Analysis of Heavy Metals on Ornamental Plant by Use of Fly Ash and Amended Soil– An Experimental Approach

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***Abstract*- The disposal and treatment of coal fired power plant generated fly ash is a major problem till date. Ornamental plant can be used to extract the heavy metals present in fly ash from terrestrial ecosystems . For this purpose calendula officinalis, a ornamental plant was chosen to assess its bioaccumulation potential of Cd,Pd,Cu and Mn from the fly ash amendment soil. Fly ash from Chandrapura Thermal Power Station (CTPS) OF Dhanbad dosed in manure mixed CIMFR garden soil in 0%, 10%, 20%, 30%, 40%.The plants were grown for three months. Each harvesting was done after three month and growth and metal concentration in Leaf, flower and soil amenment were estimated. It was found that plant growth maximum in 40% but not any particular difference Bioaccumulation of heavy metals in fly ash amendment. In this study total bioaccumulation metals by calendula officinalis, was calculated as the product of biomass and tissue metal concentration. Fom the study it was concluded that caleendula officinalis plant can be usd. For maximum bioaccumulation of flyash amendment were not clearly found. However, significance level showed that the zig-zag difference in metal content in the plant parts such as Leaf, flower and fly ash amedment.**

***Index Terms*— Fly ash, Ornamental plant, Amendment, Heavy metals analysis.**

I. INTRODUCTION

Fly ash is a burning of coal and lignite the organic source of energy. Particles of fly ash found in the size range from 0.01 to 100 mm[1]. Chemically fly ash contain, oxides, Iron, Aluminum , andother metals in trace amount [2]. The Ph of fly ash 4.5 to 12.0 [3]. Fly ash are generally two type class F and class C. Fly ash is the major waste product of thermal power plants.

Every year thermal power plant in India produce more than 100 million of fly ash [4]. Which is expected to reach 175 million tons in future [5]. India ranks fourths in world in the production of coal in China [6]. Most fly ash are disposed in landfill like fly ash ponds 30% is used in construction engineering manufacturing and agricultural activities [7]. The use of fly ash in soil additives or soil amendments to enhance establishment and growth of vegetation on coal mined lands as agriculture soils has extensively studies [8].

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Fly ash has characteristics that could be affect plant growth or environmental if improperly used. Soil amendment material generally used in agricultural production can be both positive and negative effects on soil and environmental quality. Fly ash form a soil amendments is as a source of nutrient elements for plant growth [9]. It contains useful components such as Ca, Mg, Fe,Cu, Zn, Mn, B and P and little amounts of toxic heavy metals such as Cr, Pb,Hg, Ni [10,11]. The toxic heavy metals affect on microbial population or soil fertility [12]. Coal combution as soil amendment act as a liming agent to neutralize soil acidity [13,14] and improve crop production [15]. Fly ash is rich source of carbon or active silicic acid [16] which improves soil organic matter content water holding capacity soil structure and bulk density [17]. Heavy metals are among the contaminats in the environment. Migration of these contaminants into non contaminats areas as dust or leachetes through the soil and spreading of heavy metals cantaining sewage and sluge, are some example of contamination of ecosystem [18]. Different type of method are available used to clean up the environment from contamination. Now a day phytoremediation has because effective and affordable technological solution used to extract or remove toxic metals from contaminated soil. Plant has extra-metal accumulating capacity are known as hyperaccumulator plants [19]. Toxic heavy metals harmful effect on biological systems and dose not biodigradation . Some heavy metals can be biodegraded but can be accumulated in living organisms.

They causing various type disease and disorders [20]. Our aim of the experiment to grow ornamental plants (calendula officinalis) in fly ash amended soil at different ratio (concentration). How much accumulate of heavy metals such as Cd, Pb, Cu, and Mg uptake by marigold plant tissue (leaf, flower) and different soil amendment. We want to research that fly ash amendment in different ratio is beneficial or harmful for our agriculture field or crop production. To study the our experiment uptake of heavy metals by marigold plant tissue (leaf, flower) and soil amendment we observed that heavy metals accumulation (Mg/kg) in different concentration in marigold plant tissue we not found any maximum accumulation of heavy metals concentration by experimental plant. All heavy metals concentration (mg/kg) that we found, i.e. zig – zag ratio which essential for human being and agriculture field or crop production. All over experimental is prove that fly ash is eco-friendly and beneficial for our horticulture and agriculture.

