# Assessing of Air pollution tolerance of plant species available in Barabaniarea, Paschim Bardhaman, West Bengal, India

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**ABSTRACT:**

Barabani of Paschim Bardhaman district is located in the state of West Bengal, India has open and underground coal mines with power plants, refractories, brick making factories etc. in its surroundings. Coal dust and emissions from different industrial outlets pollute the ambient air in a large scale. Not only human beings but also animals suffer a lot due to the growing air pollution. As closure of these industrial avenues is beyond economic feasibility so reduction of the air pollutant load via selection of appropriate plant species is an important investigative topic. The Air pollution tolerance index (APTI) is widely used as a selection criterion for determining plant species tolerance towards air pollutants. Shorea*robusta*(Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) has ascorbic acid content 40 and 32, 32 mg/g respectively, has total chlorophyll content 11.5, 9.0 and 8.5 mg/g respectively , has pH 6.5,6.2,6.2 respectively, has relative water content 35, 30, 30% respectively.APTI values of Shorea*robusta*(Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) are 72, 57 and 52 respectively. Among the *Azadirechtaindica*(Neem), *Mangiferaindica* (Mango) and *Shorearobusta* (Sal) have been found to be of tolerant variety. More plantations of the tolerant plants are necessary for healthy living.

**Keywords:** Air Pollutants, Biochemical parameters, Indexing, Tolerant species.

## I.INTRODUCTION

Plants are considered as the living filters of air pollutants as they can accumulate, detoxify, and metabolize the pollutants. As a result of air pollution, a severe reduction of stem perimeter, chlorophyll content and flowering and fruiting occur. The main aim of the study is to identify the specific tolerant and sensitive plants that can be used to develop green belt around the selected locality and to make the surrounding areas suitable for residential and agricultural sectors. Photosynthesis, functions of stomata etc. can be affected greatly by the deposition of coal and other

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dust particles on the surface of leaves [1]. Large surface area of the leaf provides a large area for accumulation of pollutants to reduce air pollution level and thus leaves are the good trapping device of pollutants [2-3]. Tripathi et al has also reported that physiological changes of the plant occur before damage of leaves due to air pollutants [4]. Joshi et al has reported that plants can act as the scavengers for the air borne particulates in the atmosphere (these particulates first get accumulated on the leaves and then they enter into the body of the plants) [5]. There occurs different kinds of chemical transformations of the pollutant and finally hampers the metabolic process [6]. Since the sensitivity as well as tolerance level towards pollutants is different for different plants, thus it is necessary to categories plants into sensitive and tolerant groups. The sensitive groups will be indicators of pollutants and the tolerant groups will be sinks for the abatement of air pollution in the area of study. To categorize plants we need four different biochemical parameters like ascorbic acid (AA), total chlorophyll content (TC), pH and relative water content (RWC).

The present study is centred in and on the Barabani Block (23°45′25″N, 87°01′30″E) of Paschim Bardhaman district of West Bengal state, India. Area is moderately populated according to 2021 census. As the area has rich deposits of coal so there are a lot of open cast and underground coal mines located in and around the village area. Begunia, Gourangdi, Mohanpur, Dabar, Bon-jemari, Barmundia, Manoharbahal etc. mines of Eastern Coal Fields Limited (ECL) are found in the area along with some privately managed coal mines. The various accessory industries that burn coal on a daily basis  in this area are the power plants, refractories, coke factories and brick manufacturing units. The burning of coal causes the emission of gases like SOx and NOx (from the combustion of sulphur and nitrogen content of coal) and CO (from the incomplete combustion of carbon content of coal). Particulate matter mainly coal dust and unburnt carbon also mixes into the air directly. All these pollutants not only have adverse impacts on human and animal health but also on plants. Air quality of the study area has been measured and the values are compared with the standard values.SOx, NOx, PM10, PM2.5 in μg/m³ are 120(80), 125(80),

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120(100), 80(60) respectively in 24 hours basis. CO in mg/m³ is 04(04) in 1 hour basis. Standard values of the above air quality parameters are given in parenthesis.

Many research group reported the indexing of plant species in their own area, but no report was reported by any group in the Barabani area and it is for the first time in this area. According to the availability of the plants, five different plant species have been selected for study in four different corners of the area and they are *Azadirechtaindica* (Neem), *Mangiferaindica* (Mango), *Shorearobusta* (Sal), *Tectonagrandis* (Segun), *Dalbergiasissoo* (Sissoo).

## II.MATERIALS AND METHODS

Sampling: Plants which are abundant in the area were chosen for the study. Only the leaf samples of the selected plants were collected from the predetermined sites throughout the year. Average 5 to 10 leaves, both old and new, as available were collected from each plant. Normal standards for sampling were maintained. Fresh weights of the leave were taken and recorded. Ascorbic acid content, total chlorophyll content, pH of leaf extract, relative water content were determined using suitable methods.

