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ASSESSMENT OF AIR QUALITY USING SEVERAL BIO MONITORS OF SELECTED SITES OF DURGAPUR, BURDWAN DISTRICT BY AIR POLLUTION TOLERANCE INDEX APPROACH

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ABSTRACT

Rapid industrialization leads a great role over pollution. Vegetation can absorb particulate and other gaseous pollutants into their system but they also have some limitation and tend to show symptoms of damages after prolonged exposure. Several parameters including ambient air quality monitoring as well as ascorbic acid, pH, total chlorophyll, relative water content of ten different crop species at four different sites were analyzed to evaluate the Air Pollution Tolerance Index of Durgapur, Burdwan District, West Bengal, India.From the detailed study it was found that the highest APTI valueshowed in *Polyalthialongifolia* (176.14) at Durgapur College Campus, *Nacicasesum* (158.68) at Durgapur Projects Limited, *Polyalthialongifolia* (133.26) at Amaravati and *Moringaoleifera* (129.32) at Mamrabazar. Therefore these tree species could act as the bioindicators for pollutants and could be utilized as tolerant species towards combating air pollution.

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KEYWORDS : Air Pollution Tolerance Index, Bio-Indicators

Air Pollution Tolerance Index (APTI) is an inherent quality of plants to encounter air pollution stress which is presently of prime concern particularly of urban areas of the world.Since plants are stationary and continuously exposed chemical pollutants from the surrounding atmosphere,air pollution injury to plants is proportional to the intensity of the pollution. It has also been reported that when exposed to air pollutants, most plant experience physiological changes before exhibiting visible damage to leaves . Studies has also shown the impacts of air pollution on Ascorbic acid content chlorophyll content (Flowers,et al., 2007), leaf extract pH (Klumpp, et al 2000) and relative water content (Rao, 2006). These separate parameters gave conflicting results for same species. Several contributors agrees that air pollutants effect plant growth adversely (Rao, 2006).

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 as mentioned by Pandey and Agarwal (1992). APTI is a species dependent plant attribute which expresses the inherent ability of the plant to encounter stress emanating from pollution. According to Mashita and Pise, 2001 there is a scale of APTI value which indicates the 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. According to Tiwari et al., 1993) APTI level of 25 species were found to be different at Bhopal and plants having higher APTI value are more tolerant to air pollution than those having lower APTI value. Species having lower APTI value may act as bioindicator of pollution. Chattopadhyay, (1996) reported that leaves respond to pollution and undergo quantitative changes in varying degree in a number of leaf surface micro-morphological characters. The leaves are generally used as experimental material as they take up large amount of pollution . In the current study our prime objective was to go for phyto-optimization of the air quality of the plants as meager literature in relation to application of plants for APTI value was found. .Secondly an attempt has been made to compare the APTI values of different plants and to screen out the relative sensitivity of ten plant species towards air pollution taken from four sites viz., Durgapur government college campus, Durgapur DPL,Amravati and Mamrabazar.

MATERIALS AND METHODS

A total of ten different tree species were selected for the study from 4 different spots from Durgapur. The study site includesDurgapur Government College campus,

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Durgapur DPL, Amaravati and Mamrabazar. The screening and selection of the plant species are partly based on literature survey of similar work guidelines of Central Pollution Control Board (CPCB,1999-2000). Composite leaf samples were sampled in polythene bags, tagged, brought to the laboratory and analyzed for several biochemical parameters.To trace the seasonal variation in the APTI value the sampling was done twice, once in winter season and the other in summer season. The Air Pollution Tolerance Index(APTI) was determined by calculating the ascorbic acid (Mukherjee and Choudhuri, 1983), chlorophyll (Arnon, 1949), pH (Singh and Rao, 1983) and relative water content (Barrs and Weatherley, 1962). The pH values were estimated by using a digital calibrated pH meters. Ascorbic acid, total chlorophyll of leaf extract was estimated by spectrophotometric method. Relative water content was estimated by gravimetric method by determining the leaf weight under different condition like initial, turgid and dry weight. The methodology is suggested by Agarwal et al., (1991). Estimation of chlorophyll is done by spectrophotometer while pH was determined by electrometric method. APTI is given by

$$APTI = [\{A(T+P) + R\}/100]$$

Where A is the ascorbic acid, $mg.g^{-1}$; T is totalChlorophyll, $mg.g^{-1}$ Fw; P-pH of leaf sample and

R=relative water content (%). APTI index range: 0 to 1 = most sensitive, 2 to 16 = sensitive, 17 to 29 = intermediate, 30 to 100 = tolerant

Ambient air monitoring was done by High Volume Sampler by using standard methods. {ForSOx [IS 5182 (PARTII): 2001] NOx [IS 5182 (PART VI): 1975] and for SPM [IS 5182 (PART IV): 1999129.32129.32].

