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SOIL AMENDMENT WITH COAL DUST AND ITS CONDITIONING: IMPACT ON FERTILITY STATUS AND ITS PRODUCTIVITY

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ABSTRACT

Soil amendment with coal dust in different proportions may play an important role in the soil matrix. Particles spread on land in the mining areas, during transportation on road sides, and coal dust during pulverization and storage (coal stack yard). Coal dust particles, therefore, necessitate the need for knowing the impact/effect on the soil matrix and its ultimate effect on the fertility status and productivity of the soil. Amendment through soil conditioning with the use of micro-organisms within the soil matrix using natural biological activity may be an important factor in the soil matrix on the fertility status and productivity of the soil. Moreover, it will be a viable treatment option for the remediation of coal particle-contaminated soils or the use of coal-dust-amended soil for the reclamation of waste land in a cost-effective manner with a minimum threat to the soil. The mixed microbial consortium present in the soil was used to accelerate the conditioning of the soil. This culture of microbial consortia, along with nutrients, acts in various in situ conditions of coal-contaminated soil to help remove heavy metals present in coal, as well as different organic compounds in the soil, and serves as a manure for plant growth. In the present study, pot experiments were conducted for the germination of different plants by amending coal dust particles with soil. It was observed that the soil remediation with coal dust particles is extremely useful tool for improving the quality of poor wasteland soil without the use of fertilizer because of the conversion of hydrocarbons present in coal dust into manure with the help of soil micro flora which helps for the growth of plants. The soil quality was found to be improved after remediation with respect to cation exchange capacity (CEC) and organic matter content. There was no degradation found in soil quality after germination and frequent use under control conditions will help for the next crop growth. The present study reflects that the coal dust particles amended soil or wasteland soil not only helps to increase the productivity of soil but also the ultimate use of the coal dust particles in soil also creates to cleanup existing soil contamination and help to restore soil quality in a cost effective manner.

1. INTRODUCTION

Vigorous activities are running presently in coal mining areas for the extraction of coal followed by transportation to be used as fuel in thermal power plants for energy production. Due to these activities various kinds of pollutants present in coal dust particles are emerging out due to transportation and also extraction of coal from coal mines ultimately contaminate the soil and aqueous media due to fall out on land.

Contamination of soil is a serious problem especially in India (1,2). The biological activity in soil matrix is known to be regulated by several abiotic factors (3,4), making each site unique with respect to the microbial activity, metabolicing multitude of xenobiotic chemicals (5,6). It is, therefore, interesting to understand the distribution of microbial population in varying environments, as they reportedly play an important role in the mineralization, complexation of organic matter and degradation of several environmental pollutants and soil contaminants (7,8).

This created problem in the soil if not properly managed, deteriorates the soil quality periodically by prolong use. Accordingly, the present research work is dealt with the conditioning of soil with coal dust through amendment and to observe the effect on plant growth and soil characteristics or the soil remediation.

Conditioning of soil with coal dust in different proportion plays an important role in the soil matrix. One of the methods is Bio-remediation. It is known to be an effective and environmentally safe cleanup treatments. Bioremediation through soil conditioning is the use of micro-organisms to destroy contaminants using natural biological activity. It is a viable treatment option for decomposition of hydrocarbons and conversion of heavy metals in nontoxic ways in the coal dust contaminated soils or use for reclamation of wasteland in a cost effective manner with a minimum threat to the environment. The mixed bio-consortium present in soil could be used to accelerate the degradation for the removal of pollutants. This culture of the microbial consortia alongwith nutrients when act in various contaminated soils insitu condition helps for the remediation of soils and act as a manure for the growth of the plants. The plantations of different species have maintained the nutrient regeneration due to addition of organic matter and its further decomposition. Increasing availability of organic matter also enhanced N – N-mineralization, and hence the supply of plant-available nutrients. The enhancement in plant-available nitrogen due to plantations will be further helpful in soil-nutrient cycling (9).

