38'4'' to $23^0$40'8'' N latitude and 8608'E longitude at S – E part of the state Jharkhand. The region belongs to lower Gondwana period with late Permian sequence of Barakar series formed at about 215 million years ago (Singh, 1997). The sampling location is shown in Fig.1.

Bokaro thermal power station of Damodar valley is situated in the state of Jharkhand. It is situated about 35 km from Bokaro Steel City. BTPS on the banks of a tributary (Konar) which is about 3 km away from Damodar river. The power generation capacity of BTPS is about 610 MW (Prasad, 2004).The BTPS is the first low grade coal burning power plant constructed by DVC. The plant is divided into two parts: Plant A and Plant B. The first unit was put in service on Feb 21, 1953. Power generated at BTPS is utilized by TISCO, IISCO, railways for traction and rural and urban distribution.

Sample collection & analysis

Fly ash sample from BTPS were collected from the hoppers of Electro static precipitators (ESP) in plastic bags of two Kg labelled properly and are mixed repeatedly to represent one single composite sample and subsequently used for physical and chemical characterization. In the present study soil and fly ash are mixed in different concentrations. All the analyses were done by the standard methods given by Jackson, 1958.

Fly ash is a very fine powder and tends to travel far in the air. It is the residue of combustion of coal and comprises a wide range of inorganic particles, low to medium bulk density, high surface area and sandy silt to silt loam texture (Aswar, 2001).Fly ash occurs as very fine spherical particles, having diameter in the range from few microns to 100 microns. Chemically, fly ash is ferro - aluminosilicate mineral with major elements like Si, Al, and Fe together with significant amount of Ca, Mg, K, P, and S (Adriano et al.,1980). Fly ash may often contain trace amounts of some heavy toxic metals like Molybdenum, Mercury, Selenium, and Cadmium etc (Sadasivan and Negi,1991).The chemical composition of ash is influenced to a greater extent by the geological and geographical factors related to coal deposit, the combustion conditions, and the removal efficiencies of the control devices (Sarkar et al., 2005). Mainly the nature of mineral matter and organic constituents in coal determine the chemical composition of the ash resulting during combustion (Guijan et al., 2004).

Research in the last few decades to explore utility of fly ash has achieved some success. Literature on utilization of fly ash reveals that it has been successfully utilized for improving waste land. Besides it has been used as a soil modifier and micro fertilizer (Ashokan et al.,1995). A good amount of work has already been done all over India and abroad on the yield of agricultural crops using fly ash and has found a yield increase of 15% to 25% with application of fly ash (Singh and Tewary, 2002).

Pisum sativum were selected as experimental work in pot. The Pisum (pea) is a green, pod-shaped vegetable, widely grown as a cool season vegetable crop. The average pea weighs between 0.2 and 0.38 grams.

RESULTS AND DISCUSSION

A very brief description of discussion is presented in the following paragraph.

Results of various physical parameters conducted in the Environment Science & Engg laboratory on the fly ash samples are given in the Table 1, 2, 3 and 4. The results of chemical properties and growth experiment are given in Figure 2 & 3.

The physical characteristics of different parameters of fly ash with respect to pH, electrical conductivity (EC), specific gravity, moisture content, water holding capacity, bulk density and grain size distribution are given in Table 1. From the present study various results indicate that pH of Bokaro power plant fly ash shows slightly acidic in nature; EC values 0.85 mmhos/cm, specific gravity values 2.09. Some researchers observed that specific gravity of most soils ranges from 2.60 - 2.80. It indicates that it was less than soil. Moisture content (0.31%) indicates that chances of fugitive dust emission problems in nearby areas. Water holding capacity (68.65%) of fly ash was maximum than soil. Bulk density of fly ash was low as compared to soil. The texture composition shows that percentage of sand (71.14) is highest followed by silt (28.86) and clay (1.00). From the Figure 2, it could be observed that available nitrogen, available phosphorus, available potassium and available sulphur were lowest in fly ash sample than natural soil. From the Table 2, it could be observed that trace metals only *Fe* was fairly high in the ash sample. The values obtained in the study showed that in ash samples the concentration of trace metals may not cause any serious environmental problems. From the Table 3, it could be observed that major cations were generally high in the ash sample. Similar results were observed by Singh and Tewary, 2002 on the different crops such as pea and wheat on same concentrations.

One important observation found in this present study that Pisum has increased up to 20% amended soil. A large amount of fly ash beyond 20 % a significant growth reduction is noted in pot. Similar results were reported by Singh et al., 1996. It has been found that in Table 4, that nutrient uptake such as N, P and K by Pisum plant is higher at 20% of fly ash such as 0.38, 0.23, 0.28 g/ pot respectively.

Table 1.Physical properties of fly ash.

S. No	Parameters	Values	Units
1	pH (1: 2.5)	6.7	--
2	Electrical conductivity	0.85	mmhos/cm
3	Specific gravity	2.09	---
	Moisture content	0.31	
5	Water holding capacity	68.65	%

6	Bulk density	0.86	gm/cc
7	Particle size distribution		%
	Sand	71.14	
	Silt	28.86	
	Clay	1.00	

Table 2.Trace metals of fly ash, BTPS, Jharkhand

S. No	Trace metals	Values (mg/kg)
1	Copper	000.55
2	Cobalt	000.62
3	Iron	133.4
4	Zinc	006.1
5	Manganese	007.2
6	Lead	0005.1

