INTERNATIONAL JOURNAL OF APPLIED RESEARCH AND TECHNOLOGY

RESEARCH ARTICLE

Study on Air Pollution Tolerance Index of Selected Plant Species along Roadside at Karwi, (U.P.) India

Sadhana Chaurasia[1] and Raj Karan[2]

[1]Head, Dept. of Energy & Environment, MGCGV, Chitrakoot, Satna MP.485331.
[2]Environmental Chemist, STP, HUDA, Jind, Haryana. 126102.

ABSTRACT

The APTI is very effective and important for selection of plants in order to check their susceptibility against any environmental stress like air pollution. This is a simple and easy method to adopt on different types of field conditions and reduced the use of costly environmental monitoring equipment's. To develop the usefulness of plants as bio-indicators requires an appropriate selection of plant species which entail an utmost importance for a particular situation. Air pollution tolerance index is used to select plant species tolerant to air pollution. Four physiological and biochemical parameters namely, leaf extract pH, ascorbic acid, total chlorophyll and relative water content were combined together in a formulation signifying the air pollution tolerance index of plants. In this paper APTI of common growing roadside plants have been investigated.

Corresponding author:

Dr. Sadhana Chaurasia
Sadhanamgcgv@gmail.com

Keywords: pH, Relative water content, Ascorbic acid, Chlorophyll content, APTI.

Chaurasia and Karan, 2016 1(1): 32-38
Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

INTRODUCTION

Today's growing population and increasing urbanization has resulted in deterioration of ambient air quality. Air pollution is causing vast changes in vegetation. Since plants are stationary and they are continuously exposed to chemical pollutants from the surrounding atmosphere, air pollution injury to plants is proportional to the intensity of the pollution. The pollutants enter into the plants and react in variety of ways before being removed or absorbed that may include accumulation, chemical transformation and incorporation into the metabolic system. In this process, some plants are injured while others show minimal effects (Chaudhary et al, 2009).

Air pollution tolerance index (APTI) is natural quality of plants to face problem of air pollution stress, now in present days it is most important especially in industrial and non-industrial areas. Therefore, APTI of the plants needs checked properly especially of economically important plant species that are present in the polluted and non-polluted areas. APTI is an inherent quality of plants to encounter air pollution stress which is presently of prime concern particularly of urban areas of the world. Since plants are stationary and continuously exposed chemical pollutants from the surrounding atmosphere, air pollution injury to plants is proportional to the intensity of the pollution. Air pollution has become a major problem arising mainly from industrialization and urbanization during the last few decades. Particulate matter is of great concern in relation to their adverse impact on human health and vegetation (Rai, 2013). The particulates and gaseous pollutants, alone and in combination can cause serious setbacks to the overall physiology of plants (Ashenden and Williams, 1980; Mejstrik, 1980; Anda, 1986; Das and Prasad, 2010). Trees experience the greatest exposure and influenced greatly by pollutant concentration due to their perennial habit (Raina and Sharma, 2003; Chauhan, 2010). Regional impact of air pollution on local plant species is one of the major ecological issues.

Air pollution tolerance index (APTI) is an inherent quality of plants to encounter air pollution stress which is presently of prime concern particularly in Road side and control areas. Therefore, APTI of the plants needs to be monitored and checked for the predominant species that are present in the Road side and control areas. In the present study, APTI of common growing roadside plants have been investigated.

The leaves are generally used as experimental material as they take up large amount of pollution. In the current study our prime objective was to go for phyto-optimization of the air quality of the plants as meager literature in relation to application of plants for APTI value was found. Secondly an attempt has been made to compare the APTI values of different plants and to screen out the relative sensitivity of four plant species towards air pollution taken from road side and control side of the study are

The study area Karwi coordinates are 25° North and 81° East. It is bounded in the north by Kaushambi, in the south by Satna (M.P.) & Rewa (M.P.), in the east by Allahabad (Prayag), in the west by Banda. Karwi is situated on the bank of River Mandakini.

METHODOLOGY

Fresh leaves of *Cassia siameaa, Dalbergia sissoo, Delonix regia, Syzygium cumini* were collected during pre-monsoon season (March, April and May) from road side of NH-70 (Bharatkoop to Karwi) and control side (Away from 1000 m from road

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

side in Chitrakoot area) by following necessary precautionary measures were brought to the laboratory for analysis. Leaves brought to the laboratory were weighed with dust and then after washing, width and length of the leaves were also measured.

