

IMPACT OF COAL FLY ASH ON GROWTH OF *Withania somnifera* (L.) DUNAL**TRILOK KUMAR^{a1}, S.V.K. PRASAD^b AND V.K. KANUNGO^c**^{a,c}Govt. N.P.G. College of Science, Raipur, Chhattisgarh, India^bPrincipal, Govt. College, Pakhanjur, Chhattisgarh, India.**ABSTRACT**

In developing countries like India the major source of energy to run industries is the coal. Large quantities of byproducts are generated during coal combustion responsible for pollution and today the world is searching for each and every method to control pollution in the same concern many possible beneficial applications of fly ash are being evaluated to minimize pollution, decrease cost of disposal and provide value added products. In present study the possibilities has been explored for using fly ash as soil modifier and fertilizer to upgrade soil quality and fertility for the cultivation of a medicinal plant *Withania somnifera* (L.) Dunal and to improve the growth and productivity of plant by fly ash incorporation in soil.

KEYWORDS: Fly Ash, Soil Modifier, Growth, *Withania somnifera* (L.) Dunal

Urbanization and industrialization are worldwide phenomenon. Though these are the necessity of the world but had adverse effect on problems related with the safe management and discarding of these large amount of industrial waste. Fly ash is also a byproduct generated in combustion of coal. Fly ash is the portion of ash stream which is composed of particles of size 0.001 to 0.1mm. Chemical composition of ash very with the type of coal used, its source and the method of combustion adopted but the major constituents always includes Al, Ca, Fe, Mg, K, Si, Na and Ti. These eight elements are the primary constituent of ash which makes 95% of the ash out of these elements five elements are considered as the most important nutrients in agriculture. Utilization of fly ash as a substitute of soil provides good compaction, better shear strength as well as it is ecofriendly. It can be used for plant growth as it is the mixture of fine powdered ferroaluminosilicate material. The utilization of fly ash in India is considerably low (3-5%) as compared to developed countries (Vijayan 2000). It has been reported that physical and chemical properties of fly ash can contribute to enhance agronomic properties of soil (Ashoken *et al* 1999). Various studies has been done on different crop plants which shows that fly ash addition in soil increases the growth and yield of plants like tomato, potato, cabbage, wheat, pea, sunflower, mustard (Mittra *et al* 2005, Saxena *et al* 2005). Improved growth of some crop like rice was observed by El-Mogazi *et al* (1988), wheat, mustard, maize, rice were found to show increased growth by addition of fly ash (Garg *et al* 1996, Sikka and Kansal 1995 and Singh 1996).

Fly ash has been found favorable to the plant growth its incorporation causes significant improvement in plant growth, net primary productivity, leaf area increase and photosynthetic pigment increase in cucumber (Azaz *et al* 2004). Fly ash compost mixture proves beneficial for growth of corn and sorghum

(Ghuman *et al* 2006). Dusting of fly ash on wheat caused a significant increase in growth, yield, photosynthetic pigment, protein and lysine contents (Singh *et al* 2002). Fly ash amendments caused significant improvement in soil quality, germination percentage, shoot length, leaf area, pigment composition, yield, seed weight of rice (Mishra *et al* 2007). Fly ash addition increased the yield of different crops from 10-40% which include wheat, mustard, rice, maize, cotton, sorghum, soyabean, groundnut, sunflower, paddy and potato (Kumaret *al* 2005).

Thus most studied has been carried out in crop plants. The present study is focused on the effect of fly ash on growth of a very important medicinal plant *Withania somnifera* (L.) Dunal, belongs to family solanaceae. Also known as ashwagandha, indian ginseng and winter cherry. It has been important plant in Ayurvedi and indigenous system of medicine from more than 3000 years whole plant, root, leaves, stem, green berries, fruit, seeds, bark are used in preparation of medicine. The biologically active chemical constituents of this plant are alkaloids (Ashwagandhine, cuscohygrine, anahygrine etc.), steroidal compounds including regostane type steroid withaferin, withanolides, withanone etc. other compounds include saponins, withaniol, variety of amino acids including aspartic acid, tyrosine, glycine, cysteine etc. It is used for the treatment of anxiety, depression, stress, Parkinson disease, anti-inflammation agent, anticancer, antitumor, antibacterial, antifungal cardiovascular protector, dehydration, bone weakness, impotency etc.

MATERIALS AND METHODS**Sampling of Soil and Fly Ash to Study Growth Parameters**

Soil used in the experiment was collected from the agriculture field of Raipur. Samples were prepared

for by using conventional methods. The fly ash sample were collected from ACC cement factory Jamul, Bhilai, C.G. The collected soil and fly ash samples were dried under the sun light for seven days and then passed from sieve of 2 mm.

Pot culture experiments were conducted various fly ash and soil concentrations were used. 0% (Control), 5%, 10%, 15%, 20%, 25%, 50%, 75%, 100% were named as treatment T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈, T₉ respectively. Pots are filled with this fly ash and soil mixture and 20 seeds of *Withania somnifera* (L.) Dunal were shown in each pot with treatment having three replicates and various growth parameters such as seed germination, plant height, leaf area, leaf area per plant, plant weight, photosynthetic pigments Chlorophyll *a*, chlorophyll *b* and carotenoid contents were observed. Photosynthetic pigments Chlorophyll *a*, chlorophyll *b* and carotenoid were extracted and measured in mgg⁻¹ fresh weight according to the method of Arnon (1949).

