

Effect of fly ash on vegetative growth of crop plants- *Zea mays* and *Cajanus indicus*.

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Abstract: Thermal power stations world over produces huge quantity of fly ash as a waste from coal combustion. In the present work impact of fly ash application on crop plants- *Zea mays* and *Cajanus indicus* is studied. Morphological and physiological characteristics of these two plants using different concentration of fly ash are recorded. Agricultural Soil amendment using 20% to 30 % fly ash is suggested. Disposal of fly ash through agriculture and waste land management is discussed.

Keywords: Fly ash, Agriculture, soil amendment, Waste land development.

1. Introduction

Fly Ash is a waste product from the thermal power stations produced as a result of coal combustion. About 120 coals based thermal power stations in India are producing about 112 million tons fly ash per year. This is expected to be double within next 10 years. [1]

A developing country like India, avails nearly 70 per cent of the total energy required from coal fired thermal power plants using low grade coal with ash content in the range of 37 to 45 per cent. Nearly 55 per cent of the coal produced in the world, is utilized for thermal power generation [2]. It is expected that, in the year 2020, Indian thermal power plant will consume nearly 380 MT of coal and produce 140 MT of ash [2], [3].

In Maharashtra there are nine thermal power plants. BSES thermal power plant of Dahanu is one of the power plant of Maharashtra, Which is renamed as Reliance Power plant. It is 500 MW based thermal power station, situated approximately

120 Km from Mumbai. In addition to electricity it produces fly ash as a waste product in large quantity. Now a day fly ash disposal into the environment is one of the major concerns thought out the world. Ash contain several nutrients like S, B, Ca, Mg, Cu, Cn, Mn, K, P and Fe, which are beneficial for plant growth [4],[5]. It also contains trace elements as Mo, Se etc.

It is also reported that application of Fly ash also improve physical property of soil could increase macroporosity and improve the water holding capacity [6]. Application of fly ash at 0, 5, 10, and 15% by weight in clay soil significantly reduce the bulk density and improve the soil structure which in turn improves porosity, workability, root penetration and moisture retention capacity of the soil [7].

In the present work Dahanu thermal power plant was selected as the source of fly ash. An experiment was therefore designed to investigate the impact of fly ash application on the growth of crop plants – *Zea mays* and *Cajanus indicus*.

2. Materials and Methods

The fly ash and sun dried garden soil were mix together in proportion with, 10%, 20%, 30%, 40% and 50% of fly ash. One pot without fly ash was maintained as control. Healthy seed of *Zea mays* and *Cajanus indicus* were purchased from the seed distributors of Mumbai. Prior to sowing seed were soaked in tap water over night & next day 5 seed sown each in bag.

Plants were the uprooted after the specific period i.e. 30 days. Root and shoot length were measured with the help of meter scale. The number of leaves was counted by visual observation.

Biochemical analysis: Protein content of plant material was estimated by Lowery's method [8]. The chlorophyll pigments a, b and total chlorophyll were extracted and estimated by the standard procedure by Arnon [9] and Withan [10].

3. Results and Discussion

3.1 Results of *Cajanus indicus* after 30 days-

Table no. 1 explains effect of different concentrations of fly ash on morphological and physiological characters of *Cajanus indicus*.

Root length- Plants of 30days shown root length from 19.3 cm to 22.9 cm., whereas the control plant showed root length 20.1 cm. Highest root length observed in the 20% fly ash i.e. 22.9 cm. Lowest root length observed in 50% fly ash i.e. 19.3 cm. Root length found to be increased up to 30% fly ash concentration, whereas in higher proportion of fly ash root length values found to be decreasing.

Root branches- Number of roots per plant recorded, ranged from 12 to 16. Highest number of root branches showed in 40% fly ash i.e. 16, whereas as 20% fly ash shown least number of branches i.e. 12 only. In control plant root branches are 13. Second highest number of branches i.e. 15 found in 30% fly ash concentration.

Shoot length- Shoot length measured ranges from 24.5 cm to 28.5 cm. In control plant shoot length measured is 25.1 cm. Highest shoot length noted in 30% fly ash concentration i.e.

28.5, whereas lowest shoot length observed in 10% fly ash concentration i.e. 21.5 cm.

Number of leaves- Number of leaves found higher in 20% and 30% fly ash concentration i.e. 10& 11 respectively, whereas in control plant showed 8 leaves.

Chlorophyll content- Chlorophyll-a content ranged from 0.151 mg/g to 0.218 mg/g. Highest content of chl.-a showed in 30% fly ash concentration i.e. 0.218mg/g & second highest content found in 40% fly ash concentration. 0.193mg/g. Lowest

chlorophyll- a content recorded in 50% fly ash concentration and in control i.e. 0.151mg/g. Estimation of Chlorophyll –b content showed similar result like chlorophyll-a. Chlorophyll-b content observed higher in 30% & 40% fly ash concentration i.e. 0.283mg/g & 0.268 mg/g. ,whereas lowest content found in control plant i.e.0.166mg/g. Highest amount of total chlorophyll shown in 40% fly ash concentration i.e. 0.496mg/g.

Proteins- It seems a negative correlation exist between fly ash concentration and protein content of the plants. Protein content found to be decreasing with increasing concentration of fly ash.

Table 1 Effect of different concentrations of fly ash on the growth of *Canus indicus* after 30 days.