The present study indicates that the bacterial culture present in soil matrix is capable for remediate the soil and could be applied to scattered and remote sites to get a cleaner and greener environment. Bioremediation through conditioning of soil is a less expensive tool than the other technologies to combat environmental hazard. An attempt has been made to observe the effect of coal dust contaminated soil containing variable pollutants like heavy metals & Hydrocarbon i.e., high and low molecular weight compounds on the plant growth when mixed in different proportion with the soil with proper conditioning. Accordingly pot experiments were conducted for the growth of plants in different proportion of coal dust with soil. Observations were made for plant growth rate, flowering time and fruit generation with the physico-chemical characteristics of amended soil after the growth.

2. MATERIAL AND METHODS

2.1. CHEMICALS AND REAGENTS

All chemicals, reagents and solvents used in the present study were of Analar/AR/Guaranteed reagent grade.

Glass Wares

All glass wares used in the study were of Borosil make. Prior to use, the glass wares were soaked in nitric acid (10%) solution for 24 hours, then washed with tap water and further rinsed with double distilled water prior to use.

Metal Solution

Stock metal solution of 1000 ppm of multi standards (Merck) was used. This was further used to prepare dilute solutions of desired concentrations for use in the experiment.

Instruments/Equipment

The instruments & equipment used for the study were pH Meter (model-APX 175 E/C), Conductivity Meter, (model AP X – 185), Ion Analyzer (ORION make model 720), Flame Photometer (Model No. 410, Corning, USA), Atomic Absorption Spectrophoto meter Perkin Aelmar and Gas Chromatography.

Physico-chemical Parameters, their Methods of Analysis

The physico-chemical analysis of soil was carried out by estimating parameters of significance as (i) physical parameters, (ii) Inorganic parameters, (iii) organic parameters, (iv) Nutrient parameters and (v) heavy metals. These parameters were analysed as per standard methods (10,11,12,13,14,15).

Physico-chemical Characteristics of Reference Soil (Control) and Amended Soils

Representative soil sample from depth of (0-15 cm) was collected with the help of augar and spade for estimation of physico-chemical characteristics and experimentation. This soil was further mixed with coal dust in different proportions. These amended soils were characterized physico-chemically before and after the crop growth. Standard methods (Jackson, 1976) (15) were followed for the anlaysis of different soil quality parameters of these soil samples.

Physical parameters such as bulk density, porosity and water holding capacity were determined by following KR Box Method (15).

The chemical characteristics were determined by preparing soil extract in distilled water in ratio 1:1 (as per Jackson procedure, 1967). Organic carbon was determined by Walkley & Black method (1972) (15). Fertility status of soil in terms of available nitrogen, phosphorus and potash was determined by nitrogen Kjeldahl method, extracting soil with KCl (FAO Soils Bulletin, 38/2 Rome)(14) and Olsen's method (1954)(15) respectively.

Exchangeable sodium percentage (ESP) very essential to know the productivity of the soil. The presence of sodium in exchangeable form may have deterious effect on the chemical and physical properties of soil. ESP between 4-10 can be considered as satisfactory (15). Exchangeable sodium percentage (ESP) was determined by the standard formula as given below :

$$ESP = \frac{Na^{+}}{Ca^{++} + Mg^{++} + Na^{+} + K^{+}} \times 100$$

Coal dust Analysis

Coal dust samples were collected from the coal crushing area of coal mine mixed thoroughly and made comparative and analysed as follows:

1) Proximate Analysis as percentage of moisture, Ash, volatile matter and fixed carbon.
2) Ultimate Analysis as percentage of carbon, Hydrogen, Nitrogen, Sulpher and Oxygen content.

Experimental

1) Amendment of coal dust with Soil

Pot culture experiments were carried out in the control and amended soils for the germination of different crops under various composition of soil and coal dust. In this, earthen pots of around nine inches diameter were taken in which soil, mixture of soil with coal dust in given proportion (1 to 6% in 5 kg soil per pot) were added upto a depth of 2-2.5 inches. The control and amended soils were conditioned daily by mixing them thoroughly with the addition of water.

