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EFFECT OF FLY ASH ON SOME BIOCHEMICAL PARAMETERS OF SELECTED PLANTS GROWING AT DUMPING SITE OF BADARPUR THERMAL POWER PLANT IN DELHI

SAMI ULLAH QADIR & WEQAR AHMAD SIDDIQUI

Department of Applied Sciences and Humanities, Faculty of Engineering and Technology,

Jamia Millia Islamia, New Delhi, India

ABSTRACT

One of the important causes of woodland destruction is the emission exhausts, Particulate pollutants from waste dumping sites and the consequent air pollution. Particulate pollution not only hampers plant growth instead disturbs the ecological balance. Tryouts on particulate pollution monitoring were directed in order to ascertain behavior of Fly ash dust on various plant Species at and around the Badarpur thermal power plant fly ash dumping site in Delhi. The plant species at these selected sites comprises of Neem (*Azadirachtaindica*), jungle jalebi (*Pithecellobium dulce*), Mast tree or Ashoka (*Polyalthialongifolia*), and Sheesham (*Dalbergiasisoo*). For this study leaf area, total chlorophyll, protein, Ascorbic acid was evaluated in order to study the effect of fly ash particulate contaminants resulting from dumping site. Substantial decline was found in total chlorophyll, protein content with condensed leaf area/size, however, a significant increase was observed in case of Ascorbic acid content across the study. From the study it was concluded that these plant species can be used as best indicators for assessing the fly ash contamination and the need arises to plant resistant species at this dumping site in order to remediate the same.

KEYWORDS: Chlorophyll, Fly Ash, Particulate Pollution, Remediation, Woodland

INTRODUCTION

From last few decades demand of energy in the form of electricity increased endlessly owing to increase in population and origination of new industrial expansions all over India. Which amplified energy requirement thereof. To fulfill this increasing energy demand a lot of pressure on coal based thermal power plants to produce more and more power that releases vast amount of by-product as waste commonly called fly ash (FA). According to American Society for Testing and Materials (ASTMN) and European Standards body designate fly ash into two types viz. class F and class C based on the amount of calcium, silica, alumina, and iron present[1]. Its conventional disposal practice requires large areas of land in the form of dumping sites, leads to various ecological problems such as degraded water quality, productive soils, human and animal health system and normal functioning of higher plants.[2,3]. The only alternative management is to vegetate these landfill areas as plants provide adequate leaf area for effective adsorption, accumulation and impingement of air pollutants in order to diminish the pollution load in surrounding environment with varying capacity for different species[4, 5]. Effects of air pollution on various biochemical factors such as Ascorbic acid content, Chlorophyll content and relative water content was reported from time to time[6,7]. Plantation of waste dumping sites offers one of the important choices for pollution control because plants have long been known to act as a sink for various air pollutants.

Therefore impact of pollutants on biochemical characteristics of plants is often used as a tool for evaluation of ecological contamination[8-11]. However several reports have shown that plants automatically develop characteristic resistance against various pollutants depending upon various eco-physiological factors and cyto-genetic buildup of that plant species[12, 13]. One of the most conjoint impacts is the regular vanishing of chlorophyll followed by chlorosis of foliage resulting in the impairment of photosynthetic pigments. Current study scrutinizes the influence of fly ash pollution on, chlorophyll, ascorbic acid and protein content in selected tree species.

DESCRIPTION OF THE STUDY AREA AND CLIMATIC CONDITIONS

The study was carried out at and around the dumping site of Badarpur Thermal Power Plant, situated on the Badarpur-Faridabad roadway in South Delhi (28°12' – 28°53' N and 76°50' –77°23' E; 213-219 m above msl). This power plant consists of 5 power posting parts. The normal coal intake is 10,439 metric tons per day, which outcomes in 12,181 kg of SO_2, 277,589 kg of NOx and 1,574,166 kg of CO_2 per hour added to the surrounding air[14]. In addition to this the large amount of fly ash is released through the pipes along with the water to nearby area where it is dumped in an open atmosphere and is subjected to wind erosion.

MATERIALS AND METHODS

Sampling Sites and Sampling Procedure

Four Sites (I, II, III and IV) selected for samplingsituated close to dumping site. This area is free from other anthropogenic sources of pollution units such as vehicular and industrial. University area was selected as a control site situated about 18km from the power plant. Principal tree species designated for this study includes Neem (*Azadirachtaindica*), jungle jalebi (*Pithecellobium dulce*), Ashoka or Mast tree (*Polyalthialongifolia*) and Sheesham(*Dalbergiasisoo*).

Collection of Leaf Samples

Leaf samples were collected from 4 different plant species of equal girth, Air pollution tolerance index (APTI) was determined according[4] by means of the formulae

$$APTI = \{[A_C (T_P + P_H) + R_{WC}] / 10\}.$$

Where A_C is the ascorbic acid in mg/g. T_P is the total chlorophyll in mg/g. P_H is pH of leaf sample; and R_{WC} is relative water content in mg/g. During transportation the Polythene bags were used for storing leaf samples.