Selected plants were on the edge of the road almost with similar topography or condition and leaf samples were immediately brought to the laboratory in polythene bag, kept in ice box for further analysis of various biochemical parameters such as leaf extract pH (Singh and Rao, 1983), relative water content (Singh, 1997), total chlorophyll (Arnon, 1949), ascorbic acid (Bajaj & Kaur, 1981).

Calculation of Air Pollution Tolerance Index (APTI)

Air pollution tolerance index was assessed by Singh and Rao 1983. The air pollution tolerance index was calculated using the following formula:

APTI = A (T+ P) + R/10

Where:

A =Ascorbic Acid (mg/g)

T =Total Chlorophyll (mg/g)

P = pH of the leaf extract,

R = Relative water content of leaf (%)

RESULT & DISCUSSION

The observed biochemical characteristics and the APTI for selected plants from road side and control side are given in table 1-4, fig. 1 and discussed below:

pH

pH of road side plant leaf extract range was found 07.16-07.47. The minimum pH was observed 07.16 in *Delonix regia* while maximum pH was 07.47 in *Cassia siamea*. Whereas pH of control side plant leaf extract range was 07.55-08.16. The minimum pH of control side was observed 07.55 in *Delonix regia* while maximum was 08.16 in *Cassia siamea*. However the reducing activity of ascorbic acid is pH dependent being more at higher and lesser at lower pH. Hence the leaf extract pH on the higher side gives tolerance to plants species against pollution (Agrawal, 1988). The acidic nature in road side plant may be due to the presence of SO_X and NO_X or other acidic pollutants from the auto exhaust emission in the ambient air (Swami et al., 2004)

Relative Water Content

RWC of all selected plants species of control side were higher compared to road side plant species. At road side plant the minimum RWC was found 45.0 % in *Delonix regia* while maximum RWC was 76.0 % in *Cassia siamea*. Whereas at control side minimum RWC was found 54.33 % in *Delonix regia* while maximum was 79.76% in *Cassia siamea*. The RWC indicates change in leaf matrix hydration condition and will generate higher acidity condition when RWC is low. More water helps in diluting the acidity.

Ascorbic acid

Ascorbic acid of road side range was found 02.33-03.29 mg/g. The lower ascorbic acid was observed 02.33 mg/g in *Cassia siamea* while higher was 03.29 mg/g in *Delonix regia*. Whereas ascorbic acid of control side range was 02.11-02.36 mg/g. The lower ascorbic acid of control side was observed 02.11 mg/g in *Cassia siamea* while lower was 02.36 mg/g in *Delonix regia*. Plants maintaining high ascorbic acid under pollutant conditions are considered to be tolerant to air pollution. Pollution load dependent increase in ascorbic acid content of all the plant species may be due to the increased rate of production of reactive oxygen species (ROS) during photo-

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

oxidation of SO_2 to SO_3 where sulfites are generated from SO_2 absorbed (Chaudhary and Rao, 1977). Higher ascorbic acid content of the plant is a sign of its tolerance against sulphur dioxide pollution (Varshney and Varshney, 1984).

Total chlorophyll (TC)

Total chlorophyll of road side range was found 02.41-02.81 mg/g. The lower chlorophyll was observed 02.41 in *Delonix regia* while higher was 03.29 in *Cassia siamea*. Whereas chlorophyll of control side range was 03-04-03.56. The lower chlorophyll of Control side was observed 03.04 mg/g in *Delonix regia* while higher was 03.56 in *Cassia siamea*. Chlorophyll takes part in photosynthetic activity as well as the growth and development of biomass.

Air Pollution Tolerance Index (APTI)

High dust collecting capacity of leaves may be one of the reasons for the sensitive plant species studied and highly susceptible to the auto-exhaust pollutants, making reduction or increase of different biochemical and physiological parameters (Singh, 2005).

APTI value of road side plants was compared with the Control side plants. The APTI of plant species from Road side ranged from 07.65-10.00. The minimum APTI was observed 07.65 in *Delonix regia* while maximum was 10.00 in *Cassia siamea*. The APTI value of control side ranged from 07.93-10.41.Dust pollution and chronic concentration of gaseous pollutants may affect the biochemical make up and tolerance capacity of plants to the air pollution (Rai et al., 2013).

Table: 1. Bio-chemical parameters and Air pollution tolerance index (APTI) of *Cassia siamea* in summer season.

