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Evaluation of Indoor Plants for their Pollution Tolerance Ability

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Research Article

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ABSTRACT

The present study was conducted at Defence Institute of Bio Energy Research (DIBER) Haldwani. Fully grown potted-plants of ten ornamental species viz., *Scindapsus aures* (Golden pothos), *Ficus benjamiana* (Weeping fig), Hedera helix (English ivy), *Quercue leucotrichopora* (Banjh oak), *Aglaonema crispum* (Chinese evergreen), *Dracaena marginata* (Red-edged dracaena), *Codiaeum verigatum* (croton), *Chlorophytum comosum* (Spider plant), *Sansevieria trifasciata* (Snake plant), *Chrysalidocarpus lutescens* (Areca palm) were used in the present study. To estimate the Air pollution tolerance index (APTI), various biochemical parameters such as plant leaf pH, relative water content, total chlorophyll content and ascorbic acid content were estimated. APTI values ranged from 7.37 (*Aglaonema crispum*) to 9.45 *(Ficus benjamina*). *Ficus benjamina* appeared as the most tolerant species among the tested indoor plants followed by Scindapsus aures, which must be included in indoor landscape as good air purifiers along with Aglaonema crispum as bioindicators to sense the pollution in indoor environment.

INTRODUCTION

Most of the urban areas of the world today have high concentration of air pollutants emanating from different sources like motor vehicles, power plants, industrials setups, residential heating and even indoor appliances and materials [1]. These urban air pollutants not only pose a threat to the urban environment but also a matter of concern for human health. Among the air pollutants, air borne particulates including trace elements and volatile gases are serious concern and required to be monitored and regulated through every possible means [2]. Today our life style and working environment is also forcing us to be in indoor environment for long number of hours leading to exposure of various indoor pollutants which are being released by various office appliances and décor [3]. It is well documented that plants play an important role in monitoring the ecological balance by collecting heavy metals such as mercury and lead from the air including formaldehyde, nitrogen and sulfur oxide vis-a-vis provide psychological push through mood lifting and enhanced alertness [4-8] Plants differs markedly in their responses to pollutants some being sensitive and others hardy and tolerant. The sensitivity and tolerance to the pollution in plants depend on the various biochemical parameters like ascorbic acid content total chlorophyll, relative water content and leaf extract pH [9]. The response of plants towards air can be assessed by Air pollutant tolerance index (APTI) which is being used by landscapers in selecting plant species for a particular area in order of their pollution tolerance. The sensitive species can be used as bio-indicators of pollution [10]. Though there have been several studies on scoring tree species for their APTI values but studies on indoor plants are negligible [11-14]. Considering these facts, some indoor plants were selected to test their APTI scoring to select indoor air bio-indicators to be placed in offices and remotely located soldiers huts to reduce the indoor pollution and improving the breathing air quality to some extent where keroheaters and bhukaris are used to heat up the ambience.

MATERIALS AND METHODS

The experiments were conducted at Defence Institute of Bio Energy Research (DIBER) Haldwani. Fully grown potted-plants of ten ornamental species viz., *Scindapsus aures* (Golden pothos), *Ficus benjamiana* (Weeping fig), *Hedera helix* (English ivy), *Quercue leucotrichopora* (Banjh oak), *Aglaonema crispum* (Chinese evergreen), *Dracaena marginata* (Red-edged dracaena), *Codiaeum verigatum* (croton), *Chlorophytum comosum* (Spider plant), *Sansevieria trifasciata* (Snake plant), *Chrysalidocarpus lutescens* (Areca palm) were used in the present study. To estimate the Air pollution tolerance index (APTI), various biochemical

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parameters such as plant leaf pH relative water content total chlorophyll content and ascorbic acid content were estimated [10,15,16]. Biochemical parameters were estimated using fully expanded healthy leaves of the second and third node from the top of the shoot of all selected plants. Samples were collected from the three random plants. Three samples were collected from each plant and average was worked out.

