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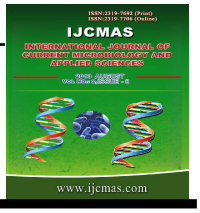

Original Research Article

The impact of fly ash on photosynthetic activity and medicinal property of plants

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Keywords

Fly ash; Chlorophyll; Phenolic compound; Growth.; *Coleus forskohlii;* Andrographis *paniculata*

A B S T R A C T

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity and Iron industries. Fly ash contains several nutrients including S, B, Ca, Mg, Fe, Cu, Zn, Mn, and P, which are beneficial for plant growth. The present work is focused on the effect of increasing amount of fly ash on plant chlorophyll content and phenol compound concentration in agriculture. In this study we have taken two plant species, *Coleus forskohlii* and Andrographis *paniculata* to analyze the effect of increasing amount of fly ash on plant chlorophyll content and phenol compound concentration. The plants were grown in three different fields as: Normal, 5% fly ash and 10% fly ash soil. We found statistically significant ($P<0.0001$) impact of fly ash on chlorophyll a and b content as well as significantly increased ($P<0.0001$) phenolic component in fly ash containing soil

Introduction

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity and Iron industries. The Siltara industrial area in Dharsiwa block at Raipur districts is major producer of fly ash in Chhattisgarh. These micron-sized earth elements consist primarily of silica, alumina and iron. In India, more than 70% of energy needs are met by coal based thermal power plants (Jala and Goyal, 2006). Burning of coal releases, oxides of nitrogen and sulphur and enormous quantity of fly ash, which gets deposited on the soil and the plants.

Fly ash contains several nutrients including S, B, Ca, Mg, Fe, Cu, Zn, Mn, and P, which are beneficial for plant growth, as well as toxic metals such as Cr, Pb, Hg, Ni, V, As, and Ba. Its addition increases the availability of Na, K, Ca, Mg, B and other nutrients (*Basu et al.*, 2009). Fly ash addition could improve the nutrient status of soil and neutralize soil acidity to a level suitable for agriculture, depending on the initial pH of the soil (Kunta *et al.*, 2004).

The chlorophyll content is an essential

physiological feature of plant which is depends on the total airily part of plant. Hens it is a growth measurable feature of plant in different ecological condition (Raverkar *et al.,* 2000). Phenolic components of plant cells are intermediate metabolite as well as secondary metabolites which are determinants of medicinal value of plants. Phenolic components as well as chlorophyll content of plants are depend on the soil PH and nutrients and can be a marker to access the soil quality (Ramana *et al.,* 2001).

Fly ash is a better option to replace the chemical fertilizers for agriculture in middle and low income countries. The present work is focused on the effect of increasing amount of fly ash on plant chlorophyll content and phenol compound concentration in agriculture. In this study we have taken two plant species, *Coleus forskohlii* and *Andrographis paniculata* to analyze the effect of increasing amount of fly ash on plant chlorophyll content and phenolic compound concentration.

Materials and Methods

Land Preparation

To analyze the effect of increasing amount of fly ash on plant chlorophyll content and phenolic compound concentration in plant cell we prepared three fields of 5 X 5 (Meter) which are physically separated by distance of 30 meters. The humidity, soil micro and macro contents, organic composition, bacterial, fungal, and light availability in all three fields are made equal to avoid variability among them.

Fly ash less soil- The field was normal without fly ash. 5% fly ash soil- The field was nourished with 100 litter solution of 5% fly ash per week.

10% fly ash soil- The field was nourished with 100 litter solution of 10% fly ash per week.

Seeding

Seeding of *Coleus forskohlii* and *Andrographis paniculata* plants were done on same day.

Chlorophyll estimation

Chlorophylls are the essential components for photosynthesis. They occur in chloroplasts as green pigments in all photo synthetic plant tissues. They are loosely bound to proteins but are readily extracted in organic solvents such as ether or acetone. Leaves were grind to a fine pulp with the addition of 20 ml. of 80% acetone. Centrifuged (5000 rpm) for five minutes. Transferred supernatant to a 100 ml. volumetric flask with 80% acetone. The absorbance of the solution was taken at 645, 663 and 652 nm against the solvent (80% acetone) blank (Schwartz and Von Elbe, 1994).

