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Evaluation of air pollution tolerant tree species for Kothagiri Municipal Town, the Nilgiris, Tamil Nadu.

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ABSTRACT:

Air pollution tolerance index (APTI) has been determined by pooling the attributes *viz*., total chlorophyll, ascorbic acid and moisture content of leaves and leaf extract pH for certain locally available tree species in and around Kothagiri Municipal Town, the Nilgiris. Of the 24 species analyzed 6 tree species such as *Alnus nepalensis, Callistemon lanceolata, Eucalyptus ficifolia, Ficus elastica, Michelia champaca* and *Toona ciliate* recorded higher APTI values. Hence, it is suggested that these tree species can be given priority for plantation programme in and around industrial complexes, road sides and also new urbanized areas in Kotagiri so as to reduce the effect of air pollution and makes the environment clean.

Keywords:
Air pollution tolerance index, Nilgiris, Urbanized area, Kothagiri.

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INTRODUCTION

Air is never found absolutely clean in nature. It is indeed deteriorated every moment due to ever increasing industrial activities, automobiles etc. The industrialized countries are dumping lot of materials and wastes in their immediate environment, which is now becoming a big source of pollution. During the past many decades, there has been a growing awareness about the serious hazards of atmospheric pollution to which we are constantly exposed. Serious discussions are going on about the effects of green house gases and carbon gases on environmental security world wide (Kanchev *et al*., 2005, Blottnitz and Curran, 2007). The damaging effects of air pollution on vegetation have been recognized (Treshow, 1970; Chang and Terwilliger, 2000; Cape, 2003). Screening of plants for their sensitivity to air pollutants is of vital importance. Many workers like Agarwal and Tiwari, 1997, Paulsamy *et al*., 2000, Ramakrishnaiah and Somasekhar, 2003, Kannan, 2003, Rathinaswamy *et al*., 2005 have identified tolerant tree species of air pollution for some industrial cities in India.

In India, Tamil Nadu is one among the leading states in industrial development. Kothagiri, one among the cities gets affected by air pollution mainly due to automobiles and agricultural pesticides in Tamil Nadu. Since, it is one of the important tourist places in Nilgiris, Kothagiri is experiencing high degree of air pollution through vehicles. In this juncture, for the control of the effect of air pollution, an attempt has been made in the present study at Kothagiri to identify suitable air pollution tolerant tree species based on air pollution tolerance index.

MATERIALS AND METHODS

The locally available tree species were analyzed for air pollution tolerance index (APTI) by estimating the contents of ascorbic acid, chlorophyll, relative moisture in leaf and leaf extract pH at monthly intervals from November 2006 to July, 2007. Leaves from tip, middle and basal canopy of trees were collected in the forenoon between 07.00 and 08.00 am. Care was taken for plants under investigation with respect to exposure of almost similar conditions for light, water, soil and pollutants. The collected samples were analyzed for ascorbic acid, total chlorophyll and relative water content and leaf extract pH. Unpolluted regions were taken 25km away from the city which served as control. The ascorbic acid and total chlorophyll contents were estimated respectively by the methods of Keller and Schwanger (1977) and MacLachlon and Zalik (1963). Relative water content was determined by following and the leaf extract pH was measured by using digital pH meter.

The air pollution tolerance index (APTI) was determined by using the following formula proposed by Singh and Rao (1983):

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

Where,

A= ascorbic acid content in leaf (mg/g); T= total chlorophyll content in leaf (mg/g); P= leaf extract pH and R= per cent water content of the leaf. The sum value is divided by 10 to get the value in reduced scale.

RESULTS AND DISCUSSION

A considerable number of 24 tree species were analyzed in the municipal town, Kothagiri. It was estimated that many tree species showed wide variation in leaf chlorophyll content at the study area. The higher chlorophyll content was prominent in tree species like *Alnus nepalensis, Callistemon lanceolata, Cupressus cashmeriana, Ficus elastica* and *Michelia champaca* (Table 1). Further, it was observed that the close proximity observed between the individuals of tree species growing in polluted (Kothagiri) and unpolluted nearby areas with respect to high chlorophyll content indicates that air pollution has no marked effect upon the synthesis of chlorophyll pigment for these species. In the other extreme, some species including *Accia dealbata*, *Pinus roxburghii*, *Podocarpus latifolia*, *Sterculia guttata* and *Syzygium cumini* have contained lower amount of chlorophyll. Speading amd Thomas (1973), Santhoskumar and Paulsamy (2006) already reported that pollution stress decreases the chlorophyll level in plants. However, the other species have been drastically affected by pollution in terms of chlorophyll production. Varshney (1982) reported that plants appearing green and normal at low concentration of sulphur-di -oxide show reduced efficiency of photosynthesis. Hence, it is known that the plants having high chlorophyll content under field condition are generally tolerant to air pollution.

