AIR POLLUTION TOLERANCE INDEX OF SOME ROAD SIDE TREES OF UJJAIN (INDIA)

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Abstract: Plant leaves act as biological filters removing large quantities of pollutants from the urban atmosphere. The loss of trees in our urban areas not only intensifies the "heat island effect" from loss of shade and evaporation, but also we lose a principal absorber of carbon dioxide and trapper of particulate pollution as well.

The present study was designed to investigate the Air Pollution Tolerance Index (APTI) of selected ten road side trees of Ujjain. Three different sites i.e. Dewas road, Mahakal road, and Maksi road were taken as polluted sites and Vikram Vatika / University Campus as reference area. APTI was calculated by Singh and Rao (1983) method. The order of tolerance of different trees growing at different sites was Maksi road> Mahakal road> Dewas road >University campus/ vikram park. *Ficus religiosa,*Linn. showed the highest APTI values reflecting its higher tolerance level while *Melia azadirach,*Linn. showed the lowest APTI values reflecting its sensitive nature against air pollution. The tolerant species (*Ficus religiosa,* Linn.) can be used as a sink for the air pollutants while the sensitive species may be used as bio-indicators.

Keywords: Air Pollution Tolerance Index (APTI), atmosphere, carbon dioxide, evaporation, pollutants.

Introduction: The increased level of industrialization along with an unplanned urbanization witnessed with an enhanced level of air pollution. The plant bodies greatly influenced with these air pollutants by absorbing, accumulating or even by integrating them. Over the years there has been a continuous increase in human population, road transportation, vehicular traffic and industries which have resulted in further increase in the concentration of gaseous and particulate pollutants (Joshi, et al., 2009). Air pollution control seems very complex. No physical or chemical method is known to ameliorate the aerial pollutants. A suitable alternative may be to develop a biological method by growing plants in and around industrial and urban areas (Pathak, et al., 2011; Rai, 2013). Pollutants can cause leaf injury, stomatal damage, premature senescence, decreased photosynthetic activity, disturbed membrane permeability and reduced growth and yield in sensitive plant species (Tiwari, et al., 2006).

Plants act as a sink or even as living filters to minimize air pollutants by developing characteristic response and symptoms. Road side plant leaves are in direct contact with air pollutants and may act as stressors for these pollutants hence to be examined for their bio-monitoring potential (Sharma et al., 2007; Rai ,2011b.). The bio-monitoring of plant is an important tool to evaluate the impact of air pollution (Rai, 2011b.).

Sensitivity and response of plants to air pollutants could be assessed by air pollution tolerance index (APTI). APTI is an unique index, incorporating four different biochemical parameters i.e., total chlorophyll, pH of leaf extract, ascorbic acid and relative water content (RWC) (Singh and Rao, 1983). APTI is helpful in assessing the sensitivity and tolerance of several plants species. Further, these studies indicated the suitability of plant species in remediation of air pollution in and around industrial areas and urban area. Sensitive plant species were suggested as bio indicator (Raina et al., 2006; and Tripathi et al., 2009). Bio-indicators are useful due to their high sensitivity towards the broad range of air pollutants (Tripathi et al., 2009).

The Present study intended to assess the suitability, selectivity and tolerance limit in terms of APTI values of ten selected plant species grown along the road sides of Ujjain.

Materials and Methods:

Study area: Ujjain is located at 23° 11' north longitude and 75°50' latitude. It has an average elevation of 491 meters (1610') from mean sea level. The Tropic of cancer passes through Ujjain. Ujjain is situated on the Malwa Plateau in Central India.

Sampling stations: Following sampling stations were selected for the study.

a. Vikram vatika/Univ.campus (Reference area) b.Dewas road (Highway)
c. Maksi road (Industrial area) d.Mahakal road (Eco-city area)

Selections of tree species: 10 tree species, commonly found in the above areas were selected for the study.

Sample collection: Leaf samples were collected early in the morning from all the sites. Leaves of nearly equal size and similar age were taken from the same height from ground level.

