Air Pollution-Phytotoxicity of Gases and its significance in Air Pollution control

Nagpurne V.S. & **Allapure R.B.**

Department of Botany

Maharashtra Udayagiri Mahavidyalaya, Udgir Dist. Latur Maharashtra State, India.

ABSRACT

Air Pollution tolerance index (APTI) of 20 species growing adjacent to roadside and exposed to varying degrees of air pollution were determined by calculating ascorbic acid, total chlorophyll, leaf extract pH and relative water content of tissues.

It is found that following top five plant species in urban areas which contribute rapid amelioration of polluted habitat and serve as sink to air pollution are *Ficus benghalensis* L., *Azadirachta indica* A. Juss., *Terminalia catappa* L., *Madhuca indica* Gmel., *Millingtonia hortensis L.f.* and *Tectona grandis* L.f.. These plants can be used as bioindicators and also be grown as bioaccumulators and highly significant in air pollution control.

INTRODUCTION :

Emissions of gaseous air pollutants have increased in the last decade in spite of increased controls and concern for air quality. Prediction of future development also indicates that a further increase in emission must be expected. When it is considered that total control of air pollutants is technically and especially economically impossible, it is important that, in the future, emissions are controlled within a technical and economic framework to such an extent that ambient pollutant concentrations near the ground present no hazard to man or his environment.

Compared with man, Animals, or materials, plants respond very sensitively to widely distributed pollutants, such as sulphur dioxide, hydrogen fluoride (HF) and hydrogen chloride. Extensive loss to agriculture and lasting changes in natural ecosystem are the result.

Studies on the effect of air pollution on vegetation, therefore, provide an important basis, particularly for preventive measures in air pollution control. Responses of plants to pollutants are not only primarily dependent on pollutant concentration and exposure time, but also on the amount of pollutant absorbed by the per unit of time.

Keeping in view of the increasing importance of bio-indicators in environmental monitoring. Generally the plant responses to pollutants are characteristic rather than specific. Attempts have been made to assess certain plant species which can specifically categorized as sensitive for a particular pollutant. The sensitive species were used for monitoring of air pollutant. The exposed plants are then analyzed with respect to changes in the selected parameters. The changes are then compared to those obtained in the same species exposed at pollution free zone and taken as control.

MATERIALS AND METHODS :

Thirty different angiosperms plants were selected to determine Air Pollution Tolerance Index (APTI).

Air pollution tolerance index (APTI) shows the tolerance level of a plant to air pollution. Singh and Rao (1983) made an attempt to determine the APTI values, to get an empirical value for the tolerance level of a plant to air pollution. The formula suggested by them was as follows:

$$\text{APTI} = \frac{A(T+P)+R}{10}$$

Where, A is ascorbic acid content of leaf in mg / gm dry weight, P is the leaf extract pH, T is total chlorophyll content & R is the relative water content of leaf. The entire sum was divided by 10 to obtain a small manageable figure.

Result and Discussion :

Table 1 : Air Pollution Tolerance Index (APTI) of some selected plant taxa located study site.

Sr. No.	Name of the Plant	Ascorbic Acid content (mg/g)	Total chlorophyll content (mg/g)	pH	Relative water content %	APTI
1	*Ailanthus excelsa* Roxb.	45	1.7	6.9	65	45.20
2	*Albizzia lebbeck* (L.) Willd.	27.1	0.9	9.2	61.9	33.56
3	Annona reticulata L.	47.5	1.9	7	70	49.28
4	*Annona squamosa* L.	47	2	7	67	49.00
5	*Azadirachta indica* A. Juss.	48.12	1.98	6.8	85.14	50.76
6	*Cassia siamea* Lamk.	43	1	6.8	69.75	40.52
7	*Dalbergia sisso* Roxb.ex Dc.	29.68	0.95	5.4	61.18	24.96
8	*Delonix elata* (L.) Gamble.	36.41	1.1	6.8	73	36.06
9	*Delonix regia (Boj.ex Hook.)* Raf.	29	2.31	6.3	81.5	33.12
10	*Derris indica* (Lamk.) Bennett.	45.5	0.74	6.8	53.2	39.63
11	*Erythrina indica* Lamk.	51	1.5	7	63.2	49.67
12	*Eucalyptus maculata* Hook.	45	1.6	6.6	60	42.90
13	*Ficus benghalensis* L .	47.45	2.31	6.5	86.2	50.42
14	*Ficus hispida* L.f.	41	1	7.5	39	38.75
15	*Ficus religiosa* L.	46.3	2	6.9	85.17	49.72
16	*Madhuca indica* Gmel.	57	1.5	6.9	60	53.88
17	*Mangifera indica* L.	27.68	1.68	5.9	75.9	28.57
18	*Millingtonia hortensis* L.f.	62	1.4	6.5	60	54.98
19	*Mimusops elegni* L.	43.1	0.9	6.5	74	39.29
20	*Morinda citrifolia* L.	42	1.15	7	70	41.23
21	*Moringa oleifera* Lamk.	28	1.1	5.5	75	25.98
22	*Parkia biglanduloa* Wt. & Arn	17.2	2.25	6.5	65	21.55
23	*Peltophorum pterocarpum* (DC.) Baker	18	2.25	6.5	68	22.55
24	*Polyalthia longifolia* S (Sonner)Thw.	23.71	0.9	9.8	39.45	29.31