Estimation of Relative Moisture Content

Relative Moisture content was measured according to method of[4] and relative water content was determined by the formulae[15]

$$RWC= [(FWT-DWT)/ (TWT-DWT)] \times 100$$

FWT=Fresh weight, DWT=Dry weight, TWT= Turgid weight

Measurement of Biochemical Parameters

Leaf area was measured using a Leaf Area Meter with Image Analysis System (Sky Instruments Ltd., UK). The chlorophyll contents of fresh leaves were assessed by the method[16] using dimethyl sulphoxide (DMSO).

Chlorophyll concentration, measured on a (Double beam UV-VIS Model 1372 EI) Spectrophotometer, and calculated by the formulae of[17] and [18]was expressed in mg/g of fresh weight. Leaf-extract pH was calculated according[15] 0.5 g of leaf material was ground to paste in pestle and mortar and dissolved in 50 ml of distilled water and pH was measured by using calibrated Docu-pH^+ (Sartorius) digital pH meter. Total soluble protein content of leaves was determined by the method [19]using 0.2M phosphate buffer (pH 7.0), 0.1N NaOH, TCA and Bradford reagent. Absorbance was measured at 595nm, and protein concentrations were measured using bovine serum albumin as reference. Ascorbic acid was estimated by 2, 6-dichlorophenol in dophenol's dye method [20]

Statistical Analysis

The data was subjected to one way analysis of variance (ANOVA) at 95% confidence interval carried out for all plants parameters.

RESULTS & DISCUSSIONS

The leaf area of plants decreased in comparison to polluted and control site, Table 1 with maximum leaf area of (12.60 cm^2) at control to (7.32 cm^2) at heavy dust area in case of *A.indica* fallowed by (144 to 124 cm^2) in case of *P. dulce* at control and polluted respectively. While as in case of *P. longifolia*and *D. sisoo* the leaf area decreased from (212-160 cm^2) and (221–203 cm^2) respectively. Leaflet size decreased with increase in the pollution stress that clearly specifies the effect of Fly ash pollution on the dumping site vegetation. Several research laboratory examinations and field trials with cultivated and natural plants showed drop in leaf extent due to the inferior air quality[21]**.** Plants when visible to different pollutants in environment, practice physiological stress before evident impairment to leaves and accumulation of certain metabolites. The best indicator commonly used to assess the impact of pollutants on plant growth is net photosynthetic rate[22] Reduced photosynthetic capacity of plants in environment has been associated to decline in the average leaf area exposed to different pollutants in their surrounding areas. The condensed leaf area results in reduced absorbance of radiations and consequently lead to reduced photosynthetic level [23].

Air Pollution Tolerance Index

Air pollution tolerance index (APTI) value of four different plant species growing at this dumping site is specified in Table 3. In this study maximum APTI was reported in *Azadirachtaindica*(18.66) fallowed by *P. dulce* (17.28), *P. longifolia* with (14.17) and minimum APTI was found in case of *D. sisoo* with (14.12). From APTI of plant species have reported the maximum APTI value for *Azadirachtaindica* and minimum for *Pongamiaglabra*[24]. It was further reported *Mangiferaindica*as trustworthy bioaccumlator plant amongst the studied ones.[25]

pH and RWC

The pH of Plant leaves and relative water content also showed significant variation between control and polluted areas in all the plant species under study Table 3. The RWC (%) leaves of the plant species varied from (65.48±6.00) to (95.33±1.20), (62.14±3.10) to (93.33±1.21) in case of *A.indica* and *P.dulce* and (59.80±4.26) to (92.12±4.99), (80.14±4.97) to (90.50±4.97), in *p.longifolia*and *D.sisoo* respectively at control and highly polluted site. The experimental results indicates that RWC was marginally increased between the sites based on the pollution load. So pollution would be one of the main factors responsible for change in RWC. Naturally RWC ratio depends on soil humidity. In the current revision the pH of the leaves shows variation between polluted and control sites, more acidity was observed in the plants exposed to

polluted environment as that of control. According to [26]pH is a warning for the development of decontamination mechanism in plants necessary for adaptation in polluted environs.

Biochemical Parameters

In present study chlorophyll content ranged from (3.70±0.13) at control to (1.62±0.16) at polluted in case of *A. indica*and from (4.67±0.29) to (1.13±0.10) in case of *P. dulce* at control and polluted sites respectively. Same pattern was observed in case of *P. longifolia*and *D. sisoo*with chlorophyll levels ranging from (2.91±0.01) to (1.52±0.08) and (2.92±0.06) to (1.90±0.02) as indicated in table 3 respectively. The evidence of reduced Chlorophyll synthesis and Chlorophyll degradation is due to the deposition of highly alkaline dust particles and crust formation resulting in the denaturation of Chloroplast and subsequent decrease in Chlorophyll [27,28].

