EVALUATION OF AIR POLLUTION TOLERANCE INDEX OF SELECTED PLANT SPECIES IN URBAN PARKS OF ISFAHAN

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ABSTRACT: Air pollution has become one of the major troubles in urban area. Air pollution tolerance index (APTI) was calculated by taking 5 different species growing commonly in 10 different areas of urban parks. In this study, the Air Pollution Tolerance Index (APTI) of five different plant species such as *Cupressus sempervirens, Ulmus carpinifolia, Platanus orientalis, Robinia pesudoacacia, Pinus eldarica* was taken from urban parks of Isfahan during summer and winter season. It has been evaluated by analyzing important biochemical parameters. Four physiological and biochemical parameters including ascorbicacid (AA) content, leaf relative water content (RWC), total leaf chlorophyll (TCh), and leaf extract pH were used to develop the APTI values. The data obtained were further analyzed by using one way ANOVA. Among the trees in the urban parks studied, higher value of APTI recorded for *Robinia pesudoacacia* and proved to be a tolerant variety while the minimum value of APTI recorded for *Platanus orientalis* and proved as sensitive species to air pollutants. Plants with high Air Pollution Tolerant Index (APTI) values recommended for development of urban parks and green area. The APTI values provide a reliable method for selecting tolerant plants.

Keywords: Air pollution, Biochemical parameters**,** APTI, Tree species

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Introduction

Air pollution tolerance index is used by landscapers to select plant species tolerant to air pollution (Liu and Ding, 2008). Four physiological and biochemical features; leaf relative water content (RWC) ascorbic acid content (AA), total leaf chlorophyll (TCh) and leaf extract pH were used to calculate the APTI values. The result showed that combining variety of these parameters gave a more reliable result than those of individual parameter (Agbaire, 2009). Sensitive plant species are suggested acting as bioindicators. Levels of air pollution tolerance vary from species to species, depending on the capacity of plants to withstand the effect of pollutants without showing any external damage. Air pollution tolerance index (APTI) of 30 plant species has been evaluated. High values of APTI were recorded in *Mangifera indica, Moringa pterydosperma, Cassia renigera* and *Ailanthus excelsa* (Shannigrahi *et al*., 2004). Response of plants towards air is being assessed by air pollution tolerance index. The air pollution tolerance index (APTI) based on all four parameters has been used for identifying tolerance levels of plant species (Liu and Ding, 2008). The effect of these pollutants is observed at acute level on sensitive species of plants, animals and human beings. It has also been reported that when exposed to air pollutants, most plant experience physiological changes before exhibiting visible damage to leaves (Dohmen, et al 1990). Physiological responses of some tree species under roadside automobile pollution stress assessed by finding out some physiological parameters, which included chlorophyll a, and b, total chlorophyll, carotenoids, ascorbic acid, pH and relative water content. Higher value of APTI recorded for S. robusta while the minimum value of APTI recorded for M. indica (Joshi and Swami, 2007). Mobile sources contribute to the emission of major urban air pollutants including: carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), particulate matter (PM), lead (Pb), photochemical oxidants such as ozone (O3) and ozone precursors like hydrocarbons and volatile organic compounds (Costa, 2001). 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 environment (Escobedo et al., 2008). Anticipated Performance Index of some tree species for green belt development to mitigate traffic produced noise evaluated in Varanasi (Tripathi et al., 2011). The Air Pollution Tolerance Index (APTI) of many plant species evaluated by analyzing important biochemical features. The Anticipated Performance Index

(API) of these plant species also calculated by considering their APTI values with other socio-economic and biological parameters. Based on these two indexes, the most suitable plant species for green belt development in urban areas identified and recommended for long-term air pollution management (Prajapati and Tripathi, 2008). The aim of this study is therefore to determine the APTI values of five tree species commonly present at the urban parks of Isfahan. The study will also identify the plant species which are tolerant to air pollution.

Material and methods:

In this study ten sampling stations were selected at urban parks of Isfahan. These include Mellat Park1 (Station 1), Mellat Park2 (Station 2), Moshtagh1 Park (Station 3), Moshtagh 2 Park (Station 4), Isargaran Park (Station 5), Aienehkhaneh Park (Station 6), Children Park (Station 7), Mirzakochekkhan Park (Station 8), Saadi Park (Station 9), Nazhvan Park (Station 10, as control). The study was conducted during summer (June) and winter (December) in 2011. Leaf samples of five tree species collected from ten sampling station of Isfahan urban parks. Plants were randomly selected from the immediate vicinity of the station. Three replicates of fully matured leaves were used and then Samples were preserved in a refrigerator. The experiments were replicated three times for each biological factor. Samples quickly transported to the laboratory and Leaf fresh weight taken. Dry weight (DW) adopted to express ascorbic acid content and total chlorophyll content (TCh). Leaf Relative water content (RWC) determined and calculated with the formula:

$$RWC= (Wf-Wd) \times 100/ (Wt-Wd) \quad (1)$$

Fresh weight gained by weighing the fresh leaf pieces on a balance (Wf). Then, these leaf pieces weighed after immersing in water overnight to get Wt, which is turgid weight. Next, leaf pieces blotted to dryness and placed in a dryer at 105℃ (2 hrs) and reweigh to get dry weight (Wd).

