Indian J.Sci.Res. 13 (2): 25-28, 2017 ISSN: 0976-2876 (Print)
ISSN: 2250-0138 (Online)

IMPACT OF COAL FLY ASH ON GROWTH OF *Withania somnifera* (Linn.) DUNAL.

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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* (Linn.) Dunal. and to improve the growth and productivity of plant by fly ash incorporation in soil.

KEYWARDS: Coal Fly Ash, Soil Modifier, Growth, *Withania somnifera* (Linn.) 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 theprimary 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 ferroalluminosilicate 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; Singh, 1996).

Coal 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 (Ajaz 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 and Siddiqui,2003). 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* (Linn.) Dunal., belongs to family Solanaceae. Also known as ashwagandha, indian ginsing and winter cherry. It has been important plant in Ayurvedic and indigenous system of medicine from more than 3000 years whole plant, root, leaves, stem, green berries, fruit, seeds, bark are used in prepration 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 experiments by using conventional methods. The fly ash

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sample were collected from ACC cement factory Jamul, Bhilai, C.G. The collected soil and fly ash samples were air dried 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 T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9 respectively. Potswere filled with this fly ash and soil mixture and 20 seeds of *Withania somnifera* (Linn.) 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 fresh weight, photosynthetic pigments chlorophyll *a*, chlorophyll *b* and carotenoid contents were observed. Photosynthetic pigments chlorophyll *a*, chlorophyll *b* and carotenoidwere 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* (Linn.) Dunal. were observed under the influence 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* (Linn.) 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). Similar results were obtained by Garg et al (1996), Singh and Siddiqui (2003), Ajaz et al 2004 and Mishra et al (2007).

Table 1: The effect of coal fly ash incorporation on seed germination of *Withania somnifera* (Linn.) Dunal.

Sl. No.	Treatment	% Fly ash	Average seed germination (%)
1	T_1	Control (0%)	100
2	T_2	5%	100
3	T_3	10%	100
4	T_4	15%	100
5	T_5	20%	90
6	T_6	25%	78
7	T_7	50%	65
8	T_8	75%	60
9	T_9	100%	52

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

Treatments / Growth parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Plant height (cm)	64.25	68.50	72.30	69.75	63.85	63.70	58.30	44.50	41.20
Number of leaves per plant	66	72	78	74	70	65	62	54	44
Leaf area per leaf (cm^2)	20.34	22.52	24.40	23.26	20.92	19.18	18.83	15.96	13.72
Leaf area per plant (cm^2)	1342.44	1621.44	1903.20	1721.24	1464.40	1246.70	1167.46	861.84	603.68
Plant fresh weight (g)	66.13	70.83	76.22	73.43	68.44	60.51	56.27	51.19	49.65
Chlorophyll *a* (mgg^{-1}fw)	2.01	2.16	2.29	2.18	1.99	1.94	1.90	1.79	1.61
Chlorophyll *b* (mgg^{-1}fw)	1.40	1.56	1.65	1.59	1.38	1.33	1.22	1.19	1.18
Carotenoids (mgg^{-1}fw)	1.14	1.30	1.63	1.39	1.13	1.12	1.09	1.02	0.98

Seed Germination

The seed behavior of healthy seeds of *Withania somnifera* (Linn.) Dunal. is observed by average percent germination. The seed germination was observed by 100% in T_1, T_2, T_3andT_4, up to 15% of fly ash addition in soil after that as the amount of fly ash increased the germination percentage show continuous decrease thus overdose of fly ash had an inhibitory effect on seed germination.

Plant Height

As the age of plant increases the height of plant increases accordingly in the growth period of 180 daysfrom sowing, the maximum plant height was found in treatment T_3 whereas minimum plant height was found

in treatment T_9. The plant height showed the increase from T_1 to $T_3$the maximum plant height was found in T_3there after decrease was recorded in T_4 to T_9.

Number of Leaf per Plant

The number of leaves increased with the age and height of plant. The averagenumber of leaves increase up to treatment T_3. The maximum number of leave per plant was recorded to be in T_3 while the minimum value was found in treatment T_9.

Leaf Area per Leaf

The maximum value for leaf area per leaf was observed as 24.40 cm^2 in treatment T_3 while the minimum was found for treatment T_9 as 13.72 cm^2.

Total Leaf Area per Plant

It depends on the age of plant and varies accordingly the highest leaf area per plant was recorded in treatment T_3 while the minimum was found in treatment T_9.

Plant Fresh Weight

The maximum value for fresh weight of plant was found in $T_3$76.22 g while the minimum was observed in treatment T_9 which was 49.65 g.

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* (Linn.) Dunal. at various treatments with fly ash from T_1 to T_9.

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 2.29 mgg^{-1}fresh weightin treatment T_3 while the minimum value was found 1.61 mgg^{-1}fresh weightfor treatment T_9. The maximum amount of chlorophyll *b*was found to be 1.65mgg^{-1}fresh weightin treatment T_3 and minimum 1.18mgg^{-1}fresh weightin treatment T_9.

Carotenoids

Carotenoid content was found to be maximum in treatment $T_3$1.63mgg^{-1}fresh weightwhile minimum was 0.98mgg^{-1}fresh weightfound in treatment T_9.

CONCLUSION

Coal fly ash incorporation shows beneficial effects on soil quality as well as productivity. Present study reveals that on 10-15% concentration of fly ash the most beneficial results were obtained and *Withania somnifera* (Linn.) Dunal. shows maximum growth thus 10-15% fly ash incorporation in soil is suitable for growth of medicinal plant *Withania somnifera* (Linn.) Dunal.

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