Reduction in photosynthesis without leaf injury may be due to underdeveloped Chlorophyll production or Oxidation of Chlorophyll by free radicals [29]. A close affiliation between pollution density and photosynthetic activity, total Chlorophyll Content and untimely leaf senescence has been reported by[30]. One of the most mutual causes of dust pollution is the fading of Chlorophyll and subsequent Chlorosis which may be associated with consequent decline in the capacity for Photosynthesis[31]

Protein Content

Protein content also showed reduced trend between polluted and control sites. Protein Content was found to be maximum at Control (14.8) and minimum (3.40) at polluted site in case of *A. indica* and (12.05) to (4.60) in case of *P.dulce*. While as in case of *P. longifolia* and *D.sisoo*the protein level dropped from (15.50) to (8.45) and (14.30) to (6.40) at control and polluted sites Table 2. Protein reduction in the plants under stress may be due to cessation of the surviving ones, a reduction in protein production or due to condensed photosynthesis. While studying the effect of Stone crushing dust on grain features of maize found lower protein values as compared to Control [32]. Considerable reduction in the protein levels was also reported in the leaves of *Mangiferaindica*and *Shorearobusta* affected by thermal power plant discharges. While studying the effect of stone crushing industry on *Shorearobusta*and *Madhucaindica*foliage in lalpahari forest area reduction in the protein content in leaf tissues was also noted by [33]

Ascorbic Acid

An increasing progress was found in case of Ascorbic acid level in plants depending upon the stress of pollution. The highest increase of ascorbic acid level was found in *A. indica* (10.15±0.50) fallowed by *P.dulce, P.longifolia* and *D.sisoo*with ascorbic acid levels of (9.35±0.11), (6.05±0.08) and (5.98±0.10) respectively at all the polluted sites in comparison to that of control site Table 3. As one of the important metabolites in plant body responsible for activation of resistance mechanism in plant body under pollution stress, as a natural oxidant ascorbic acid provide stability to plants under the stress condition with free radicals. This study clearly indicates that ascorbic acid is one of the secondary metabolites in plant body which increases under stressful conditions. The possible reason for this may be degradation of photosynthetic pigments due to pollution[34, 35, 36].

Table 1: Leaf Area (cm^2) of Selected Plants at Different Sites (N=10) at Each Site

S. No.	Sampling Location	*A. indica*	*P. dulce*	*P. longifolia*	*D. sisoo*	*P* – Value
1	I	10.4	132	189	214	
2	II	8.4	125	170	213	$7.6x10^{-15}$

Table 1: Contd.,

3	III	7.32	124	160	203	
4	IV	12.60	144	212	221	

Difference is based on one way ANOVA (at P≤0.05). Where F value in ANOVA is Significant

Table 2: Plant Protein (µg/mg) of the Selected Plant Species at Different Sites (N=10) at Each Site

S. No	Sampling Location	*A. indica*	*P. dulce*	*P. longifolia*	*D. sisoo*	P – Value
1	I	8.5	7.70	12.20	10.50	
2	II	5.35	6.70	10.4	7.90	$5.5x\ 10^{-60}$
3	III	3.40	4.60	8.45	6.40	
4	IV	14.8	12.05	15.50	14.30	

Difference is based on one way ANOVA (at P≤0.05). Where F value in ANOVA is Significant

Table 3: Various Biochemical Parameters and APTI Index of Plants. (Mean±SD), N=10

Sampling Sites	Total Chl.	pH	R.W.C.	Ascorbic Acid	APTI
A. indica					
I	2.05±0.08	6.14±0.37	92.16±4.28	1.19±0.57	10.19
II	2.52±0.13	6.35±0.43	89.20±6.18	5.16±0.55	13.49
III	1.62±0.16	7.38±0.36	95.33±1.20	10.15±0.50	18.66
IV	3.70±0.13	6.15±0.42	65.48±6.00	0.12±0.03	6.66
P. dulce					
I	2.02±0.25	6.10±0.05	75.53±5.08	7.54±0.10	13.67
II	1.04±0.02	6.96±0.06	75.40±1.90	10.15±0.55	15.66
III	1.13±0.10	7.37±0.36	93.33±1.21	9.35±0.11	17.28
IV	4.67±0.29	5.80±0.09	62.14±3.10	0.67±0.10	6.91
P.longifolia					
I	2.36±0.04	5.70±0.05	86.14±5.16	4.58±0.06	12.30
II	1.95±0.10	5.90±0.08	92.80±5.15	5.60±0.16	13.67
III	1.52±0.08	6.68±0.04	92.12±4.99	6.05±0.08	14.17
IV	2.91±0.01	5.06±0.04	59.80±4.26	0.06±0.01	6.03
D. sisoo					
I	2.93±0.10	6.40±0.38	98.40±1.17	4.04±0.56	13.16
II	1.96±0.10	5.93±0.08	92.85±5.10	5.62±0.15	13.72
III	1.90±0.02	6.59±0.06	90.50±3.60	5.98±0.10	14.12
IV	2.92±0.06	5.78±0.06	80.14±4.97	3.92±0.03	11.42

CONCLUSIONS

Tree plantation around industrial, waste dumping sites is to diminish the load of pollutants in air and to absorb particulate matter so as to reduce the threat posed by pollution to humanity. Although some trees possess stress tolerance capacity but instead they also suffer a considerable damage as evident from the study showing reduction in leaf area, inhibition of photosynthetic pigments and reduced protein levels. In order to remediate these dumping sites there is need of research in order to decontaminate these sites through resistant plant species.

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