The leaf extract pH was higher (6.5) in the species, *Ficus elastica* (Table 1). In the presence of an acidic pollutant, the leaf pH is lowered and the decline is greater in sensitive species (Scholz and

Reck, 1977). A shift in cell sap pH towards the acid side in the presence of an acidic pollutant might decrease the efficiency of conversion of hexose sugar to ascorbic acid. However, the reducing activity of ascorbic acid is pH controlled, being more at higher and less at lower pH. Hence, the leaf extract pH on the higher side gives tolerance to plants against pollution (Agarwal, 1989; Agarwal and Tiwari, 1997).

Ascorbic acid being a strong reductant protects chloroplast against sulphurdioxide induced H_2O_2, O_2^- and OH accumulation and also protects the enzymes of the CO_2 fixation cycle and chlorophyll from inactivation (Tanaka *et al.,* 1982). Together with leaf pH it plays a significant role in determining the SO_2 sensitivity of plants (Chaudhary and Rao, 1977). Thus plants maintaining higher ascorbic acid level under polluted condition are considered to be tolerant to air pollutants. The results of the present study revealed that the same five species of higher chlorophyll content are also having high ascorbic acid content in polluted regions and they are considered to be pollution tolerants (**Table 1**).

The relative water content was higher for some species such as *Alnus nepalensis*, *Callistemon lanceolata, Eucalyptus ficifolia, Ficus elastica, Michelia champaca* and *Toona ciliata* in the study area. Relative water content is associated with protoplasmic permeability in cells causes loss of water and dissolved nutrients resulting in early senescence of leaves (Masuch *et al.,* 1988). It is likely therefore that the tree species with high relative water content under polluted conditions may be tolerant to pollutants.

The obtained APTI of certain tree species *viz*., *Alnus nepalensis*, *Callistemon lanceolata, Eucalyptus ficifolia, Ficus elastica , Michelia champaca* and *Toona ciliata* was higher and it was lower in some other species like *Acacia melanoxylon*, *Biota orientalis*, *Grevillea robusta*, *Jacaranda mimosifolia*, *Podocarpus latifolia*, *Sterculia guttata*, *Syzgium cumini* etc. (Table 1). In addition, it is known that the pollutants released from chemical method of pest control and automobiles have been effectively utilized by the tree species of higher APTI value. This is evidenced by very narrow differences in the APTI values of individuals of respective species between polluted Kothagiri city and unpolluted rural areas. Different plant species vary considerably in their susceptibility to air pollution. The tree species with high and low APTI can serve as tolerant and sensitive ones respectively. Such plants can effectively be used as indicators and pollution scavengers (Singh and Rao, 1983; Agarwal, 1989; Tiwari, 1991; Agarwal and Tiwari, 1997; Paulsamy *et al.,* 2000; Santhoskumar and Paulsamy, 2006; Senthilkumar *et al*., 2008; Thanbavani *et al*., 2009). Hence it is suggested that these tree species of high APTI can be given priority for plantation programmes in and around industrial complexes, road sides and also in new urbanized areas so as to reduce the effect of air pollution and makes the environment clean for our healthy life.

REFERENCES

Agarwal AC. 1989. Air pollution control and impact on air environment for Mandhar cement factory". Project report; sponsored by CCI, Mandhar cement factory, NEERI, Nagpur.

Agarwal S and Tiwari SL. 1997. Susceptibility level of few plants on the basis of air pollution tolerance index", *Indian Forester* 319-322.

Blottnitza HV and Curranb MA. 2007. A review of assessments conducted on bio-ethanol as a transportation fuel from a net energy, greenhouse gas, and environmental life cycle perspective, J*ournal of Cleaner Production* 15(7):607-619.