The detailed layout of the experiment and operational parameters are as follows :

Layout and Operational Parameters (Experimental Design)

- Size of each pot 15 litre capacity
- Diameter 9 inch (22.86 cm)
- Net Area 410.2 sq.cm.
- Depth of each bed 2-2.5 inch (5-6.25 cm)
- Plant to plant space 1 cm
- Number of treatment 7
- Number of Pots/Treatments 2
- Total number of pots 7×2 = 14 Nos.

Treatment Details

- Blank = Soil (Control) (5 kg)
- 1% = Coal dust (50 gm) + Soil (5 kg)
- 2% = Coal dust (100 gm) + Soil (5 kg)
- 3% = Coal dust (150 gm) + Soil (5 kg)
- 4% = Coal dust (200 gm) + Soil (5 kg)
- 5% = Coal dust (250 gm) + Soil (5 kg)

- 6% = Coal dust (300 gm) + Soil (5 kg)

3. SOWING OF WHEAT AND GRAM

1) Above pots (consisting of 2 Blank readings of soil and treatments of 1 to 6% with various proportion of coal dust & Soil) were watered for 3-4 days before sowing of seeds for conditioning
2) Equal number of wheat grains (10 Nos) were sown at a distance of 1 cm apart in the above pots
3) Starting from day 1 after sowing, the seeding emergence, seedling growth and plant height were recorded properly for a period of flowering and fruiting.
4) Similar experiment and treatment were given for the gram also

4. EXPERIMENTAL RESULTS

Pot culture experiments were carried out for germination of wheat and gram crops. The control soil and soil amended with coal dust were used in the experiment and characterized for their physico-chemical parameters (Table 1) Coal dust was analysed as (i) proximate analysis comprising percentage of moisture, ash, volatile matter and fixed carbon. (ii) Ultimate analysis in terms of percentage of carbon, hydrogen, nitrogen, sulphur and oxygen. (iii) Ash analysis was carried out for different cations and anions ingredients as shown in Table 2. The details of morphometric data such as germination rate, plant height and number of fruits at different time intervals i.e., on 5th day, 15th day, 30th day were recorded and depicted in Figs. 1-3 respectively for grams and Figs. 4-7 for wheat. The fresh and dried weights of grams & wheat fruits were also measured and shown in Tables 3 & 4 respectively. The physico-chemical characteristics of control soil and amendate soil with coal dust after harvesting were carried out and presented in Tables 5 & 6 respectively. The growth rate of crops in different treatment during the experiment is shown in Plates 1-6 for gram and wheat.

Table 1 shows that the soil (control) was alkaline in reaction having pH 8.19 showing a perfect pH conditions for plant growth as per ICAR soil classification for crop growth. Whereas coal dust amended soils showed increased electrical conductivity considerably might be due to the leaching effect of minerals present (Table 2) in the coal dust and mixed with soil. The bulk density was increased in the amended soils whereas porosity and hydraulic conductivity decreased slightly. This might be due to the compactness of the soil. There was considerable increase in the organic load in the amended soils as compared to control soil whereas the nutrient load in the form of Nitrogen and Phosphorus content increased in the amended soils, as compared to control soil.

The morphological characters of plants grown in control soil and the amended soils were carried out with respect to germination growth rate in terms of flowering and fruitings height. It was observed that the number of plants of gram grown were found to be comparable initially but the growth rate was decreased slightly or became constant after 15 days. There was 70-80 percent growth observed as compared to control. Whereas encouraging results were observed for wheat in amended soils as compared to control soil. The growth rate interms of height was found to be increased considerably with the germination rate 80-100 percent. The growth rate from 5th day onward till its maturity period was found to be extremely good as compared to control soil and shown Figs. 1-7.

After flowering period, the number of fruits were observed and weighted. It was observed that the fruits grown in the amended soil were comparable for both the plants. Healthy fruits were grown in the 1-2% amended soils, however in other amended soils, the fruits weights were considerable. The results are presented in Tables 3-4 respectively for both the plants with respect to fresh weight and the dry weight basis.

To observe the effect on soil after the germination of plants, control and the amended soils were analysed physico-chemically and presented in Tables 5-6 respectively. It was observed that there was not much change in the characteristics, however the organic content and the cation exchange capacity were found to be increased considerably in the amended soils as compared to control.