RESULTS AND DISCUSSION

The analyzed value for all the ten plant species in four different selected spots of Durgapur has been presented in Table 1. From the results it was found that the pH of the leaf extract was found to be acidic in nature in case of almost all the species in all the spots although a variation exists in Amravati where pH value is basic in nature. The highest pH value was noticed in Amravati in the species *Litchi chinensis* and the lowest pH was found in the species *Tamarindus indica* in Durgapur DPL, acidic in nature,

Table 1: Biochemical constituents in leaf samples collected from different plant species at four different spots of Durgapur

Species	Ascorbic acid (mg/g)				pH				Relative Water Content (%)				Chlorophyll (mg/g fw)			
	DCC	DPL	AMV	MMB	DCC	DPL	AMV	MMB	DCC	DPL	AMV	MMB	DCC	DPL	AMV	MMB
Mangifera indica	0.85	82.26	92.23	-	6.7	6.7	7.3	-	302.45	391.15	430.43	-	0.19	0.01	0.02	-
Azadirachta indica	0.78	66.06	-	-	6.6	6.8	-	-	26.56	3.91	-	-	0.37	0.02	-	-
Psidiumguajava	0.30	34.90	-	-	6.8	7.1	-	-	291.71	86.24	-	-	0.11	0.11	-	-
Nyctanthesarbourtricis	1.82	-	-	-	7.1	-	-	-	39.95	-	-	-	0.33	-	-	-
Artocarpusheterophylls	0.12	14.96	-	17.44	7	7.3	-	6.8	529.37	181.68	-	196.19	2.64	0.77	-	0.02
Polyalthialongifoli a	0.99	112.17	74.78	87.25	6.6	7.5	7.4	6.9	195.87	240.25	32.52	64.02	0.10	0.38	0.01	0.02
Tamaridusindica	0.71	72.29	67.31	-	4.4	4.1	7.3	-	2.91	2.34	2.61	-	0.31	0.03	0.02	-
Moringaoleifera	1.78	42.38	-	184.47	5.9	6.6	-	6.7	13.36	37.82	-	28.88	0.26	0.02	-	0.09
Zizyphusmauritius	2.48	167.08	-	-	7.4	7.1	-	-	3.44	152.52	-	-	0.42	0.07	-	-
Delonixregia	2.48	220.61	-	-	7.3	6.9	-	-	0.60	1.12	-	-	0.66	0.03	-	-
Nacicasesum	-	221.86	-	220.61	-	7.0	-	6.7	-	11.55	-	19.89	-	0.06	-	0.07
Litchi chinensis	-	-	94.72	-	-	-	7.8	-	-	-	18.18	-	-	-	0.02	-
Citrus maxima	-	-	84.75	-	-	-	7.6	-	-	-	31.91	-	-	-	0.01	-
Ficusrelegiosa	-	-	-	24.93	-	-	-	6.9	-	-	-	224.91	-	-	-	0.01

[DCC- Durgapur College Campus, DPL- Durgapur Project Limited, AMV- Amravati and MMB- Mamrabazar]

which demonstrate that the air pollutants are mostly gaseous type, namely SO_2 and NO_2, diffuse and form acid radicals in leaf matrix by reacting with cellular water. This further affects the chlorophyll molecules.

R.W.C is a useful indicator of the state of water balance of a plant. The large quantity of water (in terms of RWC) in plant body helps in maintaining its physiological balance under stress conditions of air pollution. The

Relative Water Content (RWC) of leaves is an indicator of the plants water status with respect to its physiological consequences of cellular water and it ranged between 0.60% to 529.37% among the studied plant species. Highest value was rewarded by Artocarpus heterophyllsin Durgapur College Campus where as lowest value was reported by Delonix regiaat the same spot. The relative water content indicates change in leaf matrix hydration condition and will generate higher acidity condition when RWC is low. More water will dilute acidity. From the result it will can also be concluded that the former species tends to be more tolerate to air pollution stress while the latter is sensitive.

Total chlorophyll content comprises of chlorophyll-'a', chlorophyll-'b' and other accessory pigment. It provides greenness to the leaves and is the main organ of trapping sunlight and its conversion to chemical energy. The chlorophyll content is affected by pH of the leaves and ranges between 0.01 mg^{-1} fw to 2.64 mg^{-1} fw in the studied plants at the selected spots of Durgapur. The higher level of total chlorophyll content in the leaves of the selected species at Durgapur College Campus in comparison to DPL indicates lower air pollution stress. Highest value of total chlorophyll was found to be in *Artocarpus heterophylls* for DCC and lowest value were recorded in *Mangifera indica* and *Polyalthia longifoliain* DPL and AMV respectively.

