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AIR POLLUTION TOLERANCE INDEX OF VARIOUS PLANT SPECIES GROWING IN INDUSTRIAL AREA OF ORAI DISTRICT JALAUN (U.P.) INDIA

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ABSTRACT

Air pollution tolerance index (APTI) was calculated for various plant species growing in industrial area of Orai. The leaf samples collected from 24 tree species in the industrial area were used to determine their Air Pollution Tolerance Index (APTI) by calculating the ascorbic acid, chlorophyll, pH and relative water contents. The APTI values of less than 16 are reported in 19 species and they can be used as indicators of air pollution. The species *Ficus religiosa* (24.92), *Zizyphus jujuba* (21.84), *Phyllanthus emblica* (17.40), *Cassia fistula* (17.67) and *Tamarindus indica* (16.96) showed their moderate response by changing their biochemical contents and were identified as moderately tolerant to air pollution.

Figures : 02 References : 11 Table : 01
KEY WORDS : Air pollution, Orai, Plant species, Tolerance index.

Introduction

Plants play an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide, oxygen and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the air[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 at physiological and biochemical levels can be understood by analyzing 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, NOx and heavy metals and the plants growing there would be exposed not only to one but to many pollutants and their different conditions. It is possible to estimate the overall effect of a large number of pollutants as total pollution by measuring changes in the plants[1,8,10]. Plants were assessed for their tolerance index to establish the air pollution level. Air pollution effects on plants have long been known. A method of determining Air Pollution Tolerance Index (APTI) by synthesizing the values of four different biochemical parameters *i.e.* leaf extract pH, ascorbic acid, total chlorophyll and relative water contents was suggested[7]. In the present study tolerant species to air pollution were identified in respect to the above four biochemical parameters which may help in proper selection of species in urban plantation programme at Orai (Jalaun).

Materials and Methods

Orai is situated in northern belt of Bundelkhand region, Uttar Pradesh. It lies between 25^0 59' N latitude and 79^0 37' E longitude. The climate in Orai is generally dry sub-humid typically monsoonic with mean daily maximum temperature being in the range of 24.6 to 43.2^0C and mean daily minimum temperature varies between 6.6 to 29.4^0C. The annual mean humidity is 52.6% and the wind direction is generally from the North-West to South-East.

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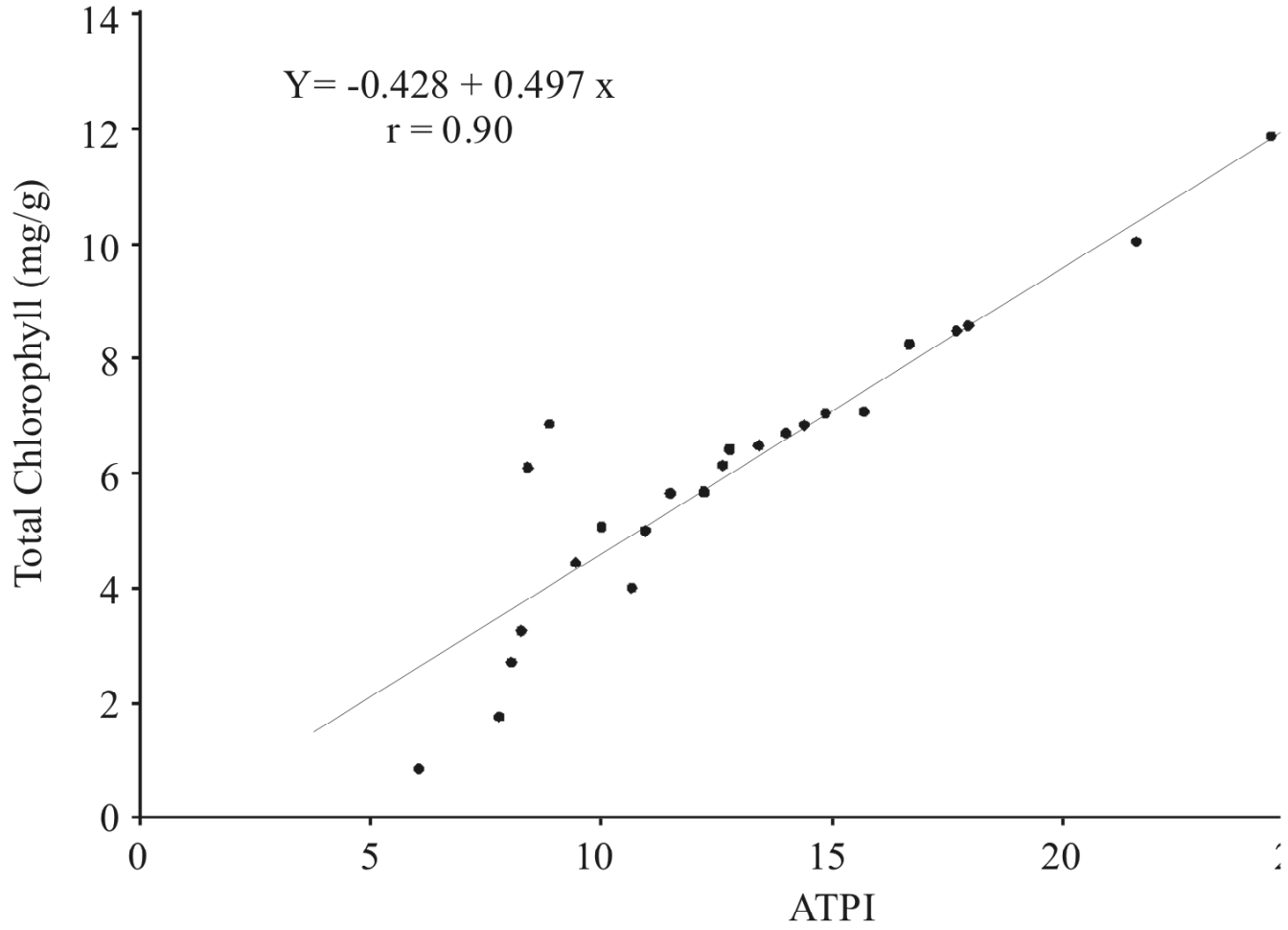