Air Pollution Tolerance Index (APTI) - Fresh leaf samples were collected and analyzed for the following

parameters.

Total chlorophyll was estimated by the method of Arnon (1949). Ascorbic acid content was measured by volumetric method (S.R.Thimmaiah, 1999). Relative water content (RWC) was estimated by the method of Weatherly (1950) and the leaf extract pH was determined by digital pH meter (MK VI). The air pollution tolerance indices (APTI) were determined by the method of Sing and Rao (1983).

Table-1: Ascorbic acid content (mg/g) of leaves of various road side trees of Ujjain.

sn	Plants name	Reference area	Dewas road	Mahkal road	Maksi road
1	*Aegle marmelos,*Linn.	0.0106	0.0113	0.0123	0.0143
2	*Annona squamosa,*Linn.	0.0101	0.0106	0.0118	0.0144
3	*Ficus religiosa,*Linn.	0.0158	0.0164	0.0179	0.0195
4	*Mangifera indica,*Linn.	0.0165	0.0162	0.0176	0.0188
5	*Melia azadirach,*Linn.	0.0108	0.0108	0.0125	0.0144
6	*Mytragyna pervifolia,*Korth.	0.0110	0.0116	0.0127	0.0146
7	*Polyalthia longifolia,*Linn.	0.0153	0.0120	0.0132	0.0169
8	*Pongamia pinnata,* (L) Pierre.	0.0103	0.0155	0.0171	0.0186
9	*Psidum guajava,*Linn.	0.0137	0.0110	0.0123	0.0146
10	*Santalum album,*Linn.	0.0194	0.0108	0.0125	0.0132

Table-2: Leaf wash pH of various road side trees of Ujjain.

sn	Plants name	Reference area	Dewas road	Mahkal road	Maksi road
1	*Aegle marmelos,*Linn.	8.38	7.20	7.11	7.00
2	*Annona squamosa,*Linn.	7.66	7.24	6.51	5.72
3	*Ficus religiosa,*Linn.	7.25	6.87	6.20	5.81
4	*Mangifera indica,*Linn.	7.51	6.92	6.11	5.68
5	*Melia azadirach,*Linn.	7.86	6.98	6.29	5.61
6	*Mytragyna pervifolia,*Korth.	8.46	7.12	6.35	6.68
7	*Polyalthia longifolia,* Linn.	8.20	6.88	6.22	5.74
8	*Pongamia pinnata,* (L.)Pierre	7.48	6.90	6.18	5.30
9	*Psidum guajava,*Linn.	7.65	6.97	6.15	5.42
10	*Santalum album,*Linn.	8.10	6.98	6.33	5.84

Table-3: Total chlorophyll contents (mg/g fr wt.) of various road side trees of Ujjain.

sn	Plant name	Reference area	Dewas road	Mahakal road	Maksi road
1	*Aegle marmelos,*Linn.	2.107	2.050	1.953	1.703
2	*Annona squamosa,*Linn.	1.755	1.868	1.623	1.718
3	*Ficus religiosa,*Linn.	2.768	2.694	1.476	1.794
4	*Mangifera indica,*Linn.	1.782	1.914	2.470	0.907
5	*Melia azadirach,*Linn.	2.925	0.433	2.605	2.188
6	*Mytragyna pervifolia,* Korth.	2.366	2.175	1.944	0.986
7	*Polyalthia longifolia,*Linn.	2.542	2.388	0.846	1.090
8	*Pongamia pinnata,* (L.)Pierre	0.888	1.537	0.914	1.793
9	*Psidum guajava,*Linn.	1.669	1.503	0.988	1.361
10	*Santalum album,*Linn.	1.988	2.106	1.329	1.319

