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RESEARCH ARTICLE

MODIFIED AIR POLLUTION TOLERANCE INDEX OF SELECTED PLANTS IN NACHARAM INDUSTRIAL AREA –TELANGANA

***Shyamala, L. and Mary Esther Cynthia Johnson**

Department of Botany, Osmania University College for Women, Koti, Hyderabad – 500 195 Telangana, India

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ABSTRACT

Plants play critical role in keeping the atmosphere clean. Plants are used in monitoring programme as indicators of air pollution. The response of plants towards air pollution was assessed by Modified Air Pollution Tolerance Index, as plants are primary receptors. The present study was aimed to calculate Modified Air Pollution Tolerance Index (Modified APTI) by adding Free Amino Acids and Tot. Carbohydrates in 15 plants at IDA Nacharam and their ability to tolerate pollution a common stress factor prevailing in the environment to know their tolerance, sensitivity. It was observed that twelve plants were Tolerant, two - Intermediate and 1 was Sensitive. These twelve Tolerant Plants can be used for Green Belt Development.

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INTRODUCTION

Plants play an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like CO_2, O_2 and also provide enormous leaf area for impingement absorption and accumulation of air pollutants to reduce the pollution level in the air environment. Plants are used in monitoring programme as indicators of air pollution. With the increasing human population, automobiles, industrialization has rapidly deteriorated the air quality by various air pollutants which are hazardous to plants. Various plants are very much sensitive to these air pollutants. The use of higher plants in abatement of air pollutants is a new concept with various plant biochemical parameters adopted for evaluating the air pollution of the environment. Air Pollution Tolerance Index was calculated by Singh and Rao (1983). Later much work has been done on Air Pollution Tolerance Index. Johnson *et al.* (2015) studied Air Pollution Tolerance Index of Plants in Hyderabad City. Krishnaveni *et al.* (2014) worked on Air Pollution Tolerance Index of Plants at Salem, Tamilnadu. Babu *et al.* (2013) studied evaluation of Air Pollution Tolerance Indices of Plant species growing in vicinity of Cement Industry and Yogi Vemana University Campus, Kadapa. Mishra and Pandey (2012) studied Effects of Air Pollution on Plants in Urban Area at Ghaziabad Uttar Pradesh. Air Pollution Tolerance Index of Hyderabad was studied by Johnson and Shailaja (2008). In the present study Modified Air Pollution Tolerance Index was calculated by adding Free Amino Acids and Total Carbohydrates. Therefore An attempt has been made to determine the Modified Air Pollution Tolerance Index (APTI) which gives an empirical value for tolerance level of plants to air pollution.

Corresponding author: Shyamala, L.
Department of Botany, Osmania University College for Women, Koti, Hyderabad – 500 195 Telangana, India.

MATERIALS AND METHODS

In the present study Fifteen common Plant species were selected 3 were shrubs and remaining 12 are Trees.The three different shrubs are *Nerium oleander* L, *Calotropis procera* L, *Tecoma stans* (L) *Juss.ex. Kunth* and the Trees are *Polyalthia longifolia var. pendula (Sonn), Thespesia popoulanea* (L) *Sol.ex. Correa, Sterculia foetida* L, *Azadiracta indica* L, *Dalbergia sissoo Roxb., Pongamia pinnata* L, *Delonix regia (Bojer ex Hook) Raf., Peltaphorum pterocarpum (DC) Hayne, Albizzia saman* L, *Terminalia catappa* L, *Syzyzium cuminii* (L) *Skeels,* and *Ficus religiosa* L.

The Industrial Developmental area Nacharam Site under study lies in the Eastern part of Ranga Reddy district, Malkajgiri mandal and is known as IDA–Nacharam. This is approximately 13 Km from Secunderabad Railway Station. The IDA Nacharam dominated by Cement, Pharmaceuticals, Iron, Food Industries, Balaji Steel Rolling Industry,

Innomations ltd, Dual Rings Pvt.Ltd, Tojym Steel etc. along with moderate flow of vehicular traffic in the region shows varied concentrations of particulates, Sulphurdioxide, Nitrogendioxide and Carbonmonoxide. The plant leaf samples were collected at the lower most position of canopy at a height of 6-7ft from ground surface at IDA Nacharam and is carried to laboratory for the plant analysis of certain Biochemical Parameters such as pH of leaf extract, Singh and Rao (1983); Ascorbic Acid and Relative Water Content, Singh (1977) Total Chlorophyll, Arnon (1949); Free Amino Acid, Thimmaiah (1999); Total Carbohydrates Hedge and Hofreiter (1962) Modified Air Pollution Tolerance Index i.e., present study was carried for a period of two Years i.e, Aug 2009- July 2011.

