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Assessment of Air Pollution Tolerance Index of Indoor Plants in Sub-tropical Climate

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ABSTRACT: The present investigation was conducted during 2017-2018 to assess the air pollution tolerance index of indoor plants commonly grown in subtropical climate. The study was carried out to determine the air pollution tolerance of indoor plants and use in urban indoor landscaping. In this study,30 flowering and foliage indoor plants were selected and the air pollution tolerance index (APTI) was assessed in which various bio-chemical parameters such as total chlorophyll content, leaf extract pH, relative water content and ascorbic acid content were estimated using CRD design. Maximum APTI value was found in *Aglaonema modestum* (9.18) followed by *Scindapsus aureus* (9.16), *Chlorophytum comosum* (9.14), *Nephrolepis exaltata* (9.054) and *Kalanchoe blossfeldiana* (8.967). Results concluded that *Aglaonema modestum, Scindapsus aureus, Chlorophytum comosum*, *Nephrolepis exaltata* and *Kalanchoe blossfeldiana* were found best to tolerate air pollution on the basis of APTI and these plants can be used in indoor landscaping for urban areas.

Keywords: Air pollution tolerance index**,** indoor plants, urban landscape, indoor pollution.

INTRODUCTION

Rapid urbanization and industrial development have increased air pollution specially in major developing countries. Urban industrialization has now become place of increased emission of air pollutants into atmosphere. These pollutants are harmful to the human beings, therefore, reducing the air pollutants in the environment is major issue of environmental concern at international, national and local level. When exposed to airborne pollutants, most plants showed physiological changes before exhibiting visible damage to leaves (Liu and Ding, 2008). Automobiles are responsible for the maximum amount of air pollutants and the crop plants are very sensitive to gaseous and particulate pollution and these can be used as indicators of air pollution (Joshi and Swami, 2009). Pollutants can cause leaf injury, stomatal damage, premature senescence, decrease photosynthetic rate, disturb membrane permeability and reduce growth (Tiwari *et al*., 2006). Air pollution stress leads to stomatal closure, which reduces carbon dioxide availability to leaves and inhibits carbon fixation. Sulphur dioxide, oxide of nitrogen and carbon dioxide as well as suspended particulate matter when absorbed by the leaves may cause a reduction in the concentration of photosynthetic pigments like chlorophyll and carotenoids, which directly affect the plant productivity (Joshi and Swami, 2009). The effectiveness of plant species as bio-indicator or tolerance to the air pollution depend upon the APTI of that particular plant. APTI index is the capability of plants to survive against the air pollution and helps to determine the tolerance and sensitivity of plants against air pollution. Plant's tolerance and sensitivity to air pollutants depends on parameters like chlorophyll content, ascorbic acid content, leaf pH and relative water content. Chlorophyll content decreases due to production of reactive oxygen species (ROS) in the chloroplast under stress. Higher ascorbic acid content in leaves protects thylakoid membrane from oxidative damage under such stress including air pollution (Tambussi *et al*., 2000). Ascorbic acid acts as defence against ROS produced by the chloroplast (Blokhina *et al*., 2003). Hence, the plants can be screened to be used as bio-indicators or tolerant to the air pollution. Plants provide sufficient leaf area for absorption and accumulation of air pollutants to reduce the air pollution in the environment (Escobedo *et al.*, 2008). The stomata help to remove the gaseous air pollutants (Kapoor, 2014). Plants are also initial acceptors of air pollution and act as the scavengers (Mahecha *et al*., 2013). Leaves at various stages of development serve as good indicator of air pollutants. Hence, bio-monitoring of plants has been considered as an important tool to evaluate the impact of air pollution (Rai *et al*., 2014). Considering these facts, the study was conducted on commonly growing indoor plants of sub-tropical climate to study their Air Pollution Tolerance Index.