II. MATERIALS AND METHODOLOGY

a). Collection of fly ash- Fresh fly ash samples were collected from Chandrapura thermal power station of Damodar valley corporation. It is located in the state of Jharkhand covering on area of 790 hectare of land and is about 45-50 km west of Dhanbad.

b). collection of soil –Soil samples were collected from native garden soil of central institute of mining and fuel research Dhanbad.

c). preparation of pots- Experiment design- we taken ten pots for experiment in which five pots is main part of experiment and five pots are duplicate of each one pots. Such ads- **0% (i) (ii), 10% (i) (ii), 20% (i) (ii), 30% (i) (ii), 40% (i) (ii) (Table-1).** Our totals amendment set of pots is five.

COMOSITION OF FIVE POTS
O% (i), (ii) – 100%soil + Bone meal + potash + farm yard manure
10% (i), (ii) – 90%soil + 10% Pond ash + Bone meal + potash + farm yard manure
20% (i), (ii) – 80%soil + 20% Pond ash + Bone meal + potash + farm yard manure
30% (i), (ii) – 70%soil + 30% Pond ash + Bone meal + potash + farm yard manure
40% (i), (ii) – 60%soil + 40% Pond ash + Bone meal + potash + farm yard manure

TABLE-1

Farmyard manure and other manure mixture we taken in equal amount in all pots. Such as- Bone meal 50gm, potash 50gm, farmyard manure 500gm. Every sample of pots taken and mixed well with soil and every different ratio of sample kept in each pot.

d). plantation of marigold plants – we taken marigold plants form market of Dhanbad. Length of all marigold plants almost 3-4cm, of Anoka species, one by one marigold plant taken and planted in pot. All pots are kept in CIMFR garden. The plants were grown for a period of three months. When well growth of leaves and flower of marigold plants. We each harvest the marigold plant after 80 days.

Leaf sampling: - Leaves and flower have been collected from plant by removing several leaves and flower from the stem and kept in the plastic container nd labelled properly. Then they were brought to the laboratory and were washed with deionized water thoroughly for 3-4 times, followed by distilled water**.** The samples were properly dried in sunlight for a whole day followed by the oven drying at 75^0C for 48 hours. Then homogenized by motor and pestle ere sieved with 40 BSS sieve. Powered sample were in 40 BSS sieve size, kept in plastic container for metal analysis.

Soil sampling: - Mixture of soil samples were powdered by using motor and pestle and quoin- quartering was done, and then it is left overnight for bench drying in laboratory. After bench drying, samples were sieved by using 72 BSS sieve. The powered samples have been in 72 BSS sieve size, kept in Petri dishes for metal analysis.

Soil analysis: - a). pH- 30 gm of each soil sample taken in a beaker and 60ml of distilled water was added and mixed properly with the help of glass rod. Then pH was determined by using pH meter (Eutech instrument) after calibration.

b). Moisture sample- Silica dishes were weighed and 1gm of each soil sample was also weighed. These samples were oven dried at 108^0C for 1 hour and then cooled. Dishes were again weighed with samples and moisture content was taken out by using formula.

Loss of weight ÷ sample weight ×100 = % of moisture

Where,

Loss of weight = total weight – total weight after oven drying

Total of weight = sample weight + dish weight

c). Loss of ignition- Soil samples after calculating moisture content were put into the Muffle furnace at 900^0C- for 1 hour and cooled. Then again weight residues and calculate the loss of ignition by using formula.

$$A - B \div C - D \times 100$$

Where,

A= dish weight + sample weight after moisture

B= dish weight + sample weight after ashing

C= sample weight after moisture

D= Initial sample weight

d). Digestion- 2gm of dried soil from each sample was taken in beaker and 25 ml of 6N HNO_3 was added and kept for overnight **.** Single acid digestion as done on a hot plate at 70-80^0C for 4-5 hours, extract total soil metals and cooled. During heating on hot plate, distilled water was added to avoid the sample from drying. After cooling the digested solution was filtered through Whatman 42 filter paper into a 50 ml volumetric flask with distilled water. After dilution the digested solution was analysed for determination of metal by Atomic Adsorption Spectrometer (AAS "Thermo Scientific").