Table-4: Relative water contents (%) of various road side trees of Ujjain.					
sn	Plant name	Reference area	Dewas road	Mahkal road	Maksi road
1	*Aegle marmelos,*Linn.	50.81	52.28	63.66	73.33
2	*Annona squamosa,*Linn.	55.55	66.96	65.24	78.20
3	*Ficus religiosa,*Linn.	75.40	82.02	85.07	96.16
4	*Mangifera indica,*Linn.	55.17	81.67	86.25	94.72
5	*Melia azadirach,*Linn.	42.30	46.66	57.44	65.35
6	*Mytragyna pervifolia,*Korth.	45.07	57.09	66.31	73.91
7	*Polyalthia longifolia,*Linn.	57.62	60.91	69.87	70.06
8	*Pongamia pinnata,*(L)Pierre.	63.49	75.00	86.91	92.57
9	*Psidum guajava,*Linn.	61.33	76.30	79.17	81.71
10	*Santalum album,*Linn.	54.09	64.26	66.89	74.33

Table-5: Air Pollution Tolerance Indices (APTI) of various road side trees of Ujjain.

sn	Plants name	Reference area	Dewas road	Mahkal road	Maksi road
1	*Aegle marmelos,*Linn.	5.098	5.238	6.377	7.345
2	*Annona squamosa,*Linn.	5.564	6.705	6.533	7.803
3	*Ficus religiosa,*Linn.	7.555	8.217	8.520	9.630
4	*Mangifera indica,*Linn.	6.592	8.181	8.638	9.484
5	*Melia azadirach,*Linn.	4.241	4.674	5.755	6.545
6	*Mytragyna pervifolia,*Korth.	4.581	5.719	6.975	7.400
7	*Polyalthia longifolia,*Linn.	5.773	6.102	6.996	7.017
8	*Pongamia pinnata,*(L)Pierre.	6.363	7.513	8.631	9.270
9	*Psidum guajava,*Linn.	6.142	7.639	7.925	8.181
10	*Santalum album,*Linn.	5.427	6.433	6.707	7.442

Results and discussion:

Total chlorophyll content: Chlorophyll measurement is an important tool to evaluate the effect of air pollution on plants (Mir et al., 2008). Total chlorophyll contents were reduced in all the selected tree species growing in the polluted sites than in the reference area. *Melia azadirach,*Linn. showed the maximum reduction in chlorophyll content. The chlorophyll content of plants varies from species to species depending upon the age of leaf, pollution level as well as with other biotic and a biotic condition (Kartiyar et al., 2001).

Ascorbic acid content: - It is a strong reducer and plays important role in photosynthesis and is related with the tolerance to pollution (Escobedo et al., 2008). *Annona squamosa,*Linn. showed the minimum ascorbic contents while *Ficus religiosa,*Linn. showed the maximum value.

Leaf extract pH: Leaf extract pH of the selected tree species exposed to road air pollution slightly shifted towards acidic side in comparison to reference area. The maximum leaf extract pH was found in *Mytragyna pervifolia,*Korth. of reference area and minimum was in *Pongamia pinnata,*(L)Pierre. from Maxi road. High pH may increase the efficiency of conversion of hexose sugar to ascorbic acid (Escobedo et al., 2008).

Relative water content (RWC)-: Plants with high Relative water contents under polluted conditions are tolerant to pollutants. (Sasmita et al.,2010, Chandawat et al.,2011). The minimum RWC was found in *Melia azadirach,*Linn. and maximum RWC was found in *Ficus religiosa,*Linn. High water content within a plant body will help to maintain its physiological balance under stress condition such as exposure to air pollution when the transpiration rates are usually high. High RWC favors drought resistance in plants.

Air Pollution Tolerance Index (APTI)-: The highest APTI was found in *Ficus religiosa,*Linn. showing its tolerance against air pollution (Mashitha et al., 2001). The plants with higher APTI were found to be resistant therefore, act as bio- accumulators for air pollution (Prasanna et al., 2005). Being a resistant species *Ficus religiosa,*Linn. can be grown in and around the industrial areas and along road sides as avenue tree. *Melia azadirach,*Linn. and *Mytragyna pervifolia,*Korth. showed lower APTI values hence,

they can be used as bio-indicators in the polluted area. All trees showed higher values of APTI in Maksi road area as compared to other sites.

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