Ascorbic acid is an antioxidant system which protects plant against oxidative damage resulting from photosynthesis and range of pollutants. Ascorbic acid being a strong reluctant activities, physiological and defense mechanisms and its reducing power is directly proportional to its concentration. A high content of ascorbic acid in plant leaf is related to biochemical and physiological species of a particular environment. It provides specific physiological defense mechanism as for plants internally and its reducing power is directly proportional to its concentration . In the present study it varied between 0.12 mg^{-1} to 221.86 mg^{-1} with *Nacicasesum* showing highest and *Artocatpu sheterophylls* having lowest content.

Air Pollution Tolerance Index

Highest APTI value was reported by *Polyalthia longifolia* (176.14)and lowest in *Zizyphus mauritiana*(20.2) in DGC (Table, 2).

From the results it can be concluded that the tenspecies selected at the four sites are sensitive towards air pollution after (Mashita and Pise, 2001). From the correlation studiesof the different biochemical constituents and APTI itwas found that APTI is positively correlated withascorbic acid content but significant both at 1% and 5% level of significance in DPL andMamrabazar respectively. (Table 3 & 4) APTI is insignificantly related with the relative water content. Total chlorophyll and APTI shows positive

Table 2: APTI values for plant species at selected spots of Durgapur

Plant Species	APTI values for Plant species at selected spots of Durgapur			
	DCC	DPL	AMV	MMB
Mangiferaindica	88.62	94.88	110.26	-
Azadirachtaindica	57.38	46.01	-	-
Psidiumguajava	49.85	33.68	-	-
Nyctanthesarbourtricis	139.27	-	-	-
Artocarpusheterophylls	62.63	33.78	-	31.54
Polyalthialongifolia	176.14	112.84	133.26	66.86
Tamaridusindica	62.62	29.66	49.61	-
Moringaoleifera	11.16	31.95	-	129.32
Zizyphusmauritius	20.02	134.65	-	-
Delonixregia	191.54	152.86	-	-
Nacicasesum	-	158.68	-	151
Litchi chinensis	-	-	75.59	-
Citrus maxima	-	-	67.37	-
Ficusrelegiosa	-	-	-	39.62

Table 3: Correlation matrix between ascorbic acid, pH, relative water content and total chlorophyll, APTI of selected plant species of Durgapur college campus area

	pH	R.W.C.	Ascorbic acid	Total Chlorophyll	APTI
pH		0.517	0.341	0.394	0.681
R.W.C	0.233		0.020	0.686	0.617
Ascorbic acid	0.336	-0.714		0.624	0.309
Total chlorophyll	0.303	0.147	0.177		0.985**
APTI	0.149	-0.181	0.358	0.007	

**Significant at 1% level * significant at 5% level.

Table 4: Correlation Matrix Between Ascorbic Acid, Ph, Relative Water Content And Total Chlorophyll, APTI of Selected Plant Species of Durgapur DPL

	pH	R.W.C.	Ascorbic acid	Total Chlorophyll	APTI
pH		0.330	0.682	0.499	0.284
R.W.C	0.345		0.540	0.521	0.815*
Ascorbic acid	0.148	-0.221		0.241	0.000
Total chlorophyll	0.243	0.231	-0.408		0.406
APTI	0.376	0.085	0.944*	-0.296	

**Significant at 1% level * significant at 5% level.

Table 5: Correlation Matrix Between Ascorbic Acid, Ph, Relative Water Content And Total Chlorophyll, Apti of Selected Plant Species Of Amravati

	pH	R.W.C.	Ascorbic acid	Total Chlorophyll	APTI
pH		0.337	0.428	0.983**	0.760
R.W.C	-0.550		0.417	0.665	0.480*
Ascorbic acid	0.467	0.447		0.609	0.786
Total chlorophyll	-0.013	0.266	0.313		0.281
APTI	-0.190	0.421	0.161	-0.604	

**Significant at 1% level * significant at 5% level.

Table 6: Correlation Matrix Between Ascorbic Acid, pH, Relative Water Content And Total Chlorophyll, APTI of Selected Plant Species oMamrabazar

	pH	R.W.C.	Ascorbic acid	Total Chlorophyll	APTI
pH		0.411	0.147	0.139	0.126
R.W.C	0.482		0.028	0.139	0.042
Ascorbic acid	-0.746	-0.918		0.051	0.000
Total chlorophyll	-0.756	-0.756	0.865*		0.053
APTI	-0.774	-0.892	0.998**	0.873*	

**Significant at 1% level * significant at 5% level.

correlation at 1% level of significance in Mamrabazar spot. (Table, 5 & 6).

CONCLUSION

Out of all the selected plant species it can be concluded that species like *Mangifera indica, Tamarindus indica*, *Litchi chinensis*, *Artocarpus heterophylls* and *Delonixregia* can be potentially used for biomonitoring of air quality in polluted areas.

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