e). Leaf Analysis- 1- 2.5gm of each powdered leaf tissue was ached in a muffle furnace (lunar), initially at 450^0C for 45 minutes for charring to avoid the graphite formation then at 850^0C for 1 hour. The resulting ash was dissolved in 25 ml of 6N HNO_3 and heated at low temperature at a bought 70^0C for whole day on a hot plate to extract total leaf metals. Sample was cooled and filtered through Whitman 42 filter paper into a 50ml volumetric flask with distilled water. After the dilution samples were ready for ready for metal analysis by AAS.

f). Flower Analysis- 2-5 gm of each powdered flower tissue was ached in a muffle furnace (lunar), initially at 450^0C for 45 minutes for charring to avoid the graphite formation then at 850^0C for 1 hour. The resulting ash was dissolved in 25 ml of 6N HNO_3 and heated at low temperature.

g). Metal Analysis- The heavy metal (Cd, Pb, Cu, and Mn) for this study was chosen because all are common anthropogenic pollutant that are frequently investigated studies analyzing the metal content of soil and plant tissue. Determination of the Cd, Pb, Cu, Mn leaf flower and soil extracts was carried out by flame Atomic Absorption spectroscopy using a Thermo Scientific M series' Atomic Absorption spectrometer. This instrument was calibrated using standard solution containing known concentration of each metal (Cu-1 to 5 ppm, Cd- 0.2 to 0.8ppm, Mn -1 to 4 ppm, Pb- 2.5 to 10 ppm). Standard solution was prepared by diluting 1000 ppm of high purify stock solution (MERCK Standard Solution) of each metal in acidic water of pH<2.

These external standard solutions were used to generate calibration curves for assessing the concentration of each metal in the soil, leaf and flower sample. Analysis is done by using respective wavelength of Cu-324.7 nm, Mn-279.8 nm, Pb-217 nm, Cd-228.8 nm. Data quality was assessed by preparing and analysing a replica of every soil, leaf and flower samples by periodically reading the standard solution during analysis. All metal concentration values are reported as mg/kg and are based on soil, leaf and flower dry weight.

III. RESULT AND FINDING

The total heavy metal content in this fly ash amended soil in different ratio determined was found in the order of Mn > Pb >Cu > Cd. The pH of different amendments of fly ash with soil was observed as acidic in nature 0% pH was as 6.15 while that of 40% fly ash amendment is 6.31 so not any different is found in Table –II.

Sample no	Fly ash conc. %		pH Value	% of Moisture Content %	L.O .I (g/kg)
1	%	I	6.515	2.31%	6.519959
		II	6.2	2.78%	7.693099
2	0%	I	6.11	1.78%	6.536347
		II	6.3	1.53%	8.405238
3	0%	I	6.38	0.92%	7.382753
		II	6.24	0.55%	6.099229
4	30%	I	6.3	0.63%	5.633236
		II	6.3	0.52%	5.613383
5	0%	I	6.31	0.08%	4.333771
		II	6.31	1.01%	4.443996

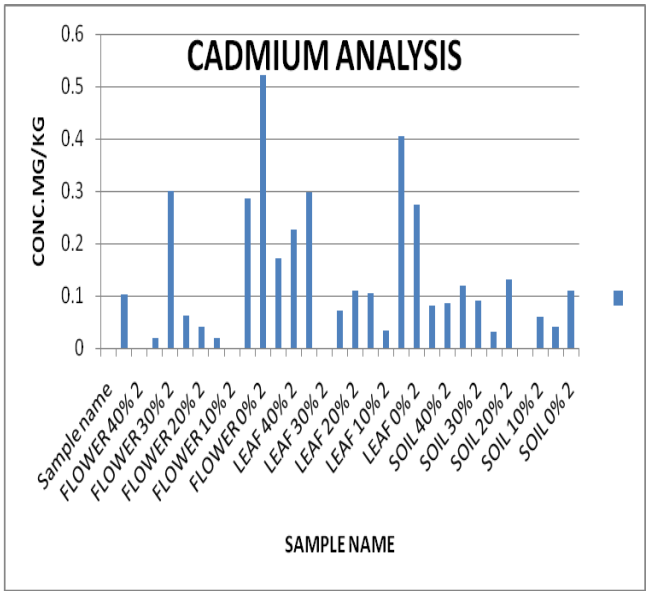
TABLE NO. II- ph and Moisture of loss of ignition content of fly ash sample.