5. RESULT AND DISCUSSION

Table 1 Physico-chemical Characteristics of Control and Amendate Soil Before Study Period

Sr. No.	Parameters	Control	1%	2%	3%	4%	5%	6%
			Proportion of coal dust and soil					

Physical Analysts								
1.	pH	8.19	8.20	8.26	8.31	8.37	8.40	8.44
2.	ECe (mS/cm)	0.48	0.51	0.66	0.93	0.96	0.98	1.06
3.	Bulk density (g/m^3)	1.38	1.42	1.56	1.78	1.79	1.82	1.92
4.	Water Holding Capacity (%)	58.20	57.60	56.20	55.80	55.30	54.80	54.70
5.	Porosity (%)	42.60	39.80	36.70	36.40	34.20	34.10	33.20
6.	Hydraulic conductivity (m/hr)	5.80	5.60	5.40	5.20	5.20	5.10	5.00
Chemical Analysis								
7.	Calcium (mg/l)	1.10	1.80	2.20	2.60	2.80	3.20	4.30
8.	Magnesium (mg/l)	0.30	0.20	1.60	2.00	2.40	2.80	3.10
9.	CEC (meq/100g)	48.80	48.60	48.80	48.80	48.70	48.80	48.80
10.	ESP	6.10	5.90	6.00	6.10	6.10	6.10	6.10
Major Available Nutrients								
11.	Total Nitrogen (%)	2.04	1.06	1.20	1.52	1.70	1.93	1.98
12.	Organic Carbon (%)	0.72	1.32	2.12	3.45	5.04	6.50	8.49
13.	Total Phosphate (mg/kg)	2760	2840	2920	3000	3060	3120	3180
14.	Na (meq/l)	270.20	270.10	272.40	277.60	282.10	289.20	292.10
15.	K (meq/l)	160	143.10	148.30	251.20	255.30	260.40	265.10

Table 2 Coal Dust and Ash Analysis

Sr. No.	Parameters	Concentration Level in Percentage (%)
Proximate Analysis		
1.	**Moisture**	**12.8**
2.	**Ash**	**38.2**
3.	**Volatile Matter**	**20.3**
4.	**Fixed carbon**	**28.7**
Ultimate Analysis		
5.	**Carbon**	**39.60**
6.	**Hydrogen**	**1.42**
7.	**Sulphur**	**0.48**
8.	**Nitrogen**	**0.34**
9.	**Oxygen (by difference)**	**5.68**
Ash Constituents		
10.	**SiO_2**	**60.10**
11.	**Al_2O_3**	**22.40**
12.	**Fe_2O_3**	**9.20**
13.	**CaO**	**1.30**
14.	**MgO**	**0.20**
15.	**Na_2O+K_2O**	**0.60**
16.	**TiO_2**	**1.80**
17.	**P_2O_5**	**0.30**
18.	**SiO_3**	**6.10**

Table 3

Fresh Weight of Fruit

Sr. No.	Plants	Fresh Weight of Fruit in gms						
		C	1%	2%	3%	4%	5%	6%
1.	Gram	7.53	7.21	6.98	7.08	6.21	5.80	5.50
2.	Wheat	8.98	9.28	7.86	7.70	7.04	6.68	6.60

C : Control

Table 4 Dry Weight of Fruit

Sr. No.	Plants	Dry Weight of Fruit in gms						
		C	1%	2%	3%	4%	5%	6%
1.	Gram	2.24	2.10	1.57	1.99	1.69	1.57	1.31
2.	Wheat	3.10	3.21	2.65	2.11	2.10	1.92	1.86

C : Control

Table 5 Physico-chemical Characteristics of Control and Remediate Soil Samples after Study Period for Gram Plant