Fig. 1 : Correlation between chlorophyll content and ATPI

Orai was selected for the study since numerous sources emit air pollutants including several major and minor industries located in the industrial areas of the city. The study was carried out in industrial and urban areas characterized by moderate industrial activity. Leaf samples were obtained form 24 tree species of different locations in industrial area of Orai. The Air pollution Tolerance Index (APTI) was determined by calculating the ascorbic acid, chlorophyll, pH and relative water contents in leaf samples. Ascorbic acid was estimated by 2,6 - dichlorophenol indophenol dye method[1]. Chlorophyll was calculated by spectrophotometer and pH was determined by digital pH meter. Relative water content of leaf material was estimated by taking the initial weight and dry weight of leaf material. The APTI was calculated by using the following formula[7]:

APTI = [A (T+P) + R] / 10

Where, A- Ascorbic acid (mg/g dry wt.),

T- Total chlorophyll (mg/g dry wt.),

P- pH of leaf extract,

R - Relative water content of leaf tissue (%).

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

Results and Discussion

Air Pollution Tolerance Index (APTI) was calculated for 24 plant species growing in industrial areas of Orai (Table-1). All biochemical parameters that were analyzed for APTI play significant role to determine resistivity and susceptibility of plant species. Ascorbic acid is important in cell wall synthesis, photosynthetic carbon fixation and cell division[2], pH is an indicator for sensitivity to air pollution[6] and total chlorophyll is also related to ascorbic acid productivity. Air pollution in urban and industrial areas may get adsorbed, absorbed, accumulated or integrated in the plant body and if toxic, may injure them in various ways. The level of injury will be high in sensitive species and low in tolerant ones. The sensitive species help in indicating air pollution and tolerant one help in abatement of air pollution[8].

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. For this purpose, evaluation of plants with respect

TABLE-1 : Air pollution tolerance index (APTI) of various plant species growing in industrial area of Orai district Jalaun