A.Ascorbic Acid (AA) content: AA is an organic compound having molecular formula $C_6H_8O_6$. It takes part in the synthesis of cell walls, regulation of photosynthesis, cell division and in the defence mechanism of body [7]. AA acts as a strong reducing agent for the plants. Higher the content of AA in the leaves of the plant, higher will be the tolerant capacity towards air pollution. Keller et al had shown that AA content in the leaves decreases due to the increase air pollution of the atmosphere [8]. AA content in the leaves can be estimated by some standard methods like spectrophotometric method [9-12], titration method etc.

Ascorbic acid is determined as follows using Bajaj and Kaur, 1981 method [13]. 1 g crushed leaf is mixed with 4 ml oxalic acid –EDTA extracting solution. Then 1 ml $H_3PO_4$ , 1 ml $H_2SO_4$, 2ml ammonium molybdate (5%), 3 ml deionised water are added gradually. Mixture is allowed to stand for 15 minutes. Absorbance is taken at 760nm.

B. Total Chlorophyll content: Chlorophyll is a green pigment which can be found in the chloroplast of green algae and plants. Chlorophyll is a complex compound formed by the attachment of Chlorine ligand with magnesium ion ($Mg^{+2}$). It has the molecular formula $C_{55}H_{72}O_5N_4Mg$ (Chlorophyll a) and $C_{55}H_{70}O_6N_4Mg$ (Chlorophyll b). Air pollutants may react (oxidise, reduce, bleaching etc.) with chlorophyll and thus degradation of chlorophyll structure occurs. Giriet. al, reported that degradation of chlorophyll to phaeophytin is occurred by the loss of magnesium ions [14]. It is

also reported by Rao et. al, that $SO_2$ reacts with chlorophyll and $Mg^{2+}$ ion is replaced by two hydrogen atoms [15]. As a result, productivity of plant decreases. Therefore plants will try to maintain their chlorophyll content even under extremely polluted condition [4, 16-23]. Estimation of total chlorophyll content (TC) is necessary to know the pollution load of the locality. Total chlorophyll content was estimated by colorimetric method (μC Colorimeter 115 of Systronics). Following is the method as described by Arnon [24].

1 g of fresh leaves are ground to paste and made an extract with 20 ml of 80% acetone. It is then centrifuged at 2500 rpm for 5 min. The supernatant liquid is taken to a spectrophotometer and an absorbance is taken at 645 and 663 nm. Content of chlorophyll a, b are calculated by the following equations:

$$Chlorophyll\ a = \frac{(12.7 * D_{663} - 2.69 * D_{645})V}{1000 * W}\ mg/g$$

$$Chlorophyll\ b = \frac{(22.9 * D_{645} - 4.68 * D_{663})V}{1000 * W}\ mg/g$$

$$Total\ Chlorophyl = \frac{(20.2 * D_{645} + 8.02 * D_{663})V}{1000 * W}\ mg/g$$

Where, $D_x$ is the absorbance of the extract at the wavelength x nm, V is the total volume of the chlorophyll solution (in ml), W is the weight of the leaf extract (in gm).

C: pH of leaf extract: The pH (P) is a log scale of the concentration of $H^+$ (pH= -log [$H^+$]). The pH of a solution is the measure of its acidity and basicity and it varies with the concentration of a pollutant. Increase in the concentration of the pollutants in the atmosphere may increase the concentration of ions absorbed by the leaf and thus the pH of the leaf extract may also change. Therefore, measurement of pH is very necessary to get the information about air quality. 5 g of fresh leaves are ground in a mortar with 10 ml distilled water. Liquid portion is then extracted and filtered. pH of the solution is determined with a pH meter (Model no 802, Systronics) which is calibrated with buffer solutions of pH 4, 7 and 9 [25-26].

D: Relative water content: Relative water content (RWC) of leaves is an indication of contamination of leaves with different pollutants. More the pollutant present in a leaf less will be the water content. To get the dry weight (DW), leaves are kept in an oven at 60-70°C for overnight and DW is taken in the next day. Percentage of RWC is calculated by the following formula[27].

$$RWC(\%) = \frac{(FW - DW)}{(TW - DW)} * 100$$

Where FW is the Fresh weight and TW is the total weight.

E:APTI: Air pollution tolerance index (APTI) may be defined as the index of interaction level between pollutants and plants. It plays a significant role to determine resistivity and susceptibility of plant species towards pollution. It is calculated by the following formula using four biochemical parameters [28].

$$APTI = \frac{AA(TC+P)+RWC}{10}$$

Standard APTI values [29]to assess the extent of impact on plant species in the polluted areas are as follows (i) <11 is for sensitive, (ii) 12-16 for intermediate and (iii) >17 is for tolerant.