25	*Spathodia companulata* P.Beauv.	57	1.25	6.5	52	49.38
26	*Sterculia foetida* L.	37.18	2.18	5.9	77.9	37.83
27	*Tamarindus indica* L.	22.18	0.65	6.8	62.8	22.80
28	*Tectona grandis* L.f.	65	1.4	6	81	56.20
29	*Terminalia catappa* L.	50.1	2.1	6.7	68	50.89
30	*Thespesia populnea* (L.) Soland.ex Corr.	22.5	1	6.5	49	21.78

APTI (Air Pollution Tolerance Index) :

The APTI values have been investigated for many areas during the June 2018 to December 2108. This value gave a correct picture of the tolerance/sensitivity level of plants (Table No. 1). The value were highest (56.20) for *Tectona grandis* L.f. and lowest (21.55) for *Parkia biglanduloa* Wt. & Arn. in the industrial area of Udgir. APTI values in response to automobile pollution at Udgir showed minimum reduction in *Azadirachta indica* A. Juss. and maximum reduction in *Parkia biglanduloa* Wt. & Arn. Therefore, the former was seen as highly tolerant to automobile pollution while the later was observed to be the most sensitive one.

Observations (Table No. 1) on the estimation of APTI values of plants growing in the Heavy Traffic site (HTS) I of Udgir town indicate that it was least in *Parkia biglanduloa* Wt. & Arn while it was highest in Heavy Traffic site (HTS) II for *Tectona grandis* L.f. further, air pollution tolerance level of each plant was different and different species showed different behaviour. The plant responses to pollutants thus depend upon a number of factors. It is seen that plants having higher index values are more tolerant to air pollution and can be used as a filter or sink to mitigate pollution, while plants having low index value can be used to indicate levels of air pollution. (Agarwal and Bhatnagar,1982)

The calculated APTI in control plants were higher than those recorded for polluted sites, and decreased progressively with increase in traffic density from 56.20 to 21.55 (Table No. 1). Air pollution tolerance index in *Parkia biglanduloa* Wt. & Arn showed maximum reduction at HTS I. The mean percent reduction of APTI over control (% ROC) demonstrated a sharp decline in *Thespesia populnea* (L.) Soland.ex Corr., *Moringa oleifera* Lamk., *Parkia biglanduloa* Wt. & Arn, *Peltophorum pterocarpum* (DC.) Baker and *Polyalthia longifolia* S (Sonner)Thw. While less significant changes were apparent in *Azadirachta indica* A. Juss., *Ficus benghalensis* L . , *Ficus religiosa* L., *Morinda citrifolia* L. and *Terminalia catappa* L..

The observed APTI value 49.72 in *Ficus religiosa* L. agrees closely with the report of Datta and Ray (1995). However, due to marginal reduction in APTI (2.62%) in *Azadirachta indica* A. Juss.the conclusion of Sunita and Rao (1997) that it is sensitive to air pollution does not appear to be true in our study. In addition neither chlorophyll nor ascorbic acid levels decreased significantly in this case.

Datta and Ray (1995) concluded that species having low index values are more sensitive to air pollution and *vice versa*. In the context of the present findings, this appears to be an arbitrary classification because the level of total chlorophyll ascorbic acid, relative water content and pH; which determine APTI level of a species; are intrinsic features of each species and no comparisons can be made amongst the species.