Sr. No.	Parameters	Control	1%	2%	3%	4%	5%	6%
			Proportion of soil with coal dust					
Physical Analysts								
1.	pH	8.73	8.71	8.64	8.62	8.60	8.58	8.52
2.	ECe (mS/cm)	0.31	0.36	0.39	0.43	0.45	0.49	0.51
3.	Bulk Density (g/m^3)	1.36	1.38	1.48	1.52	1.56	1.62	1.64
4.	Water Holding Capacity (%)	58.20	57.40	56.10	55.30	55.60	54.60	54.90
5.	Porosity (%)	39.20	38.10	37.40	36.20	34.10	33.80	33.10
6.	Hydraulic Conductivity (cm/hr)	5.60	5.20	5.00	4.80	4.70	4.70	4.80
Chemical Analysis								
7.	Calcium (meq/l)	0.80	1.00	1.00	1.20	1.40	1.60	1.80
8.	Magnesium (meq/l)	1.80	3.40	2.80	2.40	1.80	1.20	0.60
9.	CEC (meq/100 g)	46.30	49.20	50.20	51.30	55.20	56.30	58.90
10.	ESP (%)	6.10	5.80	6.00	6.00	6.00	5.90	6.00
Major Available Nutrients								
11.	Total Nitrogen (%)	1.65	1.76	1.98	2.21	2.40	2.50	2.77
12.	Organic Carbon (%)	0.72	1.99	4.89	5.85	7.30	8.45	11.83
13.	Total Phosphate (mg/kg)	2760	2860	2920	2960	2960	3000	3080
14.	Na (mg/kg)	255.80	255.90	260.70	263.10	267.90	275.10	277.60
15.	K (mg/kg)	253.40	251.00	251.00	255.80	260.70	265.50	267.90

Table 6 Physico-chemical Characteristics of Control and Remediate Soil Samples After Study Period for Wheat Plant

Sr. No.	Parameters	Control	1%	2%	3%	4%	5%	6%
			Proportion of coal dust with soil					
Physical Analysts								
1.	pH	8.62	8.59	8.51	8.48	8.39	8.32	8.28
2.	ECe (mS/cm)	0.54	0.34	0.37	0.43	0.45	0.48	0.52
3.	Bulk Density (g/m^3)	1.26	1.32	1.38	1.42	1.46	1.48	1.41
4.	Water Holding Capacity (%)	58.10	56.20	56.10	55.80	55.20	54.30	54.10
5.	Porosity (%)	39.10	38.00	37.20	36.20	34.20	38.60	33.10
6.	Hydraulic Conductivity (cm/hr)	5.20	5.00	4.80	4.30	4.10	4.10	4.00
Chemical Analysis								
7.	Calcium (meq/l)	1.00	1.00	1.20	1.40	1.40	1.60	1.80
8.	Magnesium (meq/l)	3.80	3.20	2.40	1.80	1.20	0.60	0.20
9.	CEC (meq/100 g)	46.20	48.60	50.10	51.20	51.60	52.20	54.60
10.	ESP (%)	6.10	5.90	5.80	6.00	5.90	5.40	5.60
Major Available Nutrients								
11.	Total Nitrogen (%)	1.70	1.82	1.87	2.03	2.12	2.29	2.40
12.	Organic Carbon (%)	0.76	1.98	3.52	5.01	5.79	7.16	10.42
13.	Total Phosphate (mg/kg)	2740	2840	2900	2960	3000	3020	3120
14.	Na (mg/kg)	255.80	258.20	260.70	260.80	265.50	267.90	272.70
15.	K (mg/kg)	251.00	253.40	253.30	258.20	263.10	265.50	267.90

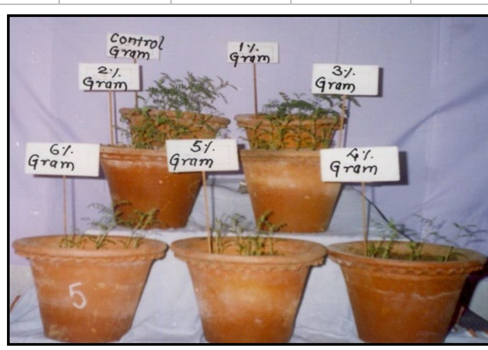

Plate 1 Pot Culture Experiments

for the Germination of Gram Plants in Soil (Control) and Amended Soils

Plate 2 Pot Culture Experiments
for Gram Plants in Soil (Control) and Amended Soils (Flowering Time)

