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Growth of Biodiesel Plant in Flyash: A sustainable approach

Response of *Jatropha curcus,* a Biodiesel Plant in Fly Ash Amended Soil with Respect to Pigment Content and Photosynthetic Rate

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Abstract

Fly-ash, an inevitable waste of coal-fired thermal power plant has great potential in the area of plant growth due to its efficacy in modification of soil health and thereby the plant performance. In this study we analyze the effects of flyash on pigment content and photosynthetic rate in *Jatropha curcus*. The observations and results of the study indicate that *Jatropha curcus* grown in different amendments of soil and flyash showed an increase in chlorophyll content at 20% flyash in soil, but further declined with the increase in concentration of flyash (40%, 60%, 80% and 100%) in soil than control. Similar trends of the increase in photosynthetic rate of *Jatropha curcus* in 20% flyash amended soil and thereby decreased results at higher concentrations have also been observed which can thereby be directly correlated with the chlorophyll content of the plant. Thus the increase in both the parameters at low dose of flyash indicates the healthy growth status of *Jatropha curcus* Hence through the present venture we are utilizing a waste that is fly ash and using it for the growth of *Jatropha curcus,* a biodiesel plant which also helps in absorbing the greenhouse gases (CO_2 AND CH_4).

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Keywords: flyash, biodiesel, chlorophyll, photosynthetic rate, soil amendments

1. Introduction

Fly ash is being produced in huge amounts from coal-fired thermal power plants and therefore its disposal is a major concern. Using fly ash for agriculture is one of the best means for its optimum utilization.[1] Fly-ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance.[2] Fly ash addition generally has shown positive impact on plant biomass

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production and nutrient uptake. Fly ash has immense potential as a soil-ameliorating agent in agriculture, forestry and wasteland reclamation because of its heterogeneous nature. Previous work to determine the feasibility of converting waste disposal problem into a soil benefaction strategy has proven true. [3] Fly ash has been studied as a useful soil-amending agent with agronomic and environmental benefits. [4] Fly ash upon amelioration at 10, 20, 30 and 40% (w/w) in clay, sandy-clay loam, sandy and sandy-loam soil has been reported to increase its pH, electrical conductivity and modify water retention capacity. [5] Fly ash, which can be acidic or alkaline depending on the source, can be used to buffer the soil pH. [6] Fly ash has been observed to have a positive effect on water holding capacity, hydraulic conductivity and pH apart from acting as source of nutrients. [7] Studies on pot-culture experiment were performed to observe the influence of fly ash amendments on the growth and accretion of heavy metal in pea plants, mug bean or other plants. [8] [9] [10]

It is observed that tomato plants grown in the fly ash soil mixture showed luxuriant growth with bigger and greener leaves. Plant growth, yield, chlorophyll and carotenoids were enhanced in 40-80 % fly ash amended soils. At 100 % fly ash, yield was considerably reduced. The most economic level of fly ash incorporation was 40 %, which improved the yield and market value of tomato fruit by 81% and 30 % respectively. [11]

Plant growth yield, carotenoid and chlorophyll contents of leaves were reported to be increased significantly as a result of fly ash application in chilly, egg plant and tomato. [12] Foliar analysis of *Picea abies* grown in the vicinity of a thermal power plant, resulted in an increased ascorbic acid content, carotenoids and chlorophyll contents. [13] Similar results of increased growth and leaf pigment content have also been discussed due to fly ash application. *Phaseolus vulgaris* grown on fly ash amended soils resulted in considerable increase in the pigment content of leaves and moreover the photosynthetic rate was also increased significantly with 20 % fly ash enrichment in the soils. [14] There are several studies available which show the positive effect on chlorophyll content in the presence of low doses of fly ash. [15] [16]

2. Material and Methods

In this study flyash was collected from Badarpur Thermal power station, India. The soil was amended using flyash at different proportions corresponding to 20%, 40%, 60%, 80% and 100% (only flyash) respectively. In control no flyash was added to the soil. The plant species selected was ***Jatropha curcus*** which is a biodiesel plant which also helps in absorbing the greenhouse gases (CO_2 AND CH_4). The sets of experiments were repeated for three complete years. The annual sapling was analyzed for three developmental stages of four successive months: I stage of leaf emergence and development, II stage of leaf maturity and optimum functioning, III stage of leaf senescence.

The chlorophyll content was determined using method given by Hiscox and Israelstain (1979). [17] The photosynthetic rate was measured using LI-6200 portable photosynthesis system. The internal microcomputer of LI-6200 performs all data collection, calculations and data storage.

The data collected for the different parameters from the selected plants was statistically analysed (mean, standard deviation, percent variation and test of significance) with a view to find out the extent of variation and the degree of authenticity of the results.

3. Results and Discussion

The estimation of chlorophyll along with the photosynthetic activity was made at different developmental stages of growth in ***Jatropha curcus*** growing in control as well as flyash treated soils.

1. **Table 1** presents data on the total chlorophyll content as affected by flyash treatments at different developmental stages of ***Jatropha curcus***. In comparison to the control plant, total chlorophyll increased in 20% flyash treatments, however with the increase in flyash concentration in soil amendments the chlorophyll content showed a negative dose dependent relationship at each developmental stage. The increase in total chlorophyll content in comparison with the control was high however (73.11%) under the influence of 20% flyash at stage II however the reduction was maximum (45.81%) with 100% flyash in soil at stage III of plant growth. The total chlorophyll content declined in investigated plant with the increasing age **[Figure 1]**

Table 1: Total Chlorophyll (mg gm^{-1} fr. wt.) of the leaves of *Jatropha curcus* during different stages of growth and at various flyash concentrations in soil.