S.N.	Name of plant species	Total Chlorophyll (mg/g)	pH	Ascorbic acid (mg/g)	R.W.C. (%)	APTI
1.	*Acacia arabica* (Babool)	3.25	4.90	3.60	54.75	8.41
2.	*Albizzia lebbeck* (Siris)	6.64	6.00	6.91	54.01	14.13
3.	*Anona squamosa* (Custard apple)	4.41	5.10	3.70	60.85	9.60
4.	*Artocarpus integrifolia* (Jack fruit)	6.10	5.90	2.90	51.05	8.58
5.	*Azadirachta indica* (Neem)	6.44	6.00	5.11	65.14	12.87
6.	*Cassia fistula* (Amaltash)	8.50	6.50	7.93	57.75	17.67
7.	*Cassia occidentalis* (Kasunda)	7.13	6.50	7.51	55.85	15.82
8.	*Delonix regia* (Gulmohar)	1.75	7.20	2.37	57.05	7.82
9.	*Eucalyptus citriodora* (Eucalyptus)	4.00	4.80	5.91	56.21	10.82
10.	*Ficus bengalensis* (Banyan)	5.13	8.20	3.75	61.10	11.10
11.	*Ficus religiosa* (Peepal)	11.87	7.80	9.60	60.38	24.92
12.	*Helianthus annus* (Sunflower)	6.13	7.30	4.07	71.82	12.65
13.	*Madhuca indica* (Mahua)	2.75	5.20	3.52	53.02	8.10
14.	*Mangifera indica* (Mango)	5.55	5.60	3.98	69.87	11.42
15.	*Morus alba* (Mulberry)	5.59	5.80	6.20	53.20	12.38
16.	*Nerium oderum* (Sweet scented oleander)	7.03	5.80	7.27	56.01	14.93
17.	*Parkinsonia aculeata* (Parkinsonia)	0.90	5.00	1.01	54.98	6.09
18.	*Phyllanthus emblica* (Amla)	8.65	5.90	7.98	63.75	17.98
19.	*Polyalthia longifolia* (Ashoka)	6.80	5.40	7.02	60.01	14.56
20.	*Pongamia pinnata* (Indian beach)	5.12	6.60	3.75	57.01	10.09
21.	*Psidium guajava* (Guava)	6.47	6.20	5.25	70.15	13.66
22.	*Syzygium jambolanum* (Black plum)	6.75	5.90	2.04	63.20	8.90
23.	*Tamarindus indica* (Tamarind)	8.32	4.20	7.87	69.75	16.83
24.	*Zizyphus jujuba* (Ber)	9.03	6.30	9.57	71.25	21.84

to their tolerance level to air pollution may be essential. To evaluate the tolerance level of plant species to air pollution, used four leaf parameters[7] to drive an empirical number indicating the Air Pollution Tolerance Index (APTI). From the Table it was evident that the plants showed varied degree of tolerance index to air pollution. Based on the APTI values the plants were conveniently grouped as follows[5] :

APTI value	Response
30 to100	Tolerant
29 to17	Intermediate
16 to I	Sensitive
< 1	Very sensitive