Month	pH		Relative Water Content		T. Chlorophyll		Ascorbic Acid		APTI of Mean Values	
	RS	CS	RS	CS	RS	CS	RS	CS	RS	CS
March	7.52	8.13	78.00	82.00	2.93	3.52	2.29	2.01	**10.00**	**10.41**
April	7.47	8.04	76.00	82.00	2.87	3.57	2.32	2.12		
May	7.42	7.92	74.00	75.00	2.62	3.60	2.39	2.21		
Average	**07.47**	**08.03**	**76.00**	**79.67**	**02.81**	**03.56**	**02.33**	**02.11**		
±SD	0.05	0.11	2.00	4.04	0.16	0.04	0.05	0.10		

RS=Road side sample, CS= Control side sample

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

Table: 2. Bio-chemical parameters and Air pollution tolerance index (APTI) of *Dalbergia sissoo* in summer season.

Month	pH		Relative Water Content		T. Chlorophyll		Ascorbic Acid		APTI of Mean Values	
	RS	CS	RS	CS	RS	CS	RS	CS	RS	CS
March	7.26	8.90	60.00	69.00	2.67	3.02	2.90	2.01	**08.37**	**08.68**
April	7.25	8.07	54.00	60.00	2.72	3.17	3.02	2.22		
May	7.09	7.51	48.00	58.00	2.74	3.19	3.09	2.28		
Average	**7.20**	**8.16**	**54.00**	**62.33**	**02.71**	**03.13**	**03.00**	**2.17**		
±SD	0.10	0.70	6.00	5.86	0.04	0.09	0.10	0.14		

RS=Road side sample, CS= Control side sample

Table: 3. Bio-chemical parameters and Air pollution tolerance index (APTI) of *Delonix regia* summer season.

Month	pH		Relative Water Content		T. Chlorophyll		Ascorbic Acid		APTI of Mean Values	
	RS	CS	RS	CS	RS	CS	RS	CS	RS	CS
March	7.26	7.60	50.00	57.00	2.33	3.33	3.26	2.01	**07.65**	**07.93**
April	7.13	7.53	43.00	54.00	2.42	3.39	3.28	2.08		
May	7.10	7.51	42.00	52.00	2.49	2.41	3.34	3.00		
Average	**07.16**	**07.55**	**45.00**	**54.33**	**2.41**	**03.04**	**3.29**	**02.36**		
±SD	0.09	0.05	4.36	2.52	0.08	0.55	0.04	0.55		

RS=Road side sample, CS= Control side sample

Table: 4. Bio-chemical parameters and Air pollution tolerance index (APTI) of *Syzygium cumini* in summer season.

Month	pH		Relative Water Content		T. Chlorophyll		Ascorbic Acid		APTI of Mean Values	
	RS	CS	RS	CS	RS	CS	RS	CS	RS	CS
March	7.60	8.40	65.00	72.30	2.63	3.46	3.02	2.30	**09.33**	**09.42**
April	7.20	7.92	63.00	66.00	2.68	3.49	3.08	2.37		
May	7.23	7.87	60.00	63.00	2.69	3.53	3.09	2.39		
Average	**07.34**	**08.06**	**62.67**	**67.10**	**02.67**	**3.49**	**03.06**	**02.35**		
±SD	0.22	0.29	2.52	4.75	0.03	0.04	0.04	0.05		