Growth of plant- Shoots length has shown in 20% amendment for almost all the marigold plant. Flower amount on the other hand has shown in 40% amendment. Among the fly ash amended soils, the plant grown in 40% amendment showed the maximum growth and lowest growth was observed in plants grow in 10% fly ash further study it indicate that fly ash is supportive to plant growth.

Metal accumulation- The metal uptake is expressed as the total metal uptake, i.e. the product of biomass (dry wt) and the tissue concentration of metal. This will give a clear picture how much metal can be scavenged by a plant from the different amendment because for the field applications it is interesting to know the metal taken up by plant rather than tissue concentration.

TABLE- III **Accumulation of cadmium (mg/kg) in plant tissue (leaf, flower) and soil amendment soil in ornamental plant (calendula offinalis) in growing in different amended.**

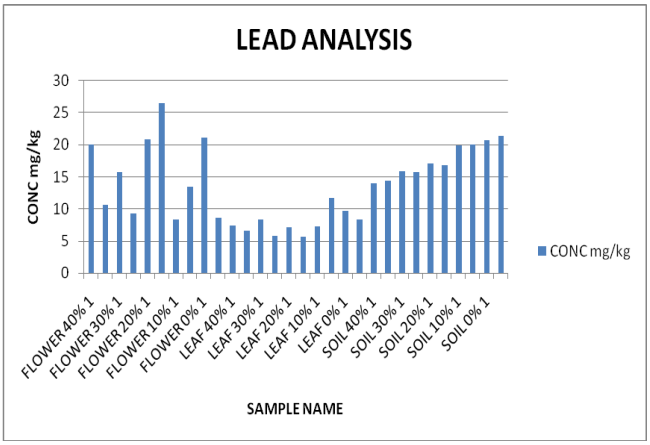
Sample name	Conc. mg/kg
FLOWER 40% 1	0.1016182
FLOWER 40% 2	BDL
FLOWER 30% 1	0.0178621
FLOWER 30% 2	0.3009127
FLOWER 20% 1	0.0617426
FLOWER 20% 2	0.0405515
FLOWER 10% 1	0.0197494
FLOWER 10% 2	BDL
FLOWER 0% 1	0.2865149
FLOWER 0% 2	0.5214612
LEAF 40% 1	0.1713277
LEAF 40% 2	0.2259326
LEAF 30% 1	0.2964599
LEAF 30% 2	BDL
LEAF 20% 1	0.0715636
LEAF 20% 2	0.1097092
LEAF 10% 1	0.1054852
LEAF 10% 2	0.0338715
SOIL 40% 1	0.079956
SOIL 40% 2	0.0849915
SOIL 30% 1	0.11997
SOIL 30% 2	0.0899685
SOIL 20% 1	0.029991
SOIL 20% 2	0.129896
SOIL 10% 1	BDL
SOIL 10% 2	0.059961
SOIL 0% 1	0.03999
SOIL 0% 2	0.1099175



GRAPH-A

TABLE-IV Accumulation of Lead (mg/kg) in plant tissue (leaf, flower) and soil amendment soil in ornamental plant (calendula offinalis) in growing in different amended.

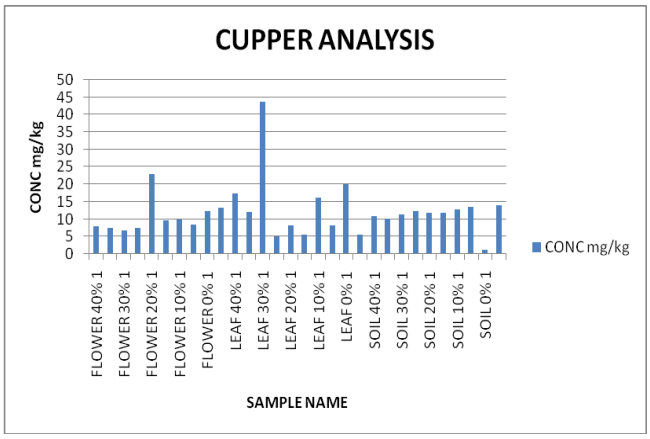
SAMPLE NAME	CONC mg/kg
FLOWER 40% 1	20.026459
FLOWER 40% 2	10.6533763
FLOWER 30% 1	15.6778687
FLOWER 30% 2	9.3082349
FLOWER 20% 1	20.8883229
FLOWER 20% 2	26.4855366
FLOWER 10% 1	8.3399164
FLOWER 10% 2	13.4470684
FLOWER 0% 1	21.164321
FLOWER 0% 2	8.6448034
LEAF 40% 1	7.377173
LEAF 40% 2	6.6347054
LEAF 30% 1	8.2776259
LEAF 30% 2	5.7996595
LEAF 20% 1	7.1911712
LEAF 20% 2	5.6289294
LEAF 10% 1	7.2131806
LEAF 0% 2	8.327947
SOIL 40% 1	13.9473289
SOIL 40% 2	14.4185581
SOIL 30% 1	15.8610347
SOIL 30% 2	15.7544859
SOIL 20% 1	17.149855
SOIL 20% 2	16.7815747
SOIL 10% 1	19.8681121
SOIL 10% 2	20.0919402
SOIL 0% 1	20.6648337
SOIL 0% 2	21.4089432