### III.RESULTS AND DISCUSSION

The study area under investigation is highly polluted by air pollutants emanating from the mines and associated factories. APTI indicates differential susceptibility of plants to air pollutants and it may be used for the detection and monitoring of the effects at various stages of plant life.

Biochemical parameters and APTI values of the above mentioned five plant species are given in the following tables for East and West direction (Table 1 and Table 2) of the area but these are not given in the manuscript for the North and South side of the selected area due to the similar nature of variations. A rigorous comparison of the individual parameters has been done for all the selected plant species from each site of investigation. Following is the analysis.

### A. Ascorbic acid

AA is an important parameter for the plants [30]. Of the five selected plants *Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) has shown a marked level of ascorbic acid given in Figure 1. On an average 40mg/g of AA was obtained for *Shorearobusta* and an average of 32 mg/g was obtained for both *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango). Since tolerant level towards pollution increases with the increase of AA [31-32], so these three plants will act as tolerant species for all directions of the study area. This may be attributed to the presence of similar type of pollutant distribution all overthe study area or due to similar reaction types of the pollutants with the aforesaid 3 different plant species.

### B. Total chlorophyll (TC):

Chlorophyll is a pigment which is responsible for the productivity of plants [11]. Chlorophyll content depends on the age of leaf, the plant species, and pollution levels and prevailing biotic and abiotic conditions of the atmosphere. More the chlorophyll content in the leaves more will be the tolerance level of plants [33]. The average chlorophyll content of

*Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) are 11.5mg/g, 9 mg/g and 8.5 mg/g respectively. So, *Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) will be more tolerant compared to the other species. A comparison is given in Figure 2. Degradation of chlorophyll content occurs to a lesser extent in the above three plant species which may be due to the reaction of chlorophyll of these plants with the ambient air pollutants.

### C. pH

pH is an important parameter for measuring the pollution load on plants [34-35]. Plants having pH values around 7 are considered to be more tolerant, whereas plant species with lower pH are more susceptible to suffering damages from air pollution [36]. Average pH of *Shoreabrobusta* (Sal) is 6.5 which are more than other plants. Both *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) has an average pH of 6.2. So *Shorearobusta* (Sal) is more tolerant compared to the others. A comparison is given in Figure 3.
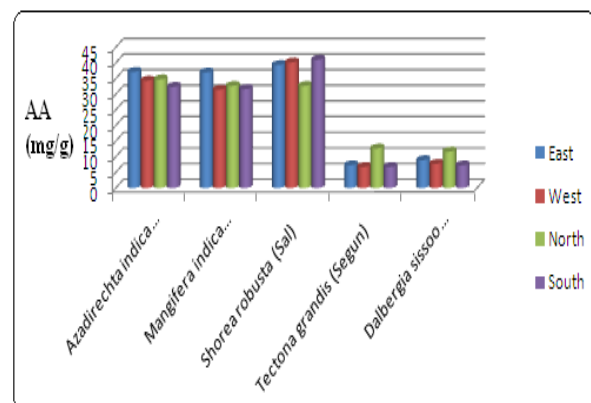


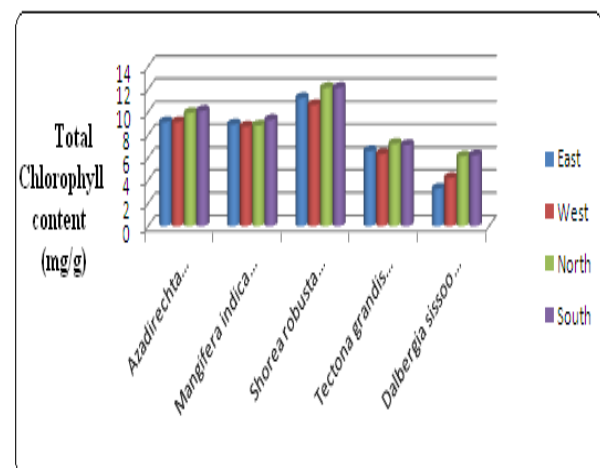**Figure 1: Comparision of ascorbic acid content for plants**



**Figure 2: Comparision of total chlorophyll content of different plants**

## D. Relative water content (RWC):

RWC for *Shorearobusta* (Sal) is 35% . It is 30% for both *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango). The other selected plant species have lesser % of RWC. So the aforementioned are the more tolerant compared to the other species. A comparison is given in Figure 4.
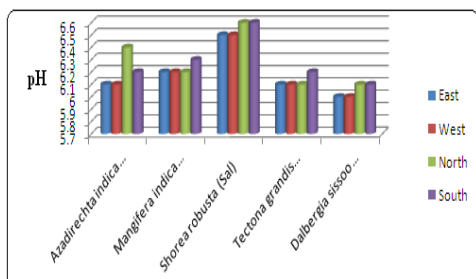


**Figure 3: Comparision of pH of different plants**

## E. APTI

*Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) are the most tolerant species compared to the others because of their higher values of APTI (average 72, 57 and 52 respectively). A comparison is given in Figure 5. Therefore *Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) are the air pollution tolerant species and will function as air pollution "sink". *Tectonagrandis* (Segun) and *Dalbergiasissoo* (Sissoo) have comparatively much lower APTI values (average 10.8 and 10.7 respectively) and hence they can be categorised as species sensitive to air pollution.