For total chlorophyll content TCh analysis, 0.5 g fresh leaves material grounded and diluted to 10 ml in distilled water. A subsample of 2.5 ml mixed with 10 ml acetone and filtered. Optical density read at 645 nm (D645) and 663 nm (D663). Optical density of TCh (CT) is chlorophyll a (D645) density and chlorophyll b (D663) density as follows:

CT = 20.2 (D645) + 8.02 (D663) (2)

For TCh (mg/g DW) calculated as follows:

TCh = 0.1 CT x (leaf DW/leaf fresh weight) (3)

For Leaf extract pH determined, about 4 g of fresh leaves homogenized in 40 ml deionized water and centrifuged at 7000 g. Extract pH measured with a photovolt pH meter at 25°C. For Ascorbic acid (AA) content analysis (mg/g DW) measured using the colorimetric 2.6-dichlorophenol -indophenal (DIP) method. The air pollution tolerance index of ten tree species calculated by following formula:

APTI= [A (T+P) +R]/10 (4)

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 results were statistically analyzed and interpreted by one way ANOVA.

RESULTS:

The results of air pollution tolerance index (APTI) calculated for each plant species studied at different sites is mentioned in Table 1. *Robinia pesudoacacia* exhibited the highest APTI value at all the sites and the minimum value of APTI recorded for *Platanus orientalis*.

Table1: Air pollution tolerance index of five plants in urban parks of Isfahan

Location	*Cupressus sempervirens*	*Ulmus carpinifolia*	*Platanus orientalis*	*Robinia pesudoacacia*	*Pinus eldarica*
Summer					
S_1	8.45±0.156*	7.52±0.183*	6.81±0.234*	9.84±0.342*	8.16±0.131*
S_2	8.62±0.175	6.85±0.236*	7.23±0.296*	8.32±0.329*	7.56±0.127*
S_3	7.86±0.223*	6.39±0.137*	7.15±0.254*	9.38±0.151*	7.89±0.344*
S_4	7.52±0.245*	7.48±0.189*	7.26±0.316*	9.87±0.312	8.39±0.161*
S_5	6.78±0.173*	7.12±0.168*	6.35±0.198*	9.61±0.183*	8.12±0.192*
S_6	8.42±0.329	6.97±0.248*	6.42±0.293*	8.67±0.096*	8.37±0.118*

S_7	7.95±0.151*	6.82±0.145*	7.15±0.159*	8.53±0.158*	7.96±0.277*
S_8	7.68±0.264*	7.86±0.156	7.07±0.183*	9.89±0.306*	7.16±0.071*
S_9	7.36±0.214*	7.38±0.131*	6.72±0.162*	9.58±0.238*	8.68±0.266
S_{10}-control	8.92±0.146	7.96±0.137	7.89±0.139	10.56±0.271	8.79±0.125
Winter					
S_1	8.96±0.145*	7.76±0.241*	7.15±0.157*	10.35±0.211	8.75±0.153
S_2	9.03±0.036*	7.15±0.196*	6.56±0.216*	9.63±0.126*	7.83±0.244*
S_3	8.06±0.125*	6.89±0.168*	6.64±0.319*	9.87±0.158*	8.38±0.105*
S_4	8.32±0.278*	7.69±0.258*	7.66±0.237	10.34±0.213	8.86±0.263
S_5	7.56±0.111*	7.89±0.234*	7.03±0.352*	9.62±0.148*	8.78±0.311*
S_6	9.12±0.239	7.83±0.157*	6.25±0.137*	9.38±0.255*	8.29±0.156*
S_7	8.23±0.321*	7.24±0.194*	6.36±0.149*	9.63±0.126*	8.24±0.268*
S_8	8.36±0.236*	7.98±0.165*	6.83±0.126*	10.19±0.361	7.56±0.106*
S_9	8.45±.0129*	7.64±0.364*	6.72±0.259*	9.68±0.233*	7.15±0.125*
S_{10}-control	9.54±.0174	8.32±0.273	7.89±0.147	10.45±0.146	8.95±0.139