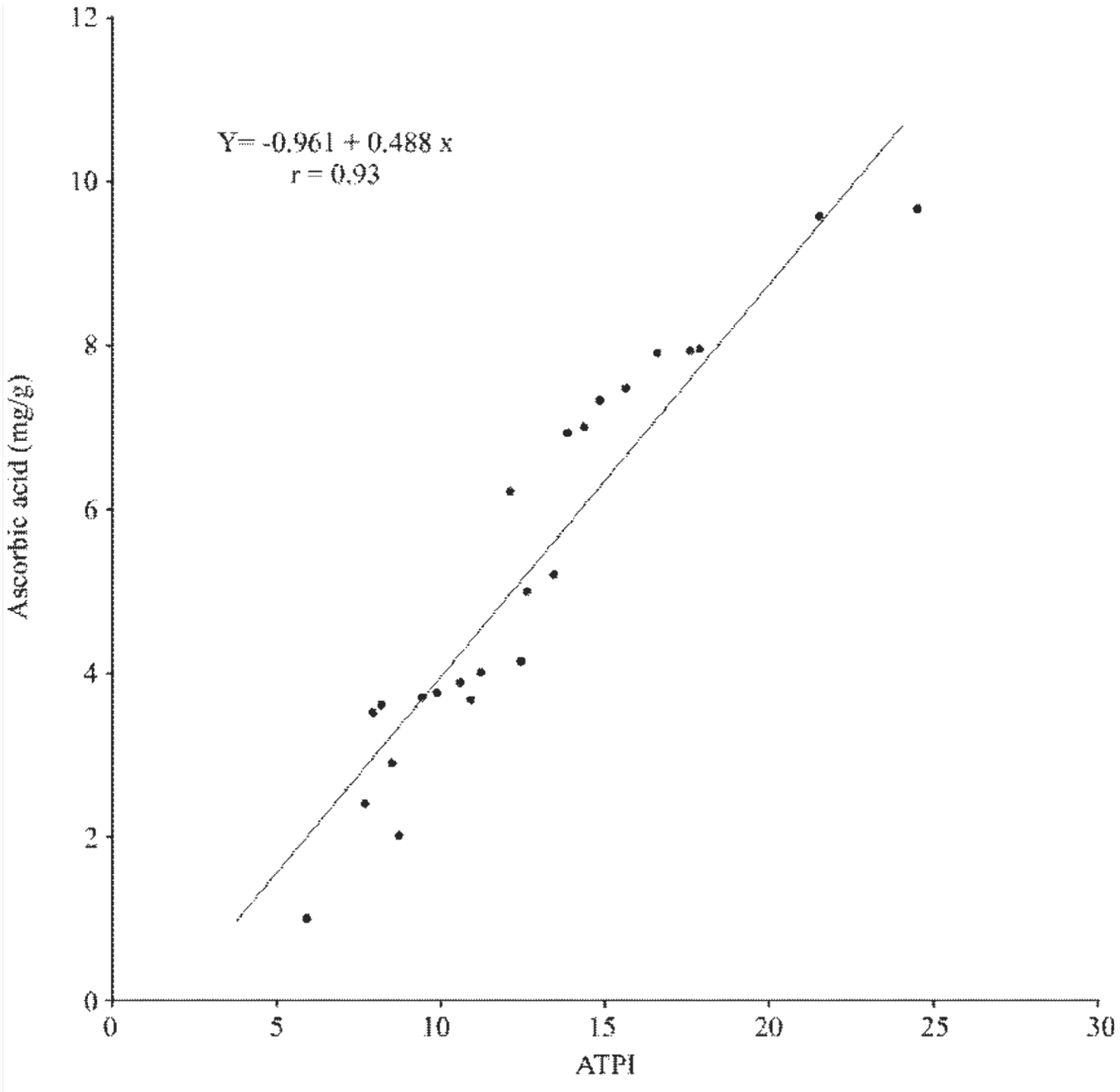

Fig. 2 : Correlation between ascorbic acid content and ATPI

In the present study out of 24 species five species such as *Ficus religiosa* (24.92), *Zizyphus jujuba* (21.84), *Phyllanthus emblica* (17.98), *Cassia fistula* (17.67) and *Tamarindus indica* (16.83) showed their moderate / intermediate response by changing their biochemical characters. The remaining nineteen species showed APTI values of less than 16 which were designated sensitive range.

The analysis of biochemical parameters showed a marked variation between tolerant and sensitive species. The ascorbic acid content ranged between 7.87 to 9.60 mg in intermediately tolerant species and 1.01 to 7.51 mg among the sensitive plant species. Relative water content ranged between 57.75% to 71.75% in intermediate tolerant species and 51.05% to 71.82% in sensitive plant species. Chlorophyll content ranged between 8.32 mg to 11.87 mg in intermediately tolerant plants and 0.90 mg to 7.13 mg in sensitive plants. The pH ranged between 4.2 to 8.20 in both intermediately tolerant and sensitive plant species.

Correlation coefficient was calculated between APTI and biochemical parameters such as ascorbic acid, total chlorophyll, leaf pH and relative water content. The total chlorophyll content was significantly correlated with APTI ($r = 0.90$, $y = -0.428 + 0.497x$) and whereas the leaf pH did not show any significant correlation with APTI (Fig. 1).

High pH may increase the efficiency of conversion from hexose sugar to ascorbic acid[4] while low leaf pH extract showed good correlation with sensitivity to air pollution and also reduce photosynthesis process in plants. The photosynthetic efficiency has been reported to be strongly dependent on leaf pH[12]. The photosynthesis was reduced in plants with low leaf pH[11]. In the present study the leaf pH values are higher than 5.0 in all the species except *Tamarindus indica* (4.20), *Eucalyptus* spp. (4.80) and *Acacia arabica* (4.90). The ascorbic acid content was also significantly correlated (r= 0.93, y= -0.961+0.488x) with APTI (Fig. 2) and the relative water content did not show any significant relation. High water content within plant body helps to maintain its physiological balance under stress conditions such as exposure to air pollution when the transpiration rates are usually high. It also serves as an indicator of drought resistance in plants[3]. In the present study ascorbic acid content was not correlated with relative water content and it is an indication that the plant species responded to the dry weather by a relative water content drop. Thus out of the 24 species of plants only 5 species can serve as indicator of industrial air pollution namely *Ficus religiosa, Zizyphus jujuba*, *Phyllanthus emblica, Cassia fistula* and *Tamarindus indica.*

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