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Air Pollution Tolerance Index of various plants species found in F.M. University Campus, Balasore, Odisha, India

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ABSTRACT

Rapid industrialisation and Automobile exhaust has led to different facets of pollution. Vegetation can absorb particulate and other gaseous pollutants into their system, but they also have some limitation and tend to show symptoms of damage after prolonged exposure. Based on the absorbing power and tolerance limit, vegetation can be classified as highly tolerant, moderately tolerant, sensitive and very sensitive. This has been incorporated by scientist into a quantitative value of Air Pollution Tolerance Index (APTI), depending on the score of the plant physiology indicators viz., Leaf Extract pH, Relative Water Content (RWC), Ascorbic Acid and Chlorophyll Content. The vegetation monitoring in terms of its APTI acts as a 'Bio-Indicator' of air pollution and can be incorporated into assessment studies. APTI was calculated for various plant species growing inside the F.M. University campus in Balasore district. The leaf samples were collected from 16 number of tree species in F.M. University campus of Balasore to determine APTI. In the present study, APTI value indicates that majority of plants are sensitive to air pollution and only four plants like Mangifera indica, Ficus religiosa, Anacardium occidentalis and Zizipus spp. are intermediately tolerant. Thus these tree species could act as the bio indicators for pollutants and could be utilized as tolerant species towards combating air pollution.

Keywords: APTI, Bio-Indicator, Intermediately Tolerant, Sensitive, F.M. University.

INTRODUCTION

AIR being an important and vital component of earth's environment and slightly change in its composition can have varied effects on the growth, development and survival of different organisms on this planet. Similarly plants also play an important role in monitoring the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide, {reg} oxygen and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the air environment. Today's growing pollution and rapid industrialisation has resulted in deterioration of ambient air quality. There are five primary or major air

pollutants these are 1.Oxides of carbon (CO, CO_2), 2. Sulphur dioxide (SO_2), 3.Oxides of nitrogen (NO_X), 4. Hydrocarbons, 5. Particulate matters, which react with one another and with other substances and go to produce secondary pollutants which are extremely harmful to living organisms. Air pollution is causing a number of changes in vegetation. Reduction in plant height, canopy area, plant biomass and chlorophyll, ascorbic acid and nitrogen content in plants growing at sites receiving higher pollution are some of the common responses [1]. Leaves responds to pollution and undergo quantitative changes in varying degree in a number of leafs surface micro morphological character [2]. The leaves are generally used as experimental material as they take up large amount of pollution [3]. APTI is species dependent plants attribute which express the inherent ability of the plant to encounter stress emanating from pollution. There is a scale of APTI value which indicates that APTI value between 30-100 the species is tolerant; APTI value 17-29 as intermittently tolerant; and plants registering APTI value in the range of 1-16 are considered as sensitive; APTI value lower than 1 is branded as highly sensitive [4]. Sensitivity and response of plants to air pollutants is variable. The plant species which are more sensitive act as biological indicators of air pollution. The response of plants to air pollution as physiological and biochemical levels can be understood by analysing the factors that determine resistance and susceptibility. Using plants as indicator of air pollution is the possibility of synergistic action of pollutants. The ambient environment of an urban area may be contaminated with several pollutants such as SO_2, CO, NO_X and Heavy metals and the plants growing there would be exposed not only to one but too many pollutants and their different conditions. Methods used to determine the APTI by synthesizing the values of four different biochemical parameters i.e. Leaf Extract pH, Ascorbic Acid, Total Chlorophyll and Relative Water Content (RWC). Species having higher APTI value are more tolerant to air pollution than those having lower APTI value. Species having lower APTI value may act as bio indicator of pollution. Impact of plant community gas also been studied worldwide in terms of plant environment interactions, since the plants are much more sensitive in comparison to other organism. The symptoms or effect including changes in the plant anatomy, physiology and biochemistry indicate a polluted environment. The pollutants enter into the plants and react in variety of ways before being removed or absorbed that may include accumulation, chemical transformation and incorporation into the metabolic system. In the present study tolerant species to air pollution have been identified in respect to the above four biochemical parameters which may help in proper selection of species in F.M. University campus in Balasore district and important finding are reported in this communication.