Plate 3 Pot Culture Experiments
for Gram Plants in Soil (Control) and Amended Soils (Fruit Germination)

Plate 4 Pot Culture Experiments
for Wheat in Soil (Control) and Amended Soils

Plate 5 Pot Culture Experiments
for Wheat in Soil (Control) and Amended Soils (Flowering Condition)

Plate 6 Pot Culture Experiments
for Wheat in Soil (Control) and Amended Soils (Fruit Germination)

Experimental Soil: Characteristics

The control of soil used in the experiment was blackish-brown in colour. It was alkaline in nature. The water holding capacity was comparable after remediation and nutritionally the soil was found to be good. Total nitrogen, available phosphate, calcium and magnesium were sufficient in range. Overall, the soil was good for the growth of plant. Heavy metals were in non detectable levels and there will not be any input from the water to be supplied when applied during the growth of the plant.

Amendment of Experimental Soil with coal dust

It was observed that before sowing, soil was alkaline in reaction and after germination it was found the same in nature, this probably gives a perfect pH condition even after harvesting and remediation. The experimental soil has some amount of organic matter before sowing but after sowing it showed increasing organic load in the form of carbon content, Na and K also. This indicates that there is certain microbial activity going on in the soil matrix in situ condition decomposed the organic matter and converted into other organic compounds supporting for the growth of the plant as a manure. There was slightly change in the porosity and water holding capacity in the soil and coal dust amended soil before and after the harvesting of both the crops. This might be due to compactness of the soil during the germination period. Thus, it is evident that remediation could be possible and beneficial for improving soil characteristic and crop yield.

Effect of Soil Remediation on Plant Germination and Height

After amending soil with coal dust in different proportions and with proper conditioning, the plant growth rate was observed. Plant height was found to be better with 1%, 2%, 3% for both plants and comparable with growth rate in control soil. This might be due to presence of better texture, trace nutrient, porosity and good water holding capacity and better conditioning with the microbial activity. The plants were healthy in 1%, 2%, 3% remediates as compared to control soil. The growth of plants gram and wheat during the study period are shown in Plates 1-6 respectively.

Effect of Coal Amendment on Biomass Production

For any soil, the important factor is the productivity. If the productivity of soil is good, then this will lead for more growth of plants and grain production. To see the productivity of the soil when amended in different proportions of coal dust, weight of fruits were measured. The observations on the fresh weight of fruits are shown in Tables 3-4 respectively for gram and wheat. The biomass was good in all the treatments. However best results were observed when soil amended with coal dust in 1%, 2%, 3%. Morphologically the plants were healthy in all the treatments.

Effect of Soil Remediation on Soil Quality

After the experiments i.e., full germination period, the soil quality (control) and amended soils were physico-chemically characterised and presented in Tables 5-6 after gram and wheat germination. It was observed that the pH of soil was found to be increased at the end of experiment, electrical conductivity was also increased in both the treatments. Nutrient content in soil amended with coal dust was found to be changed. However, concentration levels of calcium, magnesium, sodium & potassium were found to be decreased. This might be due to the uptake of the water holding capacity was decreased due to the interaction of coal dust and soil ingredients followed by microbial activity and also the exchange phenomenon in the soil matrix in situ condition. It was observed that, the microbes which were present in soil, degraded/decomposed the organic matter present in coal dust and converted into manure supporting for the growth of plant. After experiment, the quality of the amended soils was found to be improved with respect to soil fertility. The present study indicated that the crops grown on soils amended with coal dust at limited proportion are quite good as far as soil remediation in concerned.

6. CONCLUSION

Soil remediation with coal dust is extremely useful tool for improving the quality of soil without the use of fertilizer because of the decomposition of hydrocarbons present in coal dust and conversion into manure through microbial activities in soil matric and supporting for the plants crops growth.

Coal dust deposited on soil due to transportation of coal and surrounding coal mining activities contains wide variety of carbonaceous compounds and heavy metals which are potentially harmful to the environment. So, soil remediation by amending with proper conditioning of soil in a definite proportion will be better option for plant growth as well as to pollution control.