Calculation: It is done as described below

(1)mg chlorophyll - a/g. tissue as :

$$12.7(A663) - 2.69(A615) \times \frac{V_1}{1000 \times W}$$

(2)mg chlorophyll - b/g

$$= 22.9(A645) - 4.68(A663) \times \frac{V}{1000 \times W}$$

(3)mg of total chlorophyll g/tissue

$$= 20.2(A645) + 8.02(A663) \times \frac{V}{1000 \times W}$$

A =Absorbance at specific

V=Final volume of chlorophyll extract in 80% acetone

W =Fresh weight of tissue extracted

Estimation phenolic contents

Phenols are aromatic compounds with hydroxyl groups are wide spread in plant kingdom. They occur in all parts of the plants.

Phenols react with phosphor molybdicacidin folin ciocalteau reagent in alkaline mediums and produce blue colored complex (molybdenum blue). 0.5 to 1 g of sample was taken and grinded with pestle and mortar in 10 times volume of 80% ethanol in 10-time volume of 80% ethanol. Centrifuged at 10,000 rpm for 20 minutes. The residue was dissolved in a known volume of distilled water (5ml.). Different aliquots (0.2 to 2 ml.) were Pipette out in to test tubes. Added 3 ml water to make up the volume in each tube. 0.5 ml. of folin - ciocalteau reagent were added. Then 2 ml of 20% Na_2CO_3 solution to each tube were added. After mixing thoroughly the tube was placed in boiling water for exactly one minute. After cooling absorbance at 650 nm was measured against blank (Schwartz and Von Elbe, 1994).

Statistical analysis

The obtained data was analyzed by ANOVA.

Results

The impact of different concentration of fly ash in soil on plant chlorophyll content was analyzed and the results are presented in table 1. The results of Chlorophyll estimation in *A. paniculata* is showing a statistically significant (P<0.0001) impact of fly ash on chlorophyll a and b content of plant. *A paniculata* has 2.9 mg/g chlorophyll a in normal soil whereas it was 3.3 mg/ml and 3.5 mg/ml for 5% and 10% fly ash respectively. The chlorophyll b was 0.31 mg/g in normal soil and 0.5 & 0.6 mg/g in 5% and 10% fly ash respectively. Figure-1 indicated a positive correlation of increasing fly ash concentration on chlorophyll a and b content of plant.

Table-2 is showing the results of chlorophyll estimation of *C. forskohlii* with increasing concentration of fly ash in soil. The present study found the statistically significant (P<0.0001) value for chlorophyll a and b content of *C. forskohlii* correlated with increasing concentration of fly ash in soil. *C. forskohlii* has 2.7 mg/g chlorophyll a in normal soil whereas it was 2.9 mg/ml and 3.0 mg/ml for 5% and 10% fly ash respectively. The chlorophyll b was 0.5 mg/g in normal soil and 0.6 & 0.45 mg/g in 5% and 10% fly ash respectively (Fig-2).

The phenolic compound concentration in plant cells compared with increasing fly ash concentration in soil and the results are presented in table-3. The present study showing significantly increased (P<0.0001) phenolic component in fly ash containing soil. We observed 1.2 mg/100mg of phenolic component in *C. forskohlii* in normal soil whereas 1.6 mg/100 mg and 2.2 mg/ 100mg phenolic component in 5% and 10% fly ash soil respectively (Fig-3).

Phenolic components of *A. paniculata* is also influenced by fly ash concentration in soil. The normal soil growing plants had 1.2 mg / 100mg phenolic component whereas 5% fly ash growing plants had 1.7 mg/100mg and 10% fly ash growing plants had 2.4 mg/100mg phenolic component which is also statistically significant (Fig-3).