Modified Air Pollution Tolerance Index (Modified APTI) evaluated to assess the tolerant and resistance of Plants against Air Pollution. Modified APTI is a unique index because it incorporates six biochemical parameters such as pH, Total Chlorophyll, Ascorbic Acid, Relative Water Content, Free Amino Acid, Total Carbohydrates.

The formula for Modified APTI is Modified

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

A = Ascorbic Acid (mg/g)
C= Tot.Carbo. (mg/g)
AA = Free Amino Acid (mg/g)
T= Tot.Chl. (mg/g)
P= pH of leaf extract
R=RWC (%)

This will give a comphrensive picture of the Air Pollution Tolerance Index. It is a better indicator of Tolerance Index.

RESULTS AND DISCUSSION

The Biochemical analysis was done in fifteen Plants. The results of biochemical components involved in Modified Air Pollution Tolerance Index assessment is shown in Table 1.

The formula for Modified APTI is

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P= pH of leaf extract
R=RWC (%)

This will give a comphrensive picture of the Air Pollution Tolerance Index. It is a better indicator of Tolerance Index. Carbohydrates and Free Amino Acids play significant role in plant metabolism. Modified APTI is an inherent quality of plants to encounter air pollution stress. These six Physiological factors will help plants to adjust to stress in the environment. It is worth noting that combining a diversity of six parameters gave a more reliable result than when a single biochemical parameter was analysed (Agbaire, 2009). Ascorbic Acid plays a significant role in cell wall synthesis, defense and cell division. It is also a strong reducer and plays important role in Photosynthetic carbon fixation, with the reducing power directly proportional to its concentration. Hence it was given top priority and first multiplication factor in the formula. Carbohydrates are important components of storage and structural materials in the plants. They exists as free sugars and Polysaccharides.

The basic units of Carbohydrates are the monosaccharides which cannot be split by hydrolysis into more simple sugars. Carbohydrates are carbon compounds that in most cases contain hydrogen and oxygen in the ratio of 2:1. Chemically they are Polyhydroxyaldehydes (aldoses) or Polyhydroxy Ketones (Ketones) or condensation products of such compounds. Carbohydrates are major constituents of plants and animal tissues. They are of fundamental importance in living organisms as a source of metabolic energy; structural components cellulose in plant cell walls, Mucopolysaccharides of skin and connective tissue in animals and reserve storage food starch in plants and glycogen in animals. So it is given importance and used as Second multiplication factor in the formula.

Table 1. Averages of pH, Ascorbic Acid, Tot.Chl. RWC, Free Amino Acid and Total Carbohydrates in fifteen plants studied at IDA Nacharam

Plants	pH	AscorbicAcid (mg/g)	Tot.Chl. (mg/g)	RWC(%)	FreeA.A (mg/g)	Tot.Carbo. (mg/g)
Nerium oleander L	6.76	5.25	1.05	69.27	0.43	0.42
Calotropis procera L	7.01	5.77	0.88	60.34	0.40	0.47
Tecoma stans(L) *Juss.ex Kunth*	7.29	4.60	1.68	61.96	0.45	0.45
Polyalthia longifolia var.pendula (Sonn)	7.51	3.34	1.07	60.57	0.47	0.52
Thespesia populanea(L) *Sol. ex Correa*	6.79	3.13	1.01	61.75	0.35	0.35
Sterculia foetida L	6.70	5.69	1.35	62.65	0.42	0.39
Azadiracta indica L	7.16	3.84	1.49	64.58	0.55	0.42
Dalbergia sissoo Roxb.	6.72	4.60	1.03	61.21	0.43	0.44
Pongamia pinnata L	7.37	5.12	1.15	62.30	0.47	0.33
Delonix regia (Bojer ex Hook) Raf.	6.93	4.89	1.41	61.15	0.42	0.41
*Peltaphorum pterocarpum (DC)*Hayne	7.1	5.72	1.11	59.78	0.41	0.37
Albizzia saman L	6.51	4.84	1.49	62.35	0.42	0.29
Terminalia catappa L	7.16	4.15	1.40	65.43	0.63	0.46
Syzyzium cuminii (L) *Skeels*	7.03	4.78	1.19	60.20	0.40	0.46
Ficus religiosa L	6.60	5.04	1.45	58.54	0.51	0.54

The Amino Acids are the basic building blocks of all proteins. Those AminoAcids which exist in the free form in tissues and not bound to proteins are called as Free Amino Acids. Normally, during diseased conditions in plants, there will be a change in the Free Amino Acid composition.