MATERIAL AND METHODS

The study was conducted for the evaluation of different indoor plants on the basis of their Air Pollution Tolerance Index. In this experiment, mature 30 flowering and foliage indoor pot plants were selected to conduct the present study. Air Pollution Tolerance Index (APTI) of these selected indoor plants was estimated, in which various biochemical parameters such as total chlorophyll content (mg/g) as per Hiscox and Israeistam (1979), leaf extract pH as per Barrs and Weatherly (1962), ascorbic acid content (mg/g) as per A.O.A.C. (1980), relative water content (%) as per Singh (1977) were determined from leaves of fully grown plants. The data was analysed by using Completely Randomized Design (CRD). By using these parameters like ascorbic acid (*A*), relative water content (*R*), leaf pH (*P*) and total chlorophyll content (*T*), APTI was determined by the following formula;

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

Following flowering and foliage indoor plants were taken for the present study.

1. *Aeonium arboretum*	16. *Hedera helix*
2. *Aglaonema modestum*	17. *Hydrangea macrophylla*
3. *Aspidistra elatior*	18. *Jacobinia carnea*
4. *Asparagus densiflorus*	19. *Kalanchoe blossfeldiana*
5. *Aucuba japonica*	20. *Monstera deliciosa*
6. *Begonia semperflorens*	21. *Nephrolepis exaltata*
7. *Chlorophytum comosum*	22. *Pelargonium hortorum*
8. *Clivia miniata*	23. *Peperomia caperata*
9. *Cordyline compacta*	24. *Peperomia obtusifolia*
10. *Crassula ovata*	25. *Rhapis excelsa*
11. *Dracaena deremensis*	26. *Ruscus hypoglossum*
12. *Euphorbia splendens*	27. *Schefflera arboricola*
13. *Excoecaria bicolor*	28. *Scindapsus aureus*
14. *Ficus benjamina*	29. *Strobilanthuskunthianus*
15. *Fuchsia hybrida*	30. *Syngonium podophyllum*

RESULT AND DISCUSSION

Among selected 30 indoor plant species, maximum amount of ascorbic acid was found in *Ficus benjamina* (0.438 mg/g). Singh *et al.* (1991) revealed that ascorbic acid is a natural detoxicant that can prevent adverse effects of air contaminants in plant tissues, similarly,Varshney and Varshney (1984) stated that higher ascorbic acid content in plant is a measure of its resistance to contamination with sulphur dioxide. Maximum leaf extract pH was found in *Ficus benjamina* (7.193). Leaf pH is a biochemical parameter that determines the sensitivity and tolerance of plants to air pollution and plants with a pH of around 7 are more tolerant to pollution. Similar findings were obtained by Rai and Panda (2014) which reported that if the acidic pollutants present in the environment mainly due to presence of SO_2 and NO_X, the leaf extract pH will be lower and the greater decline in pH indicates sensitivity of plant to air pollution.

Maximum amount of total chlorophyll content (1.534 mg/g) was observed in *Ruscus hypoglossum* which is in congruence with the findings of Begum and Harikrishna (2010), who reported that chlorophyll content varies from species to species, as well as other biotic and abiotic conditions. Higher chlorophyll content shows more plants tolerance to the air pollution as stated by Joshi *et al.* (1993). Maximum relative water content was found in *Aglaonema modestum* (89.18%),which is in congruence with the findings of Swami *et al*. (2004) which revealed that due to pollution and transpiration loss, there is a reduction in the relative water content. High relative water content favours plants resistance to drought. These results are line with the findings of Verma (2003); Gholami *et al.* (2016).

Maximum total phenol content (0.890 mg/g) was found in *D. deremensis.* Chandawat *et al*. (2014) revealed that higher concentration of phenol content was found in plants grown in polluted site as compared to low polluted site.

Maximum APTI index (9.18) was found in *A. modestum*, followed by *S. aureus* (9.16), *N. exaltata* (9.054) and *C. comosum* (9.0). Cruz *et al*. (2014) reported that pollutants such as VOCs and CO_2 were effectively removed from the indoor environment by these plants. Similar findings were given by Gholami *et al*. (2016), who revealed that air pollution tolerances vary from species to species depending on the plant and ability to tolerate the impacts of air pollution (Table 1).