Air Pollutant Tolerance Index (APTI)

Air Pollution Tolerance Index (APTI) which gives an empirical value for tolerance level of plants to air pollution was determined using the formula [10]. The formula for ATPI is

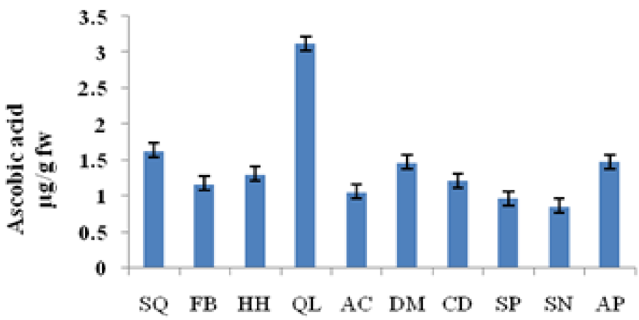
$$ATPI = \frac{A\,(T+P)+R}{10}$$

Where A = ascorbic acid (mg/ g), T = total chlorophyll (mg/g), P = pH of leaf extract, R = relative water content of leaf extract.

RESULTS AND DISCUSSION

Continuous exposure of plants to the environment forces them to absorb, accumulate and integrated pollutants impinging on their foliar surfaces. Consequently they show visible or suitable changes depending on their sensitivity level. In the present study, biochemical parameters like ascorbic acid, relative water content, total chlorophyll content, and leaf extract pH were used in the evaluating their degree of tolerance to air pollution. The maximum amount of ascorbic acid was found in *Quercue leucotrcophora* (3.12 µg/g fw) and the minimum was in *Sansevieria trifasciata* (0.86 µg/g fw) **(Figure 1)**.

Estimation of Various Biochemical Parameters for Experimental Plants



Note: Elongations of the abbreviations mentioned in above graph: SQ: *Scindapsus aures;* FB: *Ficus benjamina;* HH: *Hedera helix*; QL: *Quercue leucotrichopora*; AC: *Aglaonema crispum*; DM: *Dracaena marginata*; CD: *Codiaeum verigatum*; SP: *Chlorophytum comosum*; SN: *Sansevieria trifasciata*; AP: *Chrysalidocarpus lutescens*

Figure 1. Ascorbic acid content (µg/g fw).

Ascorbic acid has been reported to play an important role in cell wall synthesis, photosynthetic carbon fixation, and cell division vis-à-vis resistance of adverse environmental conditions including air pollution **(Figure 2)**. On the other hand, Relative Water Content (RWC) helps the plant to maintain its physiological balance under stress conditions when the transpiration rates are usually higher [17]. RWC in the plant is associated with protoplasmic permeability in cells which causes loss of water and dissolved nutrients, resulting in early senescence of leaves [18]. RWC was found minimum in *Quercue leucotrcophora* (55.21) and the maximum in *Ficus benjamina* (87.41).

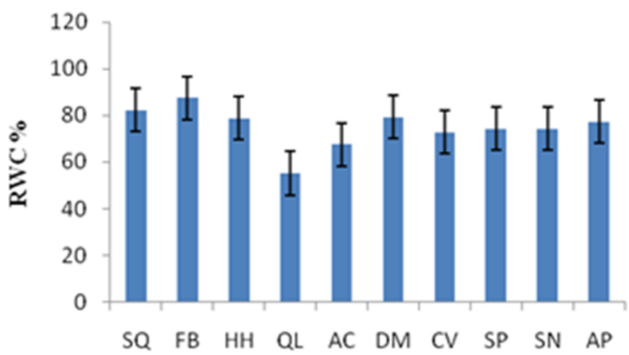


Figure 2. Relative water content (%).

Plants generally accumulate some kind of compatible solute such as proline or polyols in cystol to raise osmotic pressure and thereby maintain both turgor and driving gradient for water uptake and protect membrane and proteins. RWC has also been closely related with proline accumulation and thereby stress tolerance in plants. Total chlorophyll content varied from 0.072-0.388 mg/g **(Figure 3)**.