MATERIALS AND METHODS

Study Area : Orissa extends from $17^0$11' to $22^0$15' N latitude and from 81'29 E longitude on the eastern coast of India. Balasore is lies in the east direction of the state which extends from latitude 21'32'30"N to 85'40' 37" E longitude. The study area of around F.M University and Nuapadhi village which is well concerted to Balasore town and NH-5 and is 15KM away from NH-5 and 20KM away from SE railway. There are two industries such as Emami paper mill and Balasore Alloys ltd. These two industries are situated 2-4 km away from FM University and Nuapadhi village. There are also four crusher units are present outside to the F.M. University campus. River Sono which is a tributary of river Budhabalanga flowing in the heart of the study area. The study area experiences moderate type of the monsoon climate, rain fall is observed between June to September, normal rain fall was reported to be 1600 mm. The mean daily relative humidity (RF) is 55% during June to September and 28% in October to march, 20% during April to May. The average wind speed in the study area varies from 0.5 to 10 KM per hour wind direction of east southwest to north northwest. The highest temperature in the summer season is 45^oC and lowest temperature is 15^oC in the month of January. Nilagiri subdivision is mostly hill terrain and vegetated with tropical semi ever green forest. The hills of Nilagiri has highest peak of 1783' above the sea level. It is a region of valuable forest resource. The soil type of Nuapadhi is alluvial literate.

A total of 16 different tree species were selected for the study in the different places inside the F.M. University campus. The screening and selection of the plant species are partly based on literature survey of similar work and guideline of Central Pollution Control Board [5]. Composite leaf samples were sampled in polyethylene bags, tagged and brought to the laboratory and analysed for several biochemical parameter. The Air Pollution Tolerance Index (APTI) was developed by analysing the biochemical parameters of leaf material, viz., pH, Ascorbic Acid, Relative Water Content and Total Chlorophyll [6]. The pH values were estimated by using a digital calibrated pH meter. Total Chlorophyll and Ascorbic Acid of leaf extract was estimated by spectrophotometer method. Relative Water Content of leaf was estimated by gravimetric method by determining the leaf weight under different condition like initial weight, turgid weight and Dry weight. The formula used to determine the Air Pollution Tolerance Index "APTI" using the four parameters [7].

APTI= {A (T+P) + R}/10

Where A= Ascorbic Acid (mg/g)

T= Total Chlorophyll Content of Leaf (mg/g/fw)

P= pH of the leaf extract and

R= Relative Water Content of leaf extract (%)

The entire sum was divided by 10 to obtain a small manageable figure.

RESULTS AND DISCUSSION

Air Pollution Tolerant Index (APTI) is calculated for 16 plant species growing inside the F.M. University campus and the data is presented in table-1. All biochemical parameters that are used for analysed APTI plays significant role to determine resistivity and susceptibility of plant species. Chlorophyll content of plants signifies its photosynthetic activities as well as the growth and development of biomass. It is well evident that chlorophyll content of plants varies from species to species; age of leaf and also with the pollution levels as well as with other biotic and abiotic conditions [8]. Higher the sensitive natures of the plant species lower the chlorophyll content. Ascorbic Acid is important in cell wall synthesis, photosynthetic carbon fixation and cell division [9], pH as an indicator for sensitivity to air pollution [10], total chlorophyll is also related to ascorbic acid productivity. Pollution load dependent increase in ascorbic acid content of all the plant species may be due to the increased rate of production of reactive oxygen species (ROS) during phyto-oxidation of SO_2 to SO_3 where sulphites are generated from SO_2 absorbed. The higher ascorbic acid content of the plant is a sign of its tolerance against sulphur dioxide pollution [11, 12]. Air pollution in urban area and industrial areas may get adsorbed, absorbed, accumulated or integrated in the plant body and if toxic, may injure them in various ways. The levels of injury will be high in sensitive species and low in tolerant ones. The tolerant species of plants function as pollution "sink" and therefore a number of environmental benefits can be desired by planting tolerant species in polluted areas. To evaluate the tolerance level of plant species to air pollution used four leaf parameters to drive an empirical number indicating the Air Pollution Tolerance Index (APTI) [13]. Based on APTI values the plants were conveniently grouped as follows [14].

APTI values	**Response**
30-100	Tolerant
29-17	Intermediate
1-16	Sensitive
<1	Very sensitive

In the present study out of 16 species four species such as *Mangifera indica* (17.81), *Ficus religiosa* (22.49), *Anacardium occidentalis* (17.39) and *Zizipus spp.* (24.76) showed their intermediated response by changing their biochemical characters. The remaining twelve species showed APTI values of less than 16 which were designed as sensitive range. The analysis of biochemical parameters showed a marked variation between tolerant and sensitive species. The ascorbic acid content ranges between 7.16 to 19.75mg in intermediately tolerant species and 1.76 to 8.51mg among the sensitive plant species. The total chlorophyll content ranges between 2.6 to 10.12mg in intermediately tolerant plant and 1.89 to 11.51mg in sensitive plants. The RWC ranged between 85.24% to 87.61% in intermediately tolerant species and 80.14% to 88.71% in sensitive plant species. The pH ranges between 4.4 to 8.2 in both intermediately tolerant and sensitive plant species. In the present study out of the 16 species of plants only four species can serve as indicator of industrial air pollution namely *mangifera indica*, *Ficus religiosa*, *Anacardium occidentalis* and *Zizipus spp.*

APPLICATIONS

Appropriate species can be selected for the green belt development in industrial area.