Table.1 Results of Chlorophyll estimation in *A. paniculata*

S. N.	Content	Fly ash less soil	5% Fly ash	10% fly ash	ANOVA
1.	Chlorophyll a mg/g	2.9	3.3	3.5	$R^2 = 0.865$ P<0.0001
2.	Chlorophyll b. mg/g	0.31	0.5	0.6	$R^2 = 0.9934$ P<0.0001

Figure.1 Chlorophyll estimation in *A. paniculata*

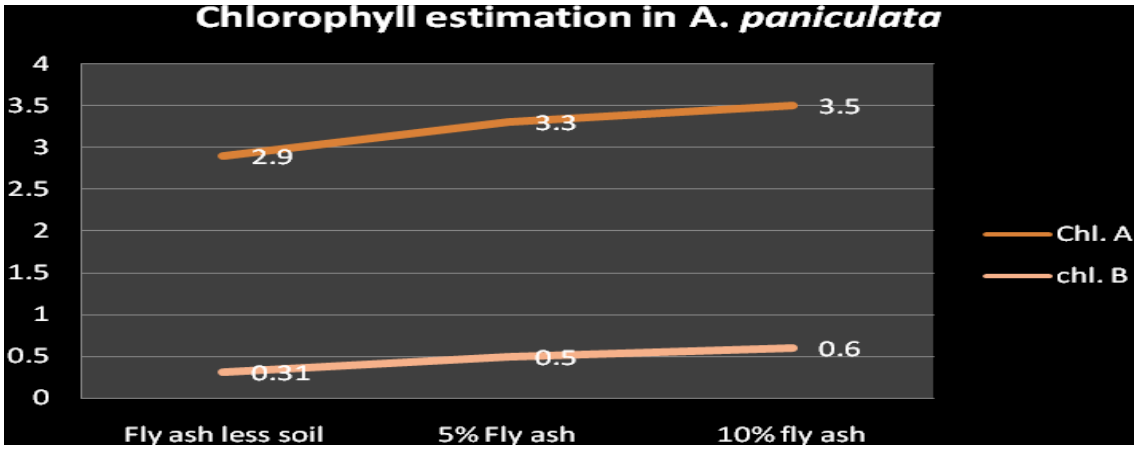


Table.2 Results of Chlorophyll estimation in *C. forskohlii*

S. N.	Content	Fly ash less soil	5% Fly ash	10% fly ash	ANOVA
1.	Chlorophyll a mg/g	2.7	2.9	3.0	$R^2 = 0.6167$ P<0.0001
2.	Chlorophyll b. mg/g	0.5	0.6	0.7	$R^2 = 0.3752$ P<0.0001