	Stage I	Stage II	Stage III
Control	1.56 ± 0.15	0.95 ± 0.12	0.74 ± 0.07
20%	2.35 ± 0.17 **(50.64)****	1.65 ± 0.22 **(73.11)****	1.20 ± 0.20 **(60.53)****
40%	1.47 ± 0.06 **(5.28)**	0.89 ± 0.12 **(6.53)**	0.66 ± 0.11 **(11.70)**
60%	1.22 ± 0.19 **(21.63)***	0.67 ± 0.07 **(29.77)****	0.44 ± 0.06 **(42.48)****
80%	1.11 ± 0.05 **(29.09)****	0.65 ± 0.08 **(30.11)****	0.42 ± 0.09 **(44.23) ****
100%	1.08 ± 0.06 **(35.51)****	0.61 ± 0.08 **(35.51)****	0.41 ± 0.09 **(45.81) ****

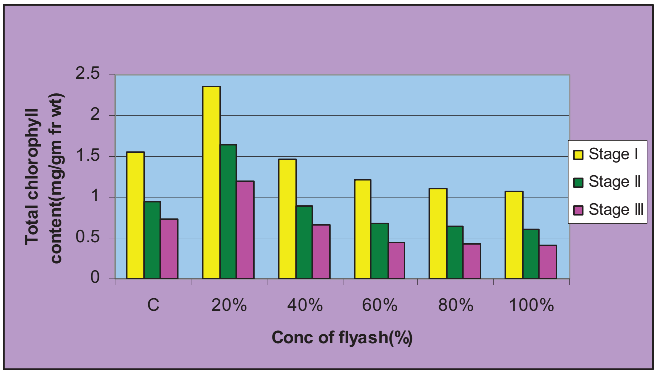

Figure 1: Comparison of Total Chlorophyll (mg gm^{-1} fr. wt.) of the leaves of *Jatropha curcus* during different stages of growth and at various flyash concentrations in soil.

2. Table 2 presents the photosynthetic rate of the leaves of *Jatropha curcus* in the control and various flyash treatments in soil at various stages of plant growth. Fly ash treatment to *Jatropha curcus* caused an increased in the photosynthetic rate at 20% treatments to soil, however as the concentration of fly ash in soil increased (40%, 60%, 80% and 100%), the net photosynthetic rate reduced significantly. In 20% fly ash treated plants, a highly significant rise (30.14%) occurred at stage III, while the photosynthetic rate got reduced with maximum variation (45.27%) also occurring at stage III under 100% fly ash concentration. The rate of leaf photosynthesis decreased with plant age in the species **[Figure 2].**

Table 2: Photosynthetic rate (μ mole CO_2 m^{-2} s^{-1}) of the leaves of *Jatropha curcus* during different stages of growth and at various flyash concentrations in soil.

	Stage I	**Stage II**	**Stage III**
Control	6.53 ± 0.39	6.01 ± 0.19	4.23 ± 0.44
20%	8.10 ± 0.36 **(24.06)***	7.51 ± 0.38 **(24.89)***	5.50 ± 0.42 **(30.14)****
40%	5.48 ± 0.25 **(16.14)***	5.14 ± 0.24 **(14.55)**	3.87 ± 0.23 **(8.51)**
60%	4.85 ± 0.39 **(25.78)****	4.57 ± 0.23 **(23.94)***	2 .98 ± 0.16 **(29.49)****
80%	4.23 ± 0.17 **(36.33)****	3.98± 0.21 **(39.84)****	2.78 ± 0.11 **(37.54)****
100%	3.98 ± 0.21 **(39.05)****	3.55 ± 0.28 **(40.89)****	2.31 ± 0.07 **(45.27)****

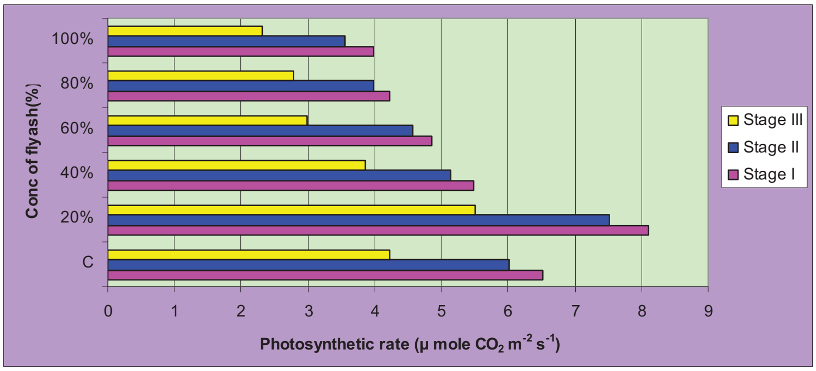

Figure 2: Comparison of Photosynthetic Rate (μ mole CO_2 m^{-2} s^{-1}) of the leaves of *Jatropha curcus* during different stages of growth and at various flyash concentrations in soil.

3. In the present venture there is an increment of pigment content as well as photosynthetic rate in ***Jatropha curcus*** at 20 % fly ash treatment of soil however at relatively higher doses of flyash, the results declined. Leaves are the primary sites of photosynthesis and product of their metabolism fuel the growth of all plant tissues. Hence the foliar response represents the overall status of plant growth and metabolic activities [18]. In this research the feasibility and ecological impact of growing a bio-diesel plant on flyash amended soil was established by observing its foliar response in relation to flyash as a base material.

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