Due to higher reduction in air pollution tolerance index over their control counterparts *Moringa oleifera* Lamk., *Parkia biglanduloa* Wt. & Arn, *Peltophorum pterocarpum* (DC.) Baker, *Polyalthia longifolia* S (Sonner)Thw. and *Thespesia populnea* (L.) Soland.ex Corr. are considered as relatively sensitive species. Conversely

Azadirachta indica A. Juss., *Ficus benghalensis* L ., *Ficus religiosa* L., *Morinda citrifolia* L. and *Terminalia catappa* L. are considered as relatively resistant species due to their least or insignificant reductions in APTI. The less degradation of chlorophyll and ascorbic acid contents further substantiates their resistant abilities. It is noteworthy that the plants of the former category are regarded as ideal species, which could be effectively employed for phytomonitoring automobile exhaust pollution along side the busy traffic ways.

Air pollution tolerance level of each plant is different, and plants do not show a uniform behavior. Plants on the basis of their response to pollutants under field conditions and laboratory conditions have been classified into sensitive and tolerant species (Jacobson and Hill, 1970). The degree of sensitivity of a plant depends on its development stage, nutritional status and other ecological factors (Guderian, 1977). Many other factors such as stomatal resistance to the entry of gases have been held responsible for the expression of pollution response. It is a universal logic that stress can either be avoided or tolerated through physiological manipulation to toxic pollutants entering into the plant body (Levitt, 1980).

The APTI determination involves assessment of the plant parameters as per their relative significance. Singh and Rao (1983) have assigned more importance to foliar ascorbic acid, as it is multiplied to the sum of total chlorophyll and leaf extract pH. Ascorbic acid is a strong reductant. It activates many physiological and defense mechanisms and its reducing power has been known to be directly proportional to its concentration. It also influences resistance to adverse environmental conditions, including air pollution (Keller and Schwager, 1977).

A plant species known to be sensitive or tolerant in one geographical area might not be so in another geographical area. The external ecological factors play their role in determination of sensitivity levels of plants because the internal physiological conditions of a plant depend much upon the external ecological factors. Moreover, tolerance or sensitivity to air pollution is a reflection of internal physiological conditions of the plant. The sensitivity level of plants to air pollution is different for herbs, shrubs and trees. Trees and shrubs having identical index for tolerance level may not show similar behaviour. Therefore, plants on the basis of their habit should be assessed separately for their pollution tolerance level.

Therefore, the APTI bio analysis is useful for the identification of suitable biomonitoring (phytomonitors) for polluted urban environment. The species growing in such hostile roadside environment present the best material to ascertain the levels of sensitivity, tolerance and resistance. Raising such tolerant species in polluted habitats will lead to rapid amelioration of habitat to cope up with polluted environment. Such plants are shown to be effectively used as indicators of pollutant scavengers and serve as sink to air pollutants. The top five species in urban area which contribute maximum pollutants stocking are *Ficus benghalensis* L ., *Azadirachta indica* A. Juss., *Terminalia catappa* L., *Madhuca indica* Gmel., *Millingtonia hortensis* L.f. . and *Tectona grandis* L.f. (Table No. 1).

References:

- Agarwal, S. K. and Bhatnagar, D.C. (1982): Auto-vehicular air pollution induced pigment and ascorbic acid changes in avenue plants. *Acta Ecol.* 13(1); 1-4.
- Datta, S.C. and Sinha Ray, S. (1995) : APTI value of five different species of higher plants from the metropolis of Calcutta. Edi. Environmental and adoptive biology of plants, scientific publishers, Jodhpur, pp. 289-294.
- Guderian, R (1977): Air Pollution-Phytotoxicity of acidic gases and its significance in Air Pollution control Vol. 22 Edi. Springer-Verlag, New York. Berlin pp. 11-22.
- Jacobson, J.S. and Hill, A.C. (1970): Recognition of air pollution injury to vegetation; A pictorial atlas. Air pollution control association, Pittsburg, Pennsylvania. pp. 80-81.
- Keller, T. and Schwager, H. (1977) : Air pollution and ascorbic acid, *Eur.J. Forest Pathol.* 7(6) ; 338-350.
- Levitt, J. (1980): Responses of plants to environmental stresses. Academic Press London, New York. pp 182.184.
- Singh, S.P. and Rao, D.N. (1983): Evaluation of plants for their tolerance to air pollution. Proc. Symp. Air pollution control. pp. 218-224.
- Sunita, M. and Rao, KV.M. (1997) : Air pollution tolerance capacities of selected plant species. *J.Indian Bot. Soc.* 76 : 95-98.