Extensive and planned plantation activities with the tolerant species will definitely increase the green cover in the study area. With that the level of SPM and RSPM in the ambient air is also expected to decrease. Further a marked improvement in the local visibility level is also expected. On a long term basis incidence and intensity of asthmatic and COPD conditions are likely to undergo betterment.
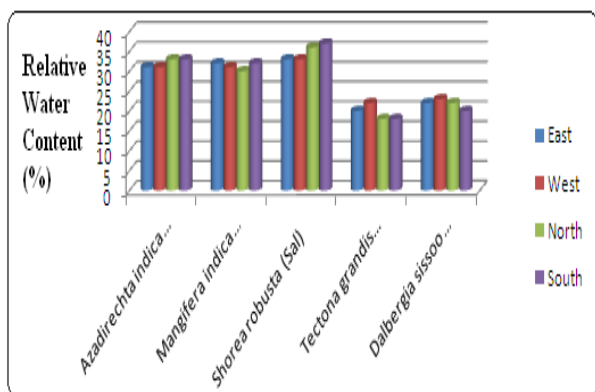


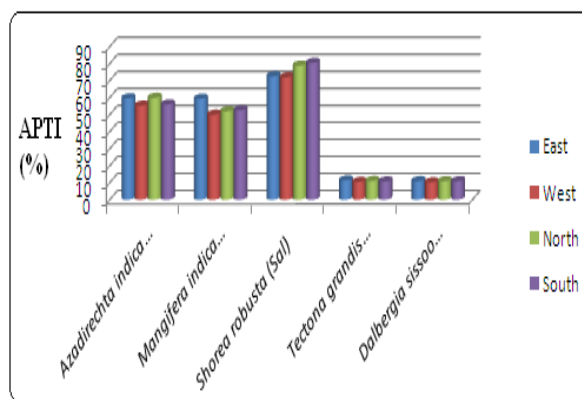**Figure 4: Comparision of relative water content for plants**

**Figure 5: Comparision of APTI for plants**

| Plants | AA (mg/g) | TC (mg/g) | pH | RWC (%) | APTI |
|---|---|---|---|---|---|
| Azadirechtaindica | 37.1 | 9.1 | 6.1 | 31 | 59.49 |
| Mangiferaindica | 36.9 | 8.9 | 6.3 | 32 | 59.29 |
| Shorearobusta | 39.3 | 11.2 | 6.4 | 33 | 72.47 |
| Tectonagrandis | 7.23 | 6.6 | 6.3 | 20 | 11.01 |
| Dalbergiasissoo | 8.89 | 3.3 | 6.5 | 22 | 10.89 |

**Table 1: Biochemical parameters of the East side**

| Plants | AA (mg/g) | TC (mg/g) | pH | RWC (%) | APTI |
|---|---|---|---|---|---|
| Azadirechtaindica | 34.3 | 9.1 | 6.1 | 31 | 55.24 |
| Mangiferaindica | 31.4 | 8.7 | 6.2 | 31 | 49.89 |
| Shorearobusta | 40.1 | 10.6 | 6.5 | 33 | 71.87 |
| Tectonagrandis | 6.7 | 6.3 | 6.1 | 22 | 10.41 |
| Dalbergiasissoo | 7.7 | 4.2 | 6.0 | 23 | 10.15 |

**Table 2: Biochemical parameters of the West side**

## IV. CONCLUSION

The present study essentially encompasses the determination of certain biochemical parameters and subsequent calculation of APTI of a few selected plant species in the Jamgram coal mine area of Paschim Bardhaman district of West Bengal, India. The study reveals that *Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) are the air pollution tolerant species and

hence they will act as pollution sinks. Plants like *Tectonagrandis* (Segun) and *Dalbergiasissoo* (Sissoo) are more sensitive to air pollution. Therefore more plantation of *Shorearobusta* (Sal), *Azadirechtaindica* (Neem) and *Mangiferaindica* (Mango) will help to reduce the ambient air pollution levels.Future investigations will include a detailed study of the reaction mechanisms of the selected biochemical parameters with the ambient air pollutants. Such studies will definitely elevate the comprehension level of pollutant interactions with plant metabolism.

## V. FUTURE SCOPE

This study will help in green belt development.

## ACKNOWLEDGEMENTS

Conflict of Interest: Authors declare that there are no conflicts of interests.

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