Figure.2 Chlorophyll estimation in *C. forskohlii*

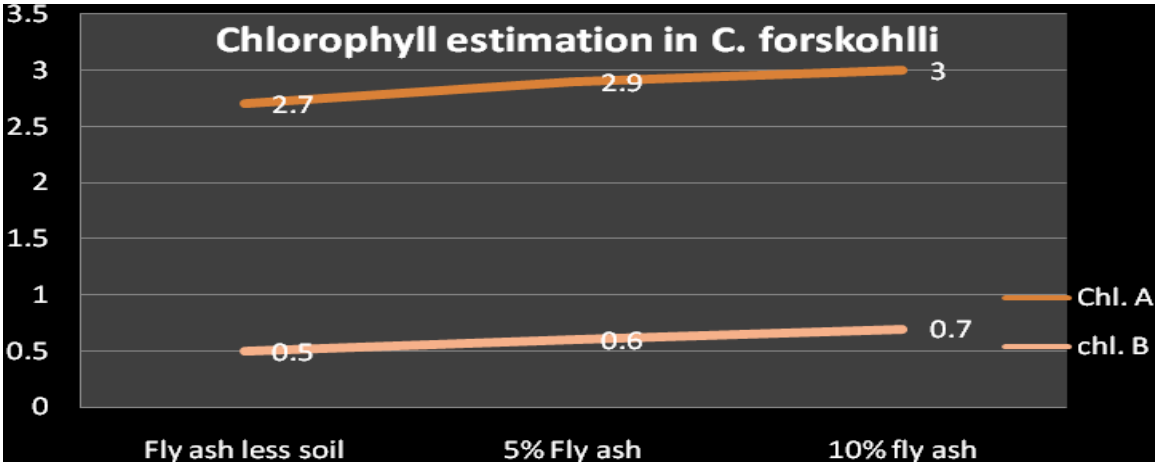


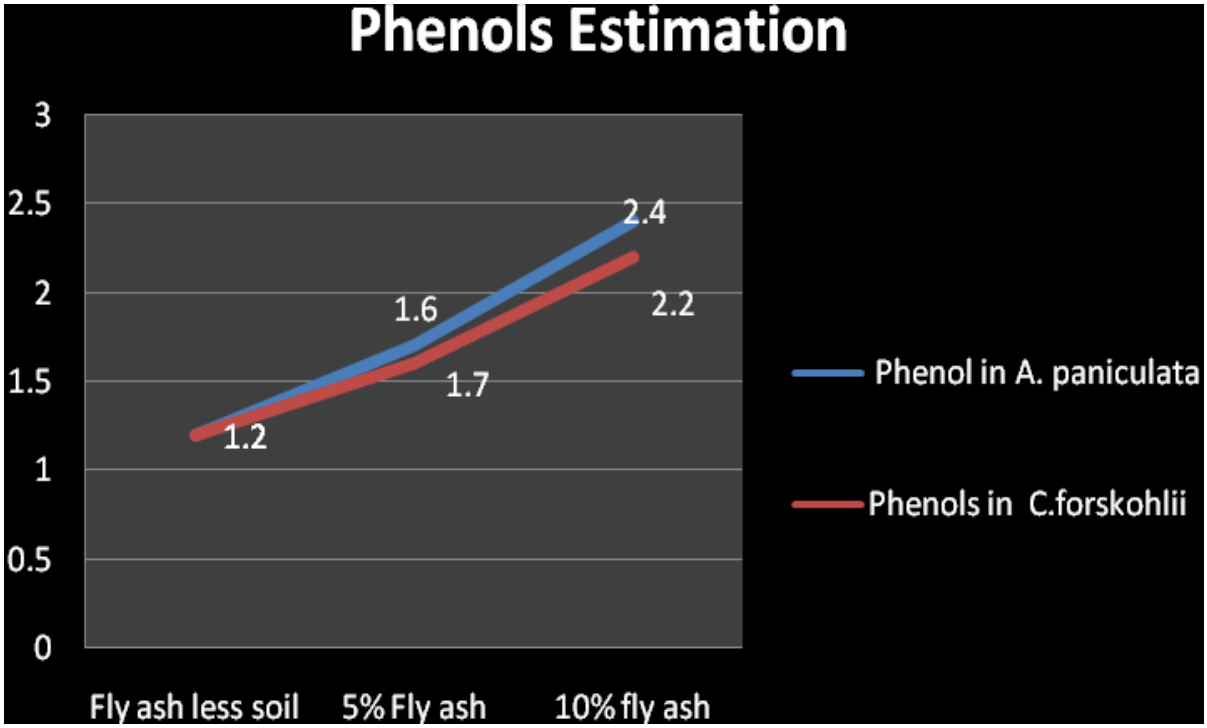
Table.3 Results of Phenols estimation in *C. forskohlii*

Content	**Fly ash less soil**	**5% Fly ash**	**10% fly ash**	**ANOVA**
Phenols in the tuber of *C.forskohlii*	1.2 mg/100 mg.	1.6 mg/100 mg.	2.2 mg/100 mg.	$R^2 = 0.8137$ P<0.0001

Table.4 Results of Phenols estimation in *A. paniculata*

Content	Fly ash less soil	5% Fly ash	10% fly ash	ANOVA
Phenols in the tuber of *A. paniculata*	1.2 mg/100 mg.	1.7 mg/100 mg.	2.4 mg/100 mg.	$R^2 = 0.8623$ P<0.0001

Figure.3 Phenols estimation



Discussion

The chlorophyll content of a plant is depending on the total area of plant which is a growth measuring parameter of plant. The chlorophyll and phenol derivatives are important physiological part of plant, when a fly ash nourished soil throwing nutrients to different parts plants the metabolism progresses in proper way and the metabolites concentration getting appropriate. Fly ash contains several nutrients including S, B, Ca, Mg, Fe, Cu, Zn, Mn, and P, which are beneficial for plant growth. The soil nourishing effect of fly ash is because of higher pH could be due to the presence of Ca, Na, Mg and OH- and calcium oxide, a major constituent of fly- ash and forms calcium hydroxide with water and thus contributes to higher pH (Devarajan *et al.,* 1994).