CONCLUSIONS

Based on the present study it is concluded that the APTI values can be used as predictor of air quality. In the present studies out of 16 species only 4 species indicates that intermediately tolerant and another twelve species are sensitive to air pollution may be due to the industrial pollution or toxic gases from nearby industries and only four plant species which can be used for Green Belt Development. In eco-friendly conservation and pollution abatement through green belt development plan for a particular sector mainly depends upon, nature and extent of pollution load,

sinking capacity of the ecosystem, climatic factors and soil and water quality. In this study the species like *mangifera indica, Ficus religiosa, Anacardium occidentalis* and *Zizipus spp.* can be potentially used for bio-monitoring of air quality in polluted areas (Table1).

Table1

Sl. No	Name of plant species	Total Chlorophyll mg/g.f.w	pH	Ascorbic Acid	RWC %	APTI	Grade
01	*Azadirachta indica*	3.03	6.1	5.93	80.14	13.43	S
02	*Mangifera indica*	4.91	6.0	8.51	85.24	17.81	I
03	*Psidium guajava*	3.39	6.6	5.51	84.51	13.96	S
04	*Ficus religiosa*	10.12	8.2	7.52	86.61	22.44	I
05	*Achras sapota*	2.16	6.3	3.78	85.21	11.72	S
06	*Suzygium cumini*	3.7	6.1	2.31	84.71	10.73	S
07	*Artocarpus heterophyllus*	3.42	6.2	3.57	88.71	12.31	S
08	*Eucalyptus species*	2.1	5.0	6.67	82.51	12.98	S
09	*Acacia melanoxylon*	1.89	7.2	7.57	83.56	15.24	S
10	*Tamarindus indica*	3.12	4.4	8.23	85.51	14.74	S
11	*Anacardium occidentalis*	7.38	4.8	7.16	86.71	17.39	I
12	*Zizipus spp.*	2.6	5.3	19.75	87.61	24.76	I
13	*Ficus bengnapensis*	11.51	7.5	3.54	86.79	15.41	S
14	*Dilonix regia*	5.91	7.4	1.76	87.71	11.11	S
15	*Caesalpinia pulcheria*	5.53	7.2	1.83	85.53	10.88	S
16	*Melia aradarach*	4.24	6.5	3.43	84.51	12.13	S

I: Intermediately Tolerant, S: Sensitive

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REFERENCES

[1] J.Pandey, M, Agarwal,.", *Environ International.* **1992**, 18, 515-520.
[2] S.D.Chattopadhyay,. *Advance Plant Sci.* ***1*996**, 9(1),10-14.

[3] S.S.Malhotra, A.A.Khan, "Biochemical and Physiological impact of major pollutants in Air pollution and plant life" (Ed.M. Treshow) Johnwiley and sons, New York. **1984,** 113-157.
[4] P.M.Mashita, V.L.Pise, *Poll. Research*, 2001, 20(2), 195-197.
[5] CPCB. Guidelines for developing greenbelts. CPCB Publication. Programme Objective Series. PROBES/75,**1999-2000.**
[6] J.Pandey, M.S.Sharma,. "Environmental Science Practical and Field". Yash Pub., Bikaner, India **2003** ,129.
[7] S.K.Singh,*J.of Environmental Management*, **1991**, 32, 45-55.
[8] V.Katiyar, P.S Dubey, *Ind. J. Environ. Toxicol*. **2001** , 11, 78-81.
[9] P.L.Conklin ,*Plant Cell Environ.*, **2001**, 24, 383-394.
[10] F.Scholz S. Reck, *Water, Air Soil Pollut.*, **1977** ,8, 41-45.
[11] C.S.Chaudhury, D.N.Rao, *Proc. Ind. Natl. Sci. Acad. Part B*, **1977,** 46, 236-241.
[12] S.R.K.Varshney, C.K.Varshney, *Environ. Pollut.*, **1984,**35, 285-291.
[13] S.K.Singh, D.N.Rao, Indian Association for Air Pollution Control, New Delhi, **1983**,218-224.
[14] Y.Kalyani, M.A.Singaracharya, *Acta Botanical Indica*, **1995** , 23:21-24.