GRAPH- B

TABLE-V Accumulation of Cupper (mg/kg) in plant tissue (leaf, flower) and soil amendment soil in ornamental plant (calendula offinalis) in growing in different amended.

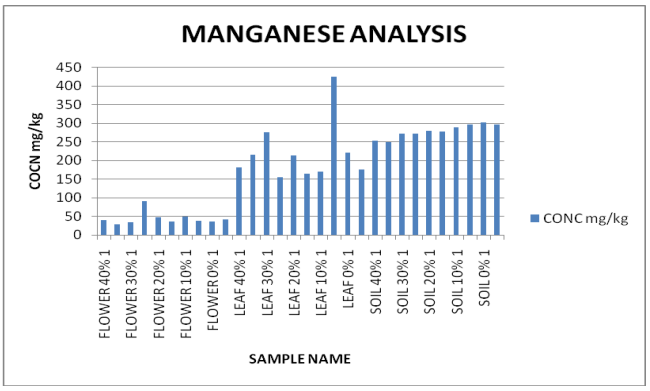
SAMPLE NAME	Conc. mg/kg
FLOWER 40% 1	8.0585167
FLOWER 40% 2	7.4700391
FLOWER 30% 1	6.8207915
FLOWER 30% 2	7.5395365
FLOWER 20% 1	22.9721386
FLOWER 20% 2	9.6701811
FLOWER 10% 1	9.9480871
FLOWER 10% 2	8.4966102
FLOWER 0% 1	12.3043984
FLOWER 0% 2	13.2746563
LEAF 40% 1	17.4099269
LEAF 40% 2	12.1562792
LEAF 30% 1	43.7423705
LEAF 30% 2	5.1188299
LEAF 20% 1	8.151306
LEAF 20% 2	5.5867336
LEAF 10% 1	16.2045408
LEAF 0% 2	5.4492119
SOIL 40% 1	10.809055
SOIL 40% 2	10.1689831
SOIL 30% 1	11.3871532
SOIL 30% 2	12.2207227
SOIL 20% 1	11.8164455
SOIL 20% 2	11.7505995
SOIL 10% 1	12.9190188
SOIL 10% 2	13.5062209
SOIL 0% 1	1.322169
SOIL 0% 2	13.9495378



GRAPH-C

TABLE-VI Accumulation of Manganese (mg/kg) in plant tissue (leaf, flower) and soil amendment soil in ornamental plant (calendula offinalis) in growing in different amended.

SAMPLE NAME	Conc. mg/kg
FLOWER 40% 1	40.1909655
FLOWER 40% 2	27.9096566
FLOWER 30% 1	33.4354027
FLOWER 30% 2	90.3440435
FLOWER 20% 1	48.0975534
FLOWER 20% 2	35.6231413
FLOWER 10% 1	49.808148
FLOWER 10% 2	37.5027937
FLOWER 0% 1	36.8596706
FLOWER 0% 2	41.7952736
LEAF 40% 1	181.2698412
LEAF 40% 2	215.8097757
LEAF 30% 1	276.3006452
LEAF 30% 2	155.5506524
LEAF 20% 1	213.0552573
LEAF 20% 2	164.753787
LEAF 10% 1	169.5700221
LEAF 0% 2	175.428827
SOIL 40% 1	254.2101843
SOIL 40%2	249.7100289
SOIL 30% 1	272.471882
SOIL 30% 2	271.5049732
SOIL 20% 1	280.0809757
SOIL 20% 2	278.257394
SOIL 10% 1	289.5638707
SOIL 10% 2	296.9969519
SOIL 0% 1	301.7388152
SOIL 0% 2	297.7766674