Cape JN. 2003. Effects of airborne volatile organic compounds on plants, *Environmental Pollution* 122 (1):145-157.

Chang E and Terwilliger VJ. 2000. The effects of air pollution on vegetation from a geographic perspective, *Progress in Physical Geography* 24 (1):53-74.

Chaudhary CS and Rao DN. 1977. Study of some factors in plants in controlling their susceptibility to SO_2 pollution, *Proc. of the Indian Natle. Sci. Academy* 43:236-241.

Kannan R and Paulsamy S. 2003. Evaluation of suitable tree species for the control of air pollution in Ooty city, 2003; Proceedings of the Seminar cum Exhibition on Student Projects 2002 - 2003, 12th & 13th Aug., Muthayammal College of Arts and Science, Kakaveri – 637 408. India. Tamilnadu State Council for Science and Technology, Chennai - 600 025. 93-95

Kanchev G, Kostandieva D and Dimitrov S. 2005. Environmental pollution, some realized projects and suggestions, *Trakia Journal of Sciences* 3 (8):14-16.

Keller T and Schwanger H. 1977. Air pollution and ascorbic acid, *European Jour. of For. Pathology* 7:338-350.

Mac Lachlon S and Zalik S. 1963. Plastid structure chlorophyll concentration and free aminoacid composition of a chlorophyll mutant of Barley, *Can. J. Bot.,* 41:1053-1062.

Masuch GH, Kicinski G, Kettrup A and Boss KS. 1988. Single and combined effects continuous and discontinuous O_3 and SO_3 emissions on Norway spruce needles. I. Histological and cytological changes, *Inter. Jour. of. Envi. Analytial Chemistry* 32:213-241.

Paulsamy S, Sivakumar R and Latha N. 2000. Evaluation of air pollution tolerant tree species in Coimbatore city, *J. Ecol. Res. Biocon* 1(2):20-23.

Ramakrishnaiah H and Somasekhar RK. 2003. Higher plants biomonitors of automobile pollution, *Eco. Env. Conserv*., 9(3):337-343.

Rathinasamy R, Paulsamy S and Manian S. 2005. Studies on the control of effect of air pollution through raising suitable green cover in Palani city, In: S. Paulsamy (ed.) Proceedings of the State level Symposium on Bioresources and their Management held at Kongunadu Arts and Science College, Coimbatore on 5th and 6th September 2003; 84 -88.

Santhoshkumar E and Paulsamy S. Studies on identification of suitable tree species for control of air pollution in Tamilnadu, *Nature Environment and Pollution Technology*, 2006; 5 (4):591-599.

Scholtz F and Reck S. 1977. Effects of acids on forest trees as measured by titration *in-vitro* inheritance of buffering capacity in Picea – Abies, *Water, Air and Soil Pollution* 8:41-45.

Senthilkumar P, Paulsamy S and Anandkumar AM. 2008. Identification of air pollution tolerant tree species for the industrial city, Tuticorin, Proceeding of the National Conference on Recent trends in climatic changes and coastal bio resources, held at Aditanar College, Tiruchendur on 11th and 12th December. 8-12.

Singh SK and Rao DN. 1983. Evaluation of plants for their tolerance to air pollution, Proc. Symposium on Air Pollution Control 218-224.

Speadding DJ and Thomas WJ. 1973. Effect of sulphuroxide on the metabolism of glycolic acid by barley (*Hordeum vulgare*) leaves, *Australian Jour. of Biol. Sci.*, 26:281-286.

Tanaka KT, Otsubo and Kondo N. 1982. Participation of hydrogen peroxide in the inactivation of calvin cycle SH enzymes in SO_2 fumigated spinach leaves, *Plant Cell Physiology* 28:1009-1018.

Thambavini DS, Sendurkumaran S and Rajeswari G. 2009. Evaluation of plants for their tolerance to air pollution in industrial area – a case study in Karaikudi region, Tamil Nadu, South India, *J. Sci. Trans. Environ. Technov* 3(2):54-58.

Tiwari SL. 1991. Studies of air pollution tolerance indices of some planted trees in urban area of Bhopal with reference to ecoplanning of industrial area, *Ph.D. Thesis*, Barkatullah University, Bhopal.

Treshow M. 1970. Ozone damage to plants, *Environmental Pollution* 1:155-161.