It is known that plants take up nitrogen in the form of nitrate (NO3-) because nitrates are more quickly available to plants as they move through the roots and as such lesser content of nitrate in 5% and 10% fly ash containing fields may be due to more hydraulic absorption because of higher water holding capacity in the fly ash amended soil (Schwartzand and Larenzo, 2001). Fly ash decreases porosity and thus increases water holding capacity. This would facilitate the absorption of nutrients as well as photosynthetic activity. Similar findings have been reported by (Thetwar, 2007). We found higher chlorophyll a and b and higher phenolic compound concentration in *Coleus forskohlii* and *Andrographis paniculata* plants could be due to the micronutrients available in fly ash than the control. Similar reports have been made by (Niyaz and Singh 2006; Hisamuddin and Singh, 2007).

The higher chlorophyll in fly ash containing soil is due to the presence of high N, K and Mg which are present in fly ash resulting in higher content of chlorophyll a (Rai *et al.,* 2002). The higher content of chlorophyll b in fly ash containing fields is due to higher P content in fly ash amended soil (Canjura *et al.,* 1991).

Fly ash is resources and not wastes. The major characteristics that make the suitability as a bio- fertilizer because it is a mix of macronutrients such as nitrate, phosphate and potassium and micronutrients such as Mg, S, Bo, Fe, Mn and Zn come from the fly ash.

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References

Basu, M., M. Pande, P.B.S. Bhadoria and Mahapatra, S. C. 2009. Potential fly-ash utilization in agriculture: A global review. Progre. Nat. Sci. (19): 1173-1186.

Canjura, F. L., S.J. Schwatz and Nunes, R. V. 1991. Degradation Kinetics of Chlorophylls and chlorophyllides. J. Food Sci. (56): 1639-1643.

Devarajan, L., G. Rajanan, R. Ramanathan and Oblisam, G. 1994. Performance of field crops under distillery effluent irrigation. Kisan World. (21): 48-50.

Hisamuddin., and Singh, S. 2007. Influence of root-knot nematode disease on yield and biomass production of *Pisum sativum* in fly ash amended soil. XXX All India Botanical Conference, Nov.

Jala, S., and Goyal, D. 2006. Fly ash as a soil ameliorant for improving crop production a review. Biores. Technol. (97): 1136–1147.

Kuntal, M.H., A.K. Biswas, K. Bandopadhyay and Mishra, K. 2004. Effect of post-methanation effluent on soil physical properties under a soyabean wheat system in a vertisol. J. Plant Nutrit. Soil Sci. (167): 584-590.

Niyaz, T., and Singh, S. 2006. Effect of fly ash amended soil on the plant growth, yield, chlorophyll and oil content of *Mentha citrata*. *National Symposium on Issue and* Challenges for Environmental management,Vision. 2025. 55-56.

Rai, U.N., R.D. Tripathi and Singh, N. 2002. Integrated biotechnological approach for phytoremidiation of fly ash dyke (abstract). 2nd International Conference on Plant and Environment Pollution. NBRI, Lucknow, India. pp. 4-9.

Ramana, S., A.K. Biswas, S. Kundu, J.K. Saha and Yadav, R.B.R. 2001. Effect distillery effluent on seed germination in some vegetable crops. Biores. Technol. (82): 273-275.

Raverkar, K.P., S. Ramana, A.B. Singh, A.K. Biswas and Kundu, S. 2000. Impact of post-methanated spent wash (PMS) on nursery raising, biological parameters of *Glyricidia sepum* and biological activity of soil. Ann. Plant. Res. (2): 161-168.

Schwartz, S. J., and Von Elbe, J. H., 1994. Kinetics of chlorophyll degradation to pyropheophytin in vegetables. J. Food Sci. (48): 1303-1306.

Schwartzand S.J., and Larenzo, T.V. 2001. Chlorophyll stability during continuous aseptic processing and storage. J. Food Sci. (56): 1059-1062.

Thetwar L. K., 2007. Studies on the effects of fly ash and plant hormones and soil metabolic activities. Asian J. Chem. (19): 3515 - 3518.