Table 1: Air pollution tolerance of different indoor plants.

Sr. No.	Plant species	Ascorbic acid (mg/g)	Total chlorophyll content (mg/g)	Leaf pH	Relative water content (%)	Total phenol content (mg/g)	Air Pollution Tolerance Index (APTI)
1.	*Acuba japonica*	0.143	1.001	5.840	79.063	0.623	8.147
2.	*Aeonium arborium*	0.177	0.329	4.403	84.827	0.337	8.756
3.	*Aglaonema modestum*	0.118	0.963	7.133	89.183	0.333	9.180
4.	*Asparagus densiflorus*	0.190	0.387	5.120	73.277	0.517	7.634
5.	*Aspidistra elatior*	0.243	1.075	5.497	79.183	0.513	8.244
6.	*Begonia semperflorence*	0.100	0.421	1.777	84.710	0.617	8.687
7.	*Chlorophytum comosum*	0.153	0.787	6.833	88.917	0.317	9.00
8.	*Cliviaminiate*	0.273	0.431	5.053	84.000	0.520	8.722
9.	*Cordyline compacta*	0.133	1.098	5.387	83.050	0.760	8.589
10.	*Crassula ovata*	0.173	0.381	4.277	85.107	0.433	8.794
11.	*Dracaena deremensis*	0.107	0.751	5.660	83.493	0.890	8.591
12.	*Euphorbia splendens*	0.217	1.314	4.660	84.320	0.550	8.720
13.	*Excoecaria bicolor*	0.110	0.518	3.370	78.057	0.497	8.046
14.	*Ficus benjamina*	0.438	1.295	7.193	81.390	0.757	8.673
15.	*Fuchsia hybrida*	0.140	0.758	4.700	82.467	0.443	8.499

16.	*Hedera helix*	0.085	0.875	6.197	75.123	0.797	7.726
17.	*Hydrangea macrophylla*	0.105	0.622	6.197	84.137	0.650	8.682
18.	*Jacobiniacarnea*	0.137	0.726	6.697	78.390	0.343	8.123
19.	*Kalanchoe blossfeldiana*	0.327	0.549	6.097	85.400	0.677	8.967
20.	*Monstera deliciosa*	0.108	1.433	6.127	87.093	0.340	8.920
21.	*Nephrolepisexaltata*	0.343	0.938	6.890	86.130	0.260	9.054
22.	*Pelargonium hortorum*	0.410	0.630	3.423	86.580	0.533	8.816
23.	*Peperomia caperata*	0.133	0.535	6.180	85.370	0.263	8.804
24.	*Peperomia obtusifolia*	0.053	0.411	5.450	85.140	0.330	8.687
25.	*Rhapisexcelsa*	0.093	0.758	5.343	84.127	0.523	8.665
26.	*Ruscushypoglossum*	0.353	1.534	6.730	69.467	0.317	7.386
27.	*Schefflera arboricola*	0.092	0.571	5.553	82.470	0.450	8.478
28.	*Scindapsus aureus*	0.063	0.880	7.047	88.830	0.557	9.164
29.	*Strobilanthuskunthianus*	0.090	1.377	7.027	72.183	0.440	7.416
30.	*Syngonium podophyllum*	0.218	0.787	6.593	81.743	0.500	8.520
$CD_{0.05}$		0.035	0 .109	0.074	2.0	0.049	0.215

CONCLUSION

From the present findings, *Aglaonema modestum*, *Scindapsus aureus*, *Chlorophytum comosum*, *Nephrolepis exaltata* and *Kalanchoe blossfeldiana* were found best indoor plants to tolerate air pollution and can be recommended for urban area having high pollution levels.

FUTURE SCOPE

These indoor plants have more APTI index to improve the air quality. It is highly recommended for interior landscaping to reduce the stress of people and improve the work efficiency.

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Conflict of Interest. None.

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