Varshney SKRK. 1982. Effect of SO_2 on plant processes, *Ph.D. Thesis*, J.N. University, New Delhi.

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Table 1. The contents of total chlorophyll, ascorbic acid and relative moisture and leaf extract pH in various tree species of Kothagiri Municipal Town, the Nilgiris with their air pollution tolerance index.

Sl. No.	Species	Total chlorophyll (mg/ml)	Leaf extract pH	Ascorbic acid (mg/g)	Relative moisture content (%)	Air pollution tolerance index (APTI)
1	*Acacia dealbata*	1.30 ± 0.24 (1.63 ± 0.12)	5.3 ± 0.15 (5.9 ± 0.32)	2.23 ± 0.09 (2.57 ± 0.08)	37.28 ± 4.74 (40.56 ± 5.11)	5.21 ± 0.63 (5.99 ± 0.50)
2	*A. melanoxylon*	1.53 ± 0.22 (1.67 ± 0.38)	5.9 ± 0.58 (6.0 ± 0.50)	2.40 ± 0.67 (3.03 ± 0.94)	28.55 ± 5.35 (32.48 ± 5.85)	4.59 ± 0.40 (5.61 ± 0.13)
3	*Alnus nepalensis*	4± .13 0.70 (4.16 ± 0.71)	6.4 ± 0.15 (6.5 ± 0.20)	3.31 ± 0.20 (3.36 ± 0.14)	59.81 ± 0.39 (60.13 ± 0.14)	9.45 ± 0.12 (9.55 ± 0.20)
4	*Araucaria excelsa*	1.73 ± 0.26 (2.35 ± 0.23)	5.0 ± 0.55 (5.2 ± 0.64)	2.44 ± 0.38 (2.66 ± 0.45)	42.78 ± 1.78 (46.85 ± 1.77)	5.92 ± 0.55 (6.71 ± 0.83)
5	*Biota orientalis*	1.84 ± 0.25 (2.42 ± 0.78)	4.8 ± 0.15 (4.8 ± 0.20)	1.60 ± 0.12 (2.22 ± 0.47)	38.56 ± 1.52 (38.75 ± 2.67)	4.92 ± 0.12 (5.51 ± 0.74)
6	*Callistemon lanceolate*	3.75 ± 0.64 (3.77 ± 0.66)	6.1 ± 0.61 (6.2 ± 0.61)	2.71 ± 0.79 (2.75 ± 0.66)	63.53 ± 4.47 (63.60 ± 5.50)	9.02 ± 0.23 (9.07 ± 0.26)
7	*Casuarina equisetifolia*	2.28 ± 0.17 (2.62 ± 0.37)	5.8 ± 0.55 (6.1 ± 0.50)	2.16 ± 0.49 (2.79 ± 0.87)	51.70 ± 3.48 (56.06 ± 3.37)	6.93 ± 0.44 (8.10 ± 0.91)
8	*Cupressus cashmeriana*	2.85 ± 0.55 (3.89 ± 0.83)	5.5 ± 0.57 (5.8 ± 0.57)	2.27 ± 0.18 (2.89 ± 0.55)	35.10 ± 1.76 (37.23 ± 3.05)	5.41 ± 0.15 (6.55 ± 1.18)
9	*Elaeocarpus tectorious*	1.82 ± 0.57 (2.43 ± 0.86)	5.6 ± 0.55 (6.3 ± 0.36)	2.01 ± 0.76 (2.64 ± 0.18)	38.77 ± 8.66 (44.95 ± 9.38)	5.38 ± 1.61 (6.51 ± 1.14)
10	*Eucalyptus ficifolia*	2.35 ± 0.76 (2.41 ± 0.79)	5.4 ± 0.25 (5.5 ± 0.36)	2.76 ± 0.35 (2.84 ± 0.27)	62.17 ± 2.61 (62.27 ± 3.29)	8.37 ± 0.13 (8.48 ± 0.16)