(L) *Juss.ex.Kunth* (11.98), *Syzyzium cuminii* (L) *Skeels* (11.82), *Polyalthia longifolia var.pendula(Sonn)* (11.78) and *Thespesia populanea* (L) *Sol ex.Correa* (11.74) *Nerium oleander* L (11.47), *Dalbergia sissoo Roxb.* (11.33), *Calotropis procera* L (11.29) are Tolerant Category Modified Air

Table 2. Sensitive, Intermediate & Tolerant Plants based on Modified Air Pollution Tolerance Index (Modified APTI) at IDA Nacharam

Sensitive	*Intermediate*	*Tolerant*
	Ficus religiosa L	*Delonix regia (Bojer ex. Hook)* Raf.
	Azadiracta indica L.	*Peltaphorum pterocarpum (DC)Hayne*
		*Pongamia pinnata*L
		Terminalia catappa L
Sterculia foetida L		*Albizzia saman* L
		Tecoma stans (L)*Juss.ex Kunth.*
		Syzyzuim cuminii (L) *Skeels*
		Polyalthia longfolia var. pendula (Sonn)
		Thespesia populanea (L)*Sol.ex Correa*
		Nerium oleander L
		Dalbergia sissoo Roxb.
		Calotropis procera L.

Incorporation of Free Amino Acids gives an indication about physiological and health condition of the plants. Free Amino Acids are individualized in monomer forms. Due to their low molecular weight, plant assimilate this form of amino acid rapidly and their effects on the process of plant and the most profound. So, it is given significance and used as third multiplication factor in the formula. pH indicates the Hydrogen ion concentration and it expresses the intensity of acidity (or) alkalinity of the leaf extract. High pH may increase the effectiveness of conversion from hexose sugar to Ascorbic Acid, While low leaf extract pH show good correlation with sensitivity to air pollution (Escobed *et al.,* 2008). Relative Water Content (%) High Relative Water Content within a plant will help to maintain its physiological balance under stress condition such as exposures to air pollution when the transpiration rates are usually high. High Relative Water Content (%) favours drought resistance in plants. If the leaf transpiration rate reduces beacause of the air pollution, plants cannot live well due to inability to pulls waterup from the roots for Photosynthesis (1to 2% of the total). Total Chlorophyll content is one of important widely employed and analysed parameter of Environmental assessment. Chlorophyll content of plant signifies its Photosynthetic activities as well as growth and development of biomass. The Product of Ascorbic Acid (A), Carbohydrates (C), Free Amino Acids (AA), Sum of leaf extract pH and Total Chlorophyll was added with RWC (R) in the Modified APTI formula.

The Modified APTI gives a Comphrensive picture. Based on the Modified APTI plants are categorized into Sensitive, Intermediate and Tolerant types. In the present study Modified Air Pollution Tolerance Index was calculated in fifteen plants. The Modified Air Pollution Tolerance Index was categorized into three types such as Sensitive 8.3- 9.4, Intermediate- 9.5-10.6, and Tolerant – 10.7-13.0. From the fifteen plants selected *Sterculia foetida* L. (9.75) was considered as Sensitive, *Ficus religiosa* L. (10.64), *Azadiracta indica* L. (10.57) were considered as Intermediate category, while *Delonix regia (Bojer ex.Hook) Raf.* (12.78) *Peltaphorum pterocarpum* (DC) *Hayne* (12.75), *Pongamia pinnata* L. (12.68), *Terminalia catappa* L. (12.16), *Albizzia saman* L. (12.05), *Tecoma stans*

Pollution Tolerance Index is an index denotes capability of a plant to combat against air pollution. Plants which have higher index value are tolerant to air pollution and can be caused as a sink to mitigate pollution, while plants with low index value show less tolerance and can be used to indicate levels of air pollution (Singh and Rao, 1983). The results of present study become very useful in landscaping, for phyto-remediation of industrial polluted air environment. Tolerant species of plants should be considered in advance for use, when air pollution is high, and Intermediate species can be modified into Tolerant Category in due course of time, while sensitive species should be used as bio-indicators of air quality.

Conclusion

Based on the present study it is concluded that the Modified APTI can be used as predictor of air quality. From the 15 plants studied it were 12 plants exhibited Tolerant Category, 2 plants were Intermediate and 1 was Sensitive. The 12 plants such as *Delonix regia (Bojer ex.Hook)* Raf., *Peltaphorum pterocarpum (DC) Hayne*, *Pongamia pinnata* L, *Terminalia catappa* L, *Albizzia saman* L, *Tecoma stans* (L) *Juss.ex.Kunth*, *Syzyzium cuminii* (L) *Skeels*, *Polyalthia longifolia var.pendula (Sonn) Thespesia populanea* (L) *Sol ex.Correa*, *Nerium oleander* L, *Dalbergia sissoo Roxb.* and,*Calotropis procera L* can be used for Green Belt Development, as they can play vital role in absorption and detoxification of toxic air pollutants. This Modified APTI is unique and very apt to calculate the Tolerant Plant species which can be used as Biomonitors.

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