RESULTS AND DISCUSSION

Growth Parameters

Various growth parameters of *Withania somnifera* (L.) Dunal were observed under the influence

Table 2: Impact of coal fly ash on growth of *Withania somnifera* (L.) Dunal at the age of 180 days (Values are mean of three replicates)

Treatments	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	Mean	SD	SE
Plant height (cm)	64.25	68.50	72.30	69.75	67.50	63.70	60.30	53.50	41.20	62.333	9.704	3.235
Number of leaves per plant	66	72	78	74	70	65	62	54	44	65	10.583	3.527
Leaf area per leaf (cm ²)	20.34	22.52	24.40	23.26	20.92	19.18	18.83	15.96	13.72	19.903	3.446	1.149
Leaf area per plant (cm ²)	1055.69	1160.38	1258.27	1191.76	1079.60	1008.48	961.34	857.81	715.23	1032.062	170.389	56.796
Plant fresh weight (g)	24.183	25.892	27.435	26.568	25.778	23.716	22.815	20.247	17.583	23.801	3.193	1.064
Chlorophyll <i>a</i> (mgg ⁻¹ fw)	1.184	1.429	1.934	1.873	1.462	1.139	0.993	0.876	0.836	1.302	0.403	0.134
Chlorophyll <i>b</i> (mgg ⁻¹ fw)	1.119	1.317	1.628	1.542	1.385	1.027	0.846	0.752	0.724	1.148	0.337	0.112
Carotenoids (mgg ⁻¹ fw)	0.984	1.106	1.230	1.204	1.192	0.937	0.813	0.735	0.698	0.988	0.206	0.069

Seed Germination

The seed behavior of healthy seeds of *Withania somnifera* (L.) Dunal is observed by average percent germination. The seed germination was observed by 98% in T₁, T₂, T₃ and T₄, up to 15% of fly ash addition in soil after that as the amount of fly ash is increased the germination percentage show continuous

of various fly ash concentrations are shown in Table 1. The observations were recorded at successive interval of time. There is positive effect of adding fly ash in growth of *Withania somnifera* (L.) Dunal with 10% to 15% application of fly ash on addition of high level of fly ash there is decline in growth parameters of the plant. (Table 1 and 2)

Table 1: The effect of fly ash incorporation on seed germination of *Withania somnifera* (L.) Dunal at 10 days after sowing

S. No.	Treatment	% Fly ash	Average seed germination (%)
1	T ₁	Control (0%)	98
2	T ₂	5%	98
3	T ₃	10%	98
4	T ₄	15%	98
5	T ₅	20%	95
6	T ₆	25%	90
7	T ₇	50%	72
8	T ₈	75%	61
9	T ₉	100%	55

decrease thus overdose of fly ash had an inhibitory effect of seed germination.

Plant Height

As the age of plant increases the height of plant increases accordingly in the growth period of 180 days from sowing, the maximum plant height was found in treatment T₃ whereas minimum plant height was found in treatment T₉. The plant height shows the

increase from T₁ to T₃ the maximum plant height was found in T₃ there after decrease was recorded in T₄ to T₉.

Number of Leaf per Plant

The number of leaves increases with the age and height of plant. The average number of leaves increase up to treatment T₃. The maximum number of leaf per plant was recorded to be in T₃ while the minimum value was found in treatment T₉.

Leaf Area per Leaf

The maximum value for leaf area per leaf was observed as 24.40 cm² in treatment T₃ while the minimum was found for treatment T₉ as 13.72 cm².

Leaf Area per Plant

It depends on the age of plant and varies accordingly the highest leaf area per plant was recorded in treatment T₃ while the minimum was found in treatment T₉.

Plant Fresh Weight

The maximum value for fresh weight of plant was found in T₃ 27.435g while the minimum was observed in treatment T₉ which was 17.583g.

Photosynthetic Pigments

The chlorophyll *a*, chlorophyll *b*, carotenoids are the photosynthetic pigments which determine the productive capacity of the plant. Their content was observed in *Withania somnifera* (L.) Dunal at various treatments with fly ash from T₁ to T₉.

Chlorophyll *a* and Chlorophyll *b*

Chlorophyll content significantly increases in initial stages their after the continuous downfall is observed till the end of plant life. The maximum content of chlorophyll *a* was found 1.934 mgg⁻¹fw in treatment T₃ while the minimum value was found 0.836 mgg⁻¹fw for treatment T₉. The maximum amount of chlorophyll *b* was found to be 1.628mgg⁻¹fw in treatment T₃ and minimum 0.724mgg⁻¹fw in treatment T₉.

Carotenoids

Carotenoid content was found to be maximum in treatment T₃ 1.230mgg⁻¹fw while minimum was 0.698mgg⁻¹fw found in treatment T₉.

CONCLUSION

Fly ash incorporation shows beneficial effects on soil quality as well as crop productivity. Present study reveals that on 10-15% concentration of fly ash

the most beneficial results are obtained and *Withania somnifera* (L.) Dunal shows maximum growth thus 10-15% fly ash incorporation in soil is suitable for growth of medicinal plant *Withania somnifera* (L.) Dunal.

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