*The values differ significantly at $p<0.05$

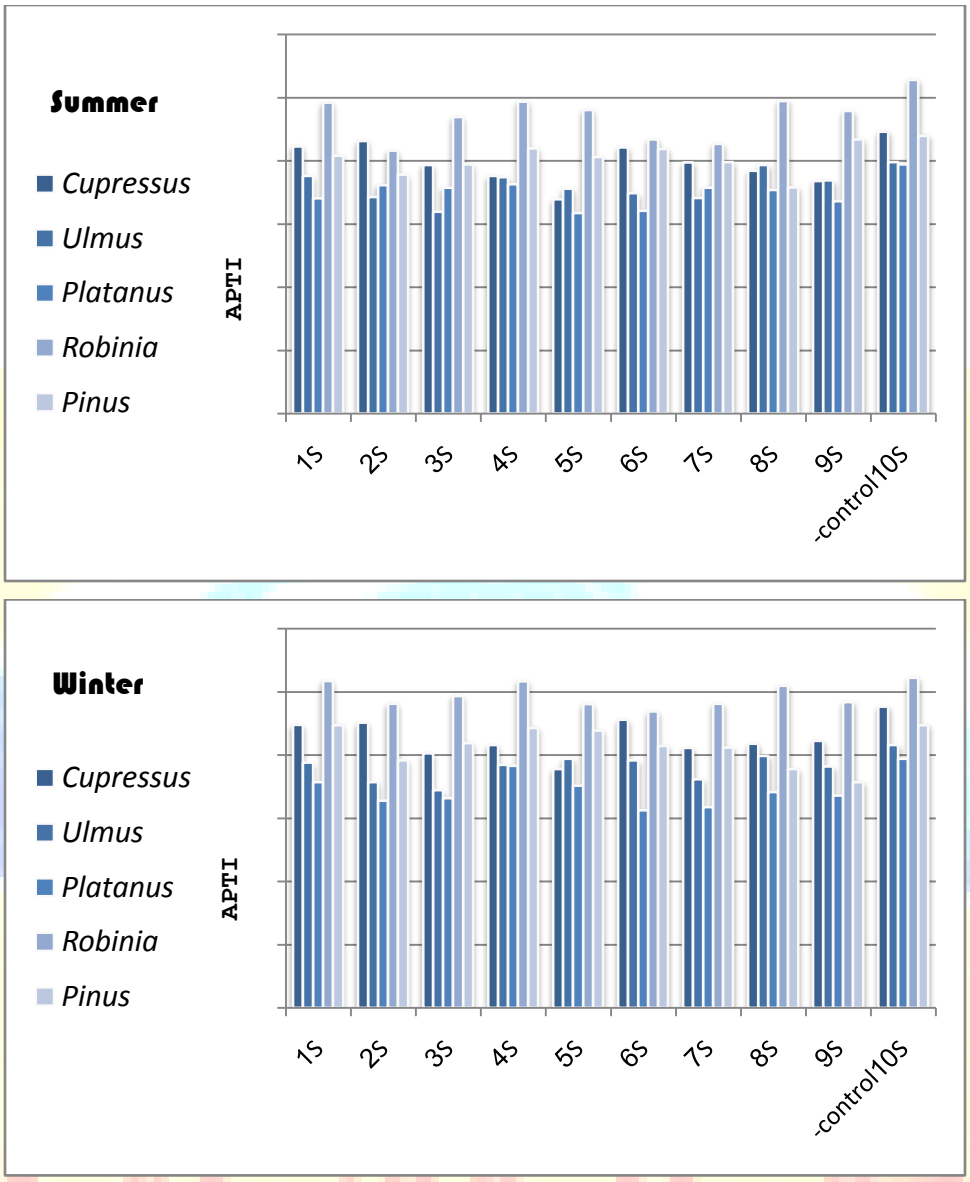

Figure 1: The Air Pollution Tolerance Index (APTI) of five plants in ten stations (urban parks) of Isfahan during different seasons.

DISCUSSION:

Different plant species shows considerable variation in their susceptibility to air pollution. The plants with high and low APTI can serve as tolerant and sensitive species respectively. In the present study, as shown in Figure 1, *Robinia pesudoacacia*, with highest air pollution tolerance index was found to show tolerant response to automobile pollutants where as *Pinus eldarica* and *Cupressus sempervirens* can be considered to show intermediate response and finally *Platanus orientalis* and *Ulmus carpinifolia* can be considered to show sensitive response.

Similar study of air pollution tolerance index was also conducted by Agbaire and Esiefarienrhe, (2009), Tripathi, *et al*., (2009), Jyothi et al. (2010).

Conclusion:

- Plants with high Air Pollution Tolerant Index (APTI) values recommended for development of urban parks and green area.
- The APTI values provide a reliable method for selecting tolerant plants.
- Plants growing in actually polluted environment have higher APTI than less from less polluted environment.

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