The soil quality after amendment and germination was found to be improved with respect to Cation Exchange Capacity (CEC) and organic matter content. There was not much change found in soil quality after germination and frequent use under control conditions will help for the next crop growth.

From the experiments, it was observed that soil remediation with coal dust in optimized condition will prove to be a major tool for the utilization of the wasteland which has a poor productivity could be used for the growth of crops/vegetation. The use of coal dust particles by amending wasteland soil not only helps to increase the productivity of soil but also the ultimate use of the coal dust and also creates to clean up existing environmental contamination and help to restore environmental quality in a cost effective manner.

7. PRECAUTIONARY MEASURES

Coal Mining whether surface or ground have vigorous activities related to the excavation, extraction, segregation, storage/dumping and transportation. During all these activities coal dust spread depending on the meteorological conditions and ultimate fall out of the coal particles on land may create environmental problems and also the degradation of land / soil quality in a longer period, leading to poor crops/plants productivity. Mine soils have a multiple problems, the major problems are related to change in soil pH and leaching of minerals, changing the soil chemistry and ultimately affecting the soil productivity. However, from the present investigation and study carried out, it is to be mentioned here that if soil or degraded soil is amended with coal dust in a definite proportion with proper soil conditioning proved to be beneficial for the growth of plants and also crops production without changing the soil quality after harvesting, moreover the carbon and nutrient load increase are supporting for the plants/crops growth.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

Alexander, M. (1977), “An Introduction to Soil Microbiology”, 2nd edition, John Wiley and Sons, pp. 438-456

IARC, (1983), (International Agency for Research on Cancer), Polycyclic Aromatic Compounds. Part I, Chemical, Environmental and Experimental data. Monographs of the evaluation of the Carcinogenic Risk of Chemical to Humans, Lyon, 32 : pp. 31-39.

Ashok, B.T.; Saxena, S. (1995), “Biodegradation of Polycyclic Aromatic Hydrocarbons : A Review”, Journal of Scientific and Industrial Research, 54, pp. 443-541

Stroo, H.F. (1992), “Biotechnology and Hazardous Waste Treatment”, Journal of Environmental Quality, 21 : pp. 167-175

Ashok, B.T.; Saxena, S.; Singh, K.P. and Musarrat, J. (1995), “Biodegradation of Polycyclic Aromatic Hydrocarbons in Soil around Mathura Oil Refinery, India”, World Journal of Microbiology and Biotechnology, 11, pp. 691-692

Lynch, J.M. (1983), “Microbiological Factors in Crop Productivity In : Soil Biotechnology”, Oxford, Blackwell Scientific

Attilio Bisio; Sharon Boots (1997), “The Wiley Encyclopedia of Energy and the Environment”, Vol. 2, A Wiley Interscience Publication, John Wiley and Sons Inc., New York, pp. 1000-1008

Bhattacharya, K.G.; Shoudhury, S.K. and Sarma, P.C. (2000), “Effect on pH and Electrical Conductivities of Soil with R/P to Extent of Degradation of Petroleum Hydrocarbon in Soil under Natural Environment”, Vol. 2

Gudadhe S.K. and Ramteke D.S. (2012) Impact of Plantation on Coal Mine Spoil Characteristic, International Journal of Life Sciences. Biotechnology & Pharma Research, Vol.1 (3): 84-92.

Purohit, S.S and Saxena, M.M. (2024) Water, Life and Pollution, A Wiley, interscience publication, John Wiley and Sons Inc., New York.

CSIR News, Vol. 49, No. 13, 15, (July 1999)

Bitton, L.N.(1984), Microbial Degradation of Aliphatic Hydrocarbons, in Microbial Degradation of Organic Compounds”, Gibson D.T. Ed., Marcel Dekker, New York

Standard Methods for the Examination of Water and Wastewater, 16th Edn., 1985, APHA, AKWA, WPCF, Washington D.C. 20005

Sexena, M.M. (1990), “Environmental Analysis : Water, Soil and Air”, Second Edition, Bikaner 334001 (India)

Jackson, M.L. (1976) "Soil Chemical Analysis" (Prentice Hall of India Pvt. Ltd.), New Delhi.