Parameters	Morphological characters				Physiological characters				
	Root length (cm.)	No. of root branches	Shoot length (cm.)	No. Of leaves	Chl. a (mg/g)	Chl. b (mg/g)	Total Chl. (mg/g)	Protein amount (mg/g)	Germination (%)
T1 (10% FA)	22.3	14	24.5	8	0.172	0.196	0.390	1.17	100
T2 (20% FA)	22.9	12	27.5	10	0.181	0.178	0.475	1.16	100
T3 (30% FA)	21.5	15	28.5	11	0.218	0.283	0.485	1.14	100
T4 (40% FA)	19.6	16	27.5	9	0.193	0.268	0.496	1.08	100
T5 (50% FA)	19.3	14	25.6	8	0.151	0.198	0.399	1.05	80
Control	20.1	13	25.1	8	0.151	0.166	0.360	1.38	100

FA = Fly ash .

Each value is mean of three replicates.

Table 2 Effect of different concentrations of fly ash on the growth of *Zea mays* after 30 days.

Parameters	Morphological characters				Physiological characters				
	Root length (cm.)	No. of root branches	Shoot length (cm.)	No. Of leaves	Chl. a (mg/g)	Chl. b (mg/g)	Total Chl. (mg/g)	Protein amount (mg/g)	Germination (%)
T1 (10% FA)	25.8	13	30.3	6	0.197	0.262	0.470	0.27	100
T2 (20% FA)	26.5	12	32.2	6	0.200	0.266	0.483	0.27	100
T3 (30% FA)	26.1	13	33.4	6	0.126	0.269	0.494	0.24	100
T4 (40% FA)	25.5	11	31.2	6	0.190	0.260	0.450	0.26	100
T5 (50% FA)	24.6	17	31.6	6	0.192	0.260	0.476	0.22	80
Control	23.6	12	30.4	6	0.192	0.262	0.421	0.60	100

FA = Fly ash.

Each value is mean of three replicates.

3.2 Results of *Zea mays* after 30 days-

Table no. 2 depicts effect of different concentrations of fly ash on morphological and physiological characters of *Zea mays*.

Root length- *Zea mays* plants grown in different concentration of fly ash showed root length ranging from 24.6 cm to 26.5 cm. Maximum root growth observed in 20% fly ash concentration i.e. 26.5 and second highest measured in 30% fly ash i.e. 26.1cm. Lowest length showed in 50% fly ash concentration i.e. 24.6 cm.

Root branches- Root branches showing a positive correlation with fly ash concentration. Highest number of root branches found 50% fly ash concentration i.e. 17, on the contrary in control there are only 12 branches.

Shoot length- Shoot length measured ranging from 30.3 cm to 33.4 cm. Highest shoot length found in the plant grown in 30% fly ash concentration i.e. 33.4cm, whereas in control it is recorded only 30.4 cm.

Number of leaves- *Zea mays* plant grown in different concentrations of fly ash showed no demarcating variations in number of leaves. In all treatments including control it remain same i.e. 6.

Chlorophyll content- Chlorophyll a content ranged from 0.126mg/g to 0.200 mg/g. Highest amount of chlorophyll a recorded i.e. 0.200 mg/g in 20% fly ash concentration, whereas second highest amount recorded is 0.190 mg/g in 40% fly ash concentration. Chlorophyll-b content recorded highest in 30% fly ash concentration i.e. 0.269mg/g and lowest chlorophyll- b amount showed in 50% fly ash concentration i.e. 0.260mg/g. Total chlorophyll amount found highest in 30% fly ash concentration i.e. 0.494 mg/g and second highest in 20% fly ash concentration i.e. 0.483mg/g.

Proteins- Protein content in *Zea mays* showed similar results like *Cajanus indicus*. It showed that the protein content decreasing with increasing concentration of fly ash in the soil.

In the year 2012 total fly ash utilization was 55%. Of the total utilization 48.13% was used by Indian cement industries whereas only 1.02% used for agriculture and west land development [11]. There is need to increase fly ash use in the agriculture as well as in waste land management through proper screening of fly ash composition.

Present study reveals that application of fly ash in the ratio from 20% to 30% has shown improved plant growth due to change in physiochemical properties of the amended soil. Increase in number of root branches is the clear indication of improvement of soil physiochemical properties by fly ash application to soil. Increase plant growth indicates adequate supply of vital plant nutrient through the fly ash [12].

Plant nutrient like Ca, Mn, K, P, Zn, Cu, B, Mb present in fly ash boost the crop growth and yielding. Similar results were reported by different worker like Bharti *et.al.* on green gram [13], Pathan *et. al.* on *Cynodon dactylon* (L.) [14], Hisamudin and Singh on *Pisum* [15]. These finding indicate that conc. of fly ash for better plant growth varies from plant to plant. In the present study range of 20% to 30% of fly ash with soil gave beneficial effect on the plant growth of *Cajanus indicus* and *Zea mays*. Higher proportion fly as composition gives negative effect on plant growth. It might due to high alkalinity and excess minerals elements in fly ash. Fly ash application is one of the best practices to bring improvement in the degraded soil. However the bioaccumulation of toxic heavy

metal and their critical level in plant parts and soil should be investigated.

4. Conclusions

Fly ash application have several potentiary benefits, such as supplying adding mineral nutrient, improvement in physiochemical properties of soil and absorption of water & minerals. Considering the type of soil and crop variety, use of fly ash in proper ratio will definitely solve the problem of fly ash disposal in sustainable way.

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