GRAPH-D

IV. DISCUSSION

Cdmium analysis in leaf, flower an fly ash amendement soil. The result shows that leaf accumulation less metal then flower in 0% concentration in this graph- A showed that 0% ratio is maximum metal accumulation by merigold plant in leaf and flower tissue. This may be due to the exclusion strategy adopted by the plant. Leaf in this plant is restricted by plant to avoid heavy metal toxicity. How ever the total metal content zig-zag in both the plant parts. The metal content was more in control plant in compared to all the fly ash amendment plants. Among the fly ash amendent plant highest metal content was observed in the 30% flower tissue and 40% leaf tissue. As it was stated above that the biomass produced was highest by these plants at this amendment level. As the fly ash amendment was less in 10% flower and 30% leaf. The total metal content in fly ash amendment soil is high compared to uptake by plant tissue. However Table – V significnce level showed that the difference in metal content in plant parts and fly ash amendment.

Lead- Lead analysis in leaf, flower and fly ash amendment. The result shows that leaf accumulated less metal than flower in 0% conc. In this Graph- B showed that 0% conc. Is maxmium metal accumulated by merigold plant in leaf or flower and fly ash amendment. This may be due to the exclusion strategy adopted by the plant 0% only soil content heavy metal conc. less after amendment of fly ash. However, the total metal content zig-zag in both the plant tissue. Among the fly ash amendment plant highest metal content in the 20% in flower or 10% in leaf. However, Table VI significance showed that the difference in metal content in plant tissue and fly ash amendment.

Cupper- Cupper analysis in leaf flower an fly ash amendment. The result shows that flower accumulated less metal than leaf in different fly ash amendment concentration. The fly ash ratio heavy metal uptake by plant tissue maximum in 20% in flower and 30% in leaf and 10% in soil amendment. However **Table – V** showed that the concentration of Cupper less in 0% only soil compared to fly ash amendment. All over difference in heavy metal concentrtion in plant tissue in different amendment. All over difference in heavy metal concentration in plant tissue in different amendment given in Table.

Manganese- Manganese analysis in leaf flower and fly ash amendment the result shows that flower accumulated less metal than leaf in all over study of Table VI. However total heavy metals content in plant tissue and soil amendment is zig-zag. The fly ash amendment among the all ratio 30% flower and 10% leaf in heavy metal accumulation high compared to other amendment. Among the four metals studied Mn, was the most accumulation heavy metals. The concentration of Mn reached upto 425.7649316 mg/ kg in10% amendment by merigold leaf. However all over study of all Table of heavy metals analysis uptake by marigold plant tissue in fly ash amendment order to Mn>Pb>Cu>Cd.

The relative total concentration of accumulated metals in plant flower was Mn>Pb>Cu>Cd and leaf was Mn>Cu>Pb>Cd and flyash amendment Mn>Pb>Cu>Cd. The reason behind this may be the bioavalibility of metals. Some metls are more bioavalibility in the prevaling soil physico-chemical condition and some are less. So plants take metals which are more bioavalibility or exchangebale. As Cd usually less bioavalibility metals in fly ash despite of their higher concentration in soil. Furthermore, the studied metals abundance order in flower differed with that in leaf. Other hand, fly ash not estimated any particular effects on plant growth and bioaccumulation of heavy metals.

V. CONCLUSION

From the study it can be concluded that the plant growth parameters (shoot, leaf, flower) of calendula affcinalis (merigold) plant were significantly incresed at all amendment in fly ash combinations. The plant growth was

better in 40% combinations but equel to 0% only soil sample. The plant growing in fly ash amendment soil showed a different accumulatio of heavy metals as-Mn>Pd>Cu>Cd. In general study observed that no any effect of fly ash on plant growth or heavy metals accumulation so fly ash work as well as like soil. In all over study indicates that fly ash acts as an excellent modifier and conditioner and a source of essential plant nutrients for appreciably improving the texture and fertility of the degraded soil and is supportive to plant growth. However, there is a study to declare fly ash totally safe and eco-friendly to be used as a soil ameliorator.

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