Table 3. Major Cations of fly ash, BTPS. Jharkhand

S. No	Exchangeable cations	Values (C mole kg^{-1})
1	Ca^{2+}	15.43
2	Mg^{2+}	9.40

Table 4. Effect of fly ash on uptake of N, P, K (g/pot) by Pisum

Fly ash/ Fertilizer	Without fertilizer recommended			With fertilizer level		
	N	P	K	N	P	K
0%	0.20	0.08	0.14	0.22	0.05	0.22
5%	0.27	0.09	0.16	0.33	0.14	0.24
10%	0.30	0.15	0.24	0.35	0.18	0.26
20%	0.35	0.18	0.27	0.38	0.23	0.28
40%	0.12	0.02	0.15	0.22	0.07	0.15
100%	0.07	0.04	0.03	0.15	0.02	0.05

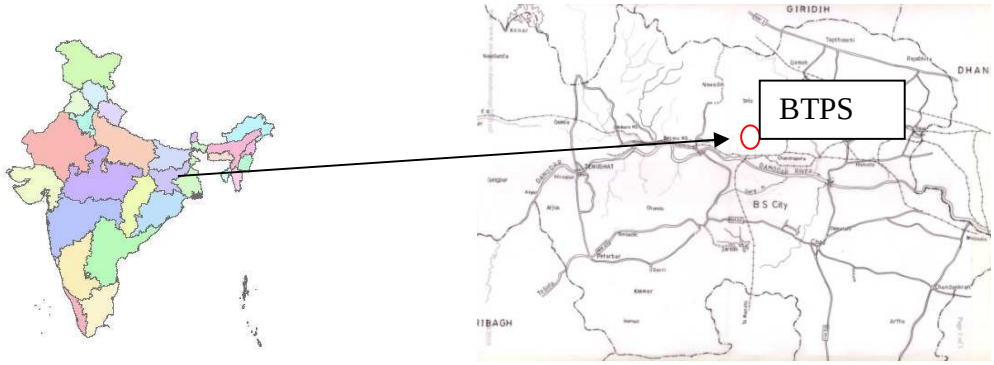

Figure 1. Location of BTPS in Jharkhand, India. (map not to scale)

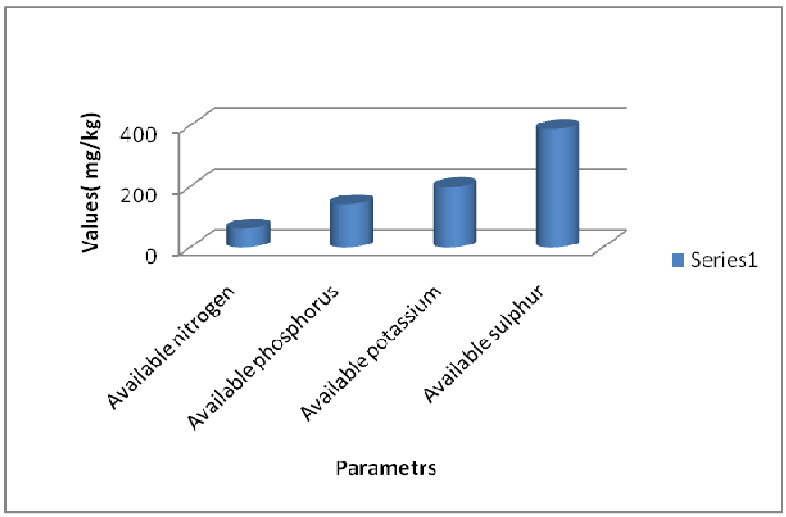

Figure 2. Chemical properties of fly ash, BTPS, Jharkhand

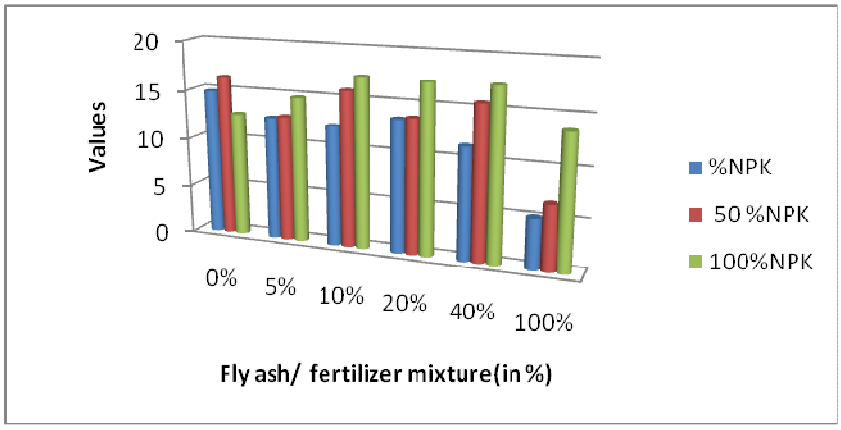

Figure 3. Effect of fly ash and fertilizer levels on dry matter yield (g/pot) of Pisum

CONCLUSION

On the basis of the several properties as well as growth experiment with Pisum (pea) with respect to suitable concentration of the fly ash the following conclusions can be drawn.

This fly ash can be used to increase the moisture content, improves the texture conditions and water holding capacity of soil due to its physical nature. The elements present in fly ash also improve the fertility of land.

Fly ash of BTPS has shown very high concentration of plant nutrients to support crops growth. Growth experiment with pea, showed beneficial effects up to 20% .So, it can be concluded that fly ash of BTPS can be used in the management of vegetation programmed as well as agricultural production. It is also noted that utilisation of fly ash of BTPS is always a better practices in bio reclamation than its disposal in bare land. This baseline data can be used in bioreclamtion.

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