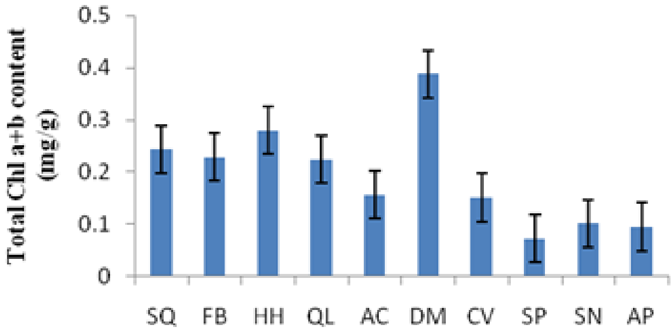


Figure 3. Total chlorophyll content (mg/g).

Air pollutants get their entry in to plant system through stomata and cause partial denaturation of chloroplast and decrease pigment content due to replacement of Mg ions with hydrogen atoms [10,19]. Chlorophyll degradation leads to lower carbon dioxide fixation. Higher chlorophylly content might favour the plants to tolerate pollution better [20]. pH of leaf extract was in the range of 4.86 – 6.31 **(Figure 4)**.

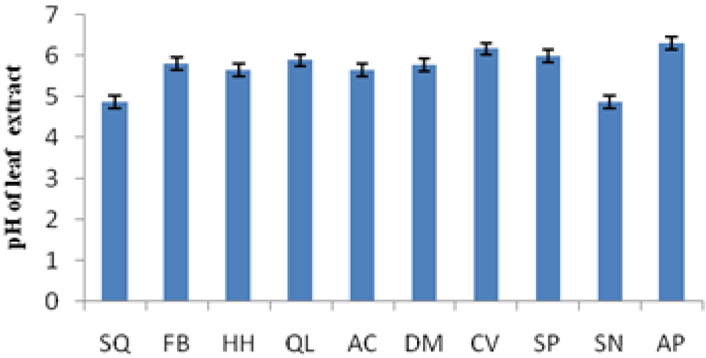


Figure 4. pH of leaf extract.

The lowest value was observed in *Sindepsus aures* and maximum value was observed in *Chrysalidocarpus lutescens.* Plant species with neutral to alkaline nature have been reported to have better pollution tolerance as alkalinity increases the hexosugar conversion efficiency to ascorbic acid and photosynthetic efficiency [21,22]. In the present study, APTI values ranged from 7.37 (Aglaonema crispum) to 9.45 (Ficus benjamina) **(Table 1)**.

Estimated APTI Values for Indoor Plants

Table 1. APTI values followed by the same letters are not significantly different as per Duncan's Multiple Range Test, significance tested at P≤0.01.

Plants	APTI values
Scindapsus aures	9.06^{bc}
Ficus benjamiana	9.45^{b}
Hedera helix	8.66^{bcdef}
Quercue leucotrichopora	7.43^{a}
Aglaonema crispum	7.37^{a}
Dracaena marginata	8.84^{bcd}
Codiaeum verigatum	8.05^{a}
Chlorophytum comosum	8.03^{a}
Sansevieria trifasciata	7.86^{a}
Chrysalidocarpus lutescens	8.69^{bcde}

APTI values provide reliable estimates of plant susceptibility to air pollutants. The sensitive species can be used as

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bioindicators and tolerant species can be used as sink for air pollution mitigation. Plants having low APTI values are rated as sensitive. APTI values mostly in tree and shrubs have been reported which ranged from 3-5, 2014), 9.4 – 64.1 6.51- 25.77 6-12 6.42- 21.65 and 22.95- 87.82 [14,23,24]. *Ficus benjamina* appeared as the most tolerant species among the tested indoor plants followed by *Scindapsus aures*, which must be included in indoor landscape as good air purifiers along with *Aglaonema crispum* as bioindicators to sense the pollution in indoor environment [25].

CONCLUSION

Although plant sensitivity to pollution is affected by climatic conditions and harsh climatic with low temperatures at high altitude pose challenges to human survival due to hypoxial condition but addition of these indoor plants over others can help in improving the indoor air quality.

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