11	*Eucalyptus* sp	1.80 ± 0.60 (2.84 ± 0.97)	4.9 ± 0.50 (5.8 ± 0.40)	2.59 ± 0.97 (2.74 ± 0.83)	50.81 ± 3.98 (55.27 ± 4.13)	6.82 ± 1.08 (7.84 ± 0.86)
12	*Ficus elastica*	3.36 ± 0.42 (3.38 ± 0.42)	6.5 ± 0.25 (6.6 ± 0.15)	3.50 ± 0.04 (3.56 ± 0.08)	72.30 ± 0.70 (72.62 ± 0.99)	10.67 ± 0.16 (10.80 ± 0.24)
13	*Grevillea robusta*	1.95 ± 0.54 (2.43 ± 0.70)	5.4 ± 0.20 (6.2 ± 0.12)	1.74 ± 0.34 (2.44 ± 0.88)	36.12 ± 1.77 (40.18 ± 2.36)	4.88 ± 0.33 (6.06 ± 0.63)
14	*Jacaranda mimosifolia*	2.02 ± 0.30 (2.87 ± 0.36)	5.2 ± 0.85 (5.8 ± 0.96)	1.81 ± 0.26 (2.47 ± 0.65)	40.73 ± 8.94 (43.27 ± 8.41)	5.40 ± 0.80 (6.51 ± 0.40)
15	*Kigelia pinnata*	1.46 ± 0.21 (2.13 ± 0.65)	5.2 ± 0.32 (5.9 ± 0.06)	2.42 ± 0.04 (3.08 ± 0.10)	47.79 ± 2.50 (52.96 ± 3.80)	6.40 ± 0.20 (7.76 ± 0.16)
16	*Michelia champaca*	2.91 ± 0.49 (2.96 ± 0.47)	5.5 ± 0.59 (5.6 ± 0.67)	3.12 ± 0.66 (3.13 ± 0.53)	67.42 ± 4.99 (67.47 ± 6.12)	9.39 ± 1.09 (9.45 ± 1.10)
17	*Pinus roxburghii*	1.33 ± 0.10 (1.61 ± 0.25)	5.4 ± 0.53 (5.4 ± 1.13)	2.56 ± 0.07 (3.16 ± 0.53)	37.46 ± 1.13 (39.92 ± 2.05)	5.47 ± 0.12 (6.15 ± 0.30)
18	*Podocarpus latifolia*	1.40 ± 0.58 (2.75 ± 1.30)	6.3 ± 0.46 (6.8 ± 0.06)	2.59 ± 0.04 (2.91 ± 0.47)	28.69 ± 0.43 (34.35 ± 1.39)	4.86 ± 0.32 (6.27 ± 1.02)
19	*Schleichera oleosa*	1.96 ± 0.58 (2.79 ± 0.97)	6.2 ± 0.06 (6.7 ± 0.26)	2.00 ± 0.14 (3.04 ± 0.83)	42.00 ± 1.20 (45.56 ± 1.17)	5.83 ± 0.11 (7.49 ± 1.28)
20	*Spathodea companulata*	2.00 ± 0.02 (2.48 ± 0.01)	4.7 ± 0.50 (5.4 ± 1.00)	1.98 ± 0.56 (2.84 ± 0.80)	55.46 ± 2.42 (59.09 ± 1.34)	6.89 ± 0.20 (8.20 ± 0.96)
21	*Sterculia guttata*	1.44 ± 0.64 (2.08 ± 0.81)	6.2 ± 0.15 (6.6 ± 0.20)	1.25 ± 0.02 (1.64 ± 0.12)	40.17 ± 1.23 (45.76 ± 2.34)	4.97 ± 0.10 (6.01 ± 0.28)
22	*Syzygium cumini*	1.23 ± 0.33 (1.78 ± 0.34)	6.2 ± 0.06 (6.6 ± 0.40)	1.42 ± 0.23 (1.89 ± 0.40)	40.61 ± 1.72 (46.19 ± 4.53)	5.12 ± 0.30 (6.20 ± 0.73)
23	*Toona ciliata*	2.59 ± 0.19 (2.65 ± 0.17)	5.5 ± 0.12 (5.6 ± 0.12)	2.91 ± 0.07 (2.96 ± 0.05)	59.78 ± 0.95 (59.98 ± 1.20)	8.34 ± 0.11 (8.42 ± 0.13)
24	*Vernonia monosis*	1.57 ± 0.53 (2.12 ± 0.90)	4.6 ± 0.44 (5.5 ± 0.29)	1.88 ± 0.07 (2.35 ± 0.47)	43.64 ± 1.22 (47.05 ± 2.32)	5.52 ± 0.35 (6.54 ± 0.95)