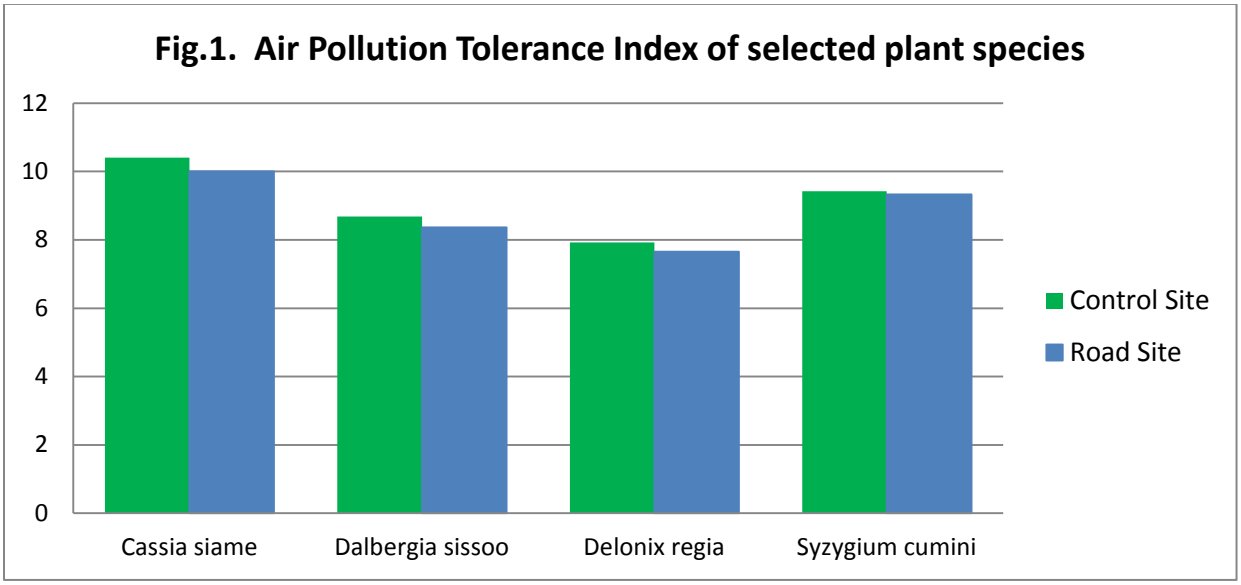
RS=Road side sample, CS= Control side sample

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

Table: 5. Standard APTI values

S.No.	APTI range	Level of tolerance
1.	< 1	Highly sensitive
2.	1-16	Sensitive
3.	17-29	Intermittently tolerant
4.	30-100	Tolerant

Source:- Mashita and Pise 2001.



CONCLUSION

The study suggests that plants have the potential to serve as excellent quantitative and qualitative indices of pollution. Since bio-monitoring of plants is an important tool to evaluate the impact of air pollution on plants *Cassia siameaa, Dalbergia sissoo, Delonix regia, Syzygium cumini* can be used as bio-monitors of vehicular pollution stress. From the study it was concluded that *Syzgium cumini* was the most tolerant species followed by *Cassia siame*. *Delonix regia* was found in most sensitive among the four selected species.

REFERENCES

Singh S.K & Rao D.N. (1983) Evaluation of plants for their tolerance to air pollution,In**:**Proceedings Symposium on Air Pollution Control,Indian Association for Air Pollution Control,New Delhi, India,1: 218-224.

Anda A. (1986) Effects of cement kiln dust on the radiation balance and yields of plants. Environ. Pollut. 40: 249-259.

Arnon D.I. (1949) Coenzyme in isolated chloroplast. Polyphenol oxidase in *Beta vulgaris*. Plant Physiol. 24:1-15.

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016

Ashenden T.W. and Williams I.A.D. (1980) Growth reduction in *Lolium multiflorum Lam and Phleum pratense L* as a result of sulphur dioxide and nitrogen dioxide pollution. Environ. Pollut, 21: 131-139.

Das S. and Prasad P. (2010) Seasonal variation in air pollution tolerance indices and selection of plant species for industrial areas of Rourkela. Indian J. Environ. Prot., 30(12): 978-988.

Keller T. and Schwager H. (1977) Air pollution and ascorbic acid. Europ. J. Forest Pathol., 7: 338-350.

Mejstrik V. (1980) The influence of low SO_2 concentration on growth reduction of *Nicotiana tabacum* L.W.Samsum and Cucumis sativus L.cv Unikat. Environ. Pollut., 21: 73-76.

Agbaire P.O. and Esief Arienrhe E. (2009) Air pollution tolerance indices (APTI) of some plants around Otorogun Gas plant in Delta state, Nigeria. Journal of Applied Science and Environmental Management, 13(1): 11-14.

Rai P.K., Panda L.S., Chutiya B.M. and Singh M. (2013) Comparative assessment of air pollution tolerance index (APTI) in the industrial (Rourkela) and non-industrial area (Aizawal) of India: An eco-management approach, AJEST, 7(10): 944-948.

Chaudhary C.S. and Rao D.N. (1977) Study of some factors in plants controlling their susceptibility to sulphur dioxide pollution. Proc. Ind. Natl. Sci. Acad. Part B., 46: 236-241.

Varshney S.R.K. and C.K. Varshney (1984) Effects of sulphur dioxide on ascorbic acid in crop plants. Environ. Pollut., 35: 285-291.

Singh P.K. (2005) Plants as indicators of air pollution - An Indian experience. Indian Forester, 131: 71-80.

Received August 11, 2016; Revised September 27, 2016 Published October 29, 2016