Publications
PUBLICATIONS


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Participated, presented and attended more than 35 International/National Conferences Seminars/Symposium/Workshops and Training Programs.
ASSESSMENT OF RELATIVE WATER CONTENT, LEAF EXTRACT pH, ASCORBIC ACID AND TOTAL CHLOROPHYLL OF SOME PLANT SPECIES GROWING IN SHIVAMOGGA

Adamsab M. Patel and Hina Kousar

Department of Environmental Science, Kuvempu University, Shankarghatta (Karnataka), India.

Abstract

Shimoga is situated in picturesque Malnad Region, literally in the lap of the Sahyadri Western Ghats, Karnataka state of India. The geographical location of the city is 13° 55' 18" N 75° 34' 12" E. Height is 584 meter, above MSL (Minimum Sea Level). It has been known for at least 250 years that air pollution can have damaging effects on plants. Today there is great need to increase public awareness to plant trees in urban areas to enhance the beauty of the concrete landscape and for healthy living. Plants play an important role in maintaining the ecological balance by actively participating in the cycling of nutrients and atmospheric gases and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the environment. The study examined air pollution indices (APTI) of fourteen plant species around Shimoga city as Experimental site and Kuvempu University, Shankarghatta control site. The assessment of relative water content, leaf extract pH, ascorbic acid and total chlorophyll were used to compute the air pollution tolerance index values. Results revels that high values of air pollution tolerance index (APTI) were recorded in Azadirachta indica, (37.74) Mangifera indica, (28.4) Eucalyptus mysoresins (27.93), Carica papaya (24.62), Ricinus communis (22.46), Polyalthia longifolia (20.76), Calotropis gigantean (19.84), Nerium indicum (18.49), Psidium guajava (17.51), Parthenium hysterophorus (14.91), Bougainvillea (13.35), Muntingia calabura (11.68), Terminalia catappa (10.71) and Tamarindus indica (9.12) where in control site the high degree of tolerance is found in Azadirachta indica (29.46) and low in Tamarindus indica (6.85).

Key words: Air pollution, relative water content, leaf extract pH, ascorbic acid, total chlorophyll, Shimoga.

Introduction

Air Pollution Tolerance Index (APTI) suggested by Singh and Rao (1983), is one of the widely used tools in India, to describe the tolerant species.

The index takes into account the changes in the chlorophyll and ascorbic acid contents along with the measures like pH of the cell sap and relative water content. These four attributes are known to influence the plants in different ways. The APTI is general response of species to the overall or collective pollutant load of the ambient air. This index is an inclusive one covering aptly such parameters which have a bearing on stress tolerance. The most important among these factors is the ascorbic acid since it enhances the antioxidative capacity increasing peroxidase and superoxide dismutase (Mukherjee and Choudhuri, 1983). Escalated activities of these enzymes reduce the superoxides and free radical formation. Thus, ascorbic acid dampens the action of such pollutants which tend to increase accumulation of the free radicals. Moreover variation of chlorophyll contents of different plant species at different study areas indicate the differential response of plant species to pollutant (Alok Chandra Samal and Santra, 2002). Jissy Jyothi S. and Jaya D. S. (2010) have worked on six different species Polyalthia longifolia, Alstonia scholaris, Mangifera indica, Clerodendron infortunatum, Eupatorium odoratum, Hytis suaveolens growing adjacent to the National Highway-47 passing through Thiruvananthapuram district. Among the trees in the roadside areas studied, Polyalthia longifolia expressed highest APTI values and proved to be a tolerant variety and the others as sensitive species to air pollutants. And Agbaire P. O. (2009) have worked on ten plant species around the Erhoike- kokori oil exploration station of delta state. The result showed that combining variety of these parameters gave a more reliable result than those of individual parameter. The order of tolerance is Psidium guajava< Elaesis guineesis < Musa paradisiacal<...
Imperata cylindrica < Chromolaena odorata < Mangifera indica.

Air pollution tolerance levels of each different plant do not show a uniform behavior. It is seen that plant having higher index value are tolerant to air pollution and can be used as a filter or sink to mitigate the pollution, while plants having low index value show less tolerance and can be used to indicate levels of air pollution from the study area.

**Materials and Methods**

Experimental site, Shimoga is situated in picturesque Malnad Region, literally in the lap of the Sahyadri Western Ghats, Karnataka State of India. The geographical location of the city is 13° 55’ 18” N 75° 34’ 12” E. Height is 584 meter, above MSL (Minimum Sea Level). The growing number of vehicles, small scale industries, demolition of buildings for widening of roads, construction of flyovers and diversions coupled with a burgeoning population has significantly raised the air pollution levels.

Control site, the Kuvempu University campus (130 41’ N 750 38’ E, altitude 680-720m) is located 28 km south east of Shimoga city and the campus is only 2 km from the magnificent Bhadra reservoir across the river Bhadra, one of the important life lines of the area. The university campus sprawls over an area of 300 acres of land with varied habitats.

The study area was classified into two zones, control site and experimental site. The control site leaf samples
Relative Water Content, Leaf Extract, pH, Ascorbic Acid and Total Chlorophyll of Some Plant Species in Shivamogga

Table 1: Air pollution tolerance index (APTI) of plant species growing in experimental site (Shivamogga).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Plant species</th>
<th>RWC</th>
<th>TCH</th>
<th>pH</th>
<th>AA</th>
<th>APTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Carica papaya</td>
<td>86.04</td>
<td>0.79</td>
<td>6</td>
<td>23.6</td>
<td>24.62</td>
</tr>
<tr>
<td>2.</td>
<td>Calotropis gigantea</td>
<td>61.22</td>
<td>0.76</td>
<td>6.5</td>
<td>18.9</td>
<td>19.84</td>
</tr>
<tr>
<td>3.</td>
<td>Eucalyptus mysoresins</td>
<td>85.71</td>
<td>0.25</td>
<td>5.6</td>
<td>33.1</td>
<td>27.93</td>
</tr>
<tr>
<td>4.</td>
<td>Parthenium hysterophorus</td>
<td>79.1</td>
<td>0.51</td>
<td>6.9</td>
<td>9.45</td>
<td>14.91</td>
</tr>
<tr>
<td>5.</td>
<td>Nerium indicum</td>
<td>84.37</td>
<td>0.93</td>
<td>6.2</td>
<td>14.1</td>
<td>18.49</td>
</tr>
<tr>
<td>6.</td>
<td>Polyalthia longifolia</td>
<td>87.8</td>
<td>0.24</td>
<td>6.1</td>
<td>18.9</td>
<td>20.76</td>
</tr>
<tr>
<td>7.</td>
<td>Mangifera indica</td>
<td>90.9</td>
<td>0.51</td>
<td>4.6</td>
<td>37.8</td>
<td>28.4</td>
</tr>
<tr>
<td>8.</td>
<td>Rcinus communis</td>
<td>89.7</td>
<td>1.24</td>
<td>5.9</td>
<td>18.9</td>
<td>22.46</td>
</tr>
<tr>
<td>9.</td>
<td>Psidium guajava</td>
<td>77.14</td>
<td>1.25</td>
<td>5.7</td>
<td>14.1</td>
<td>17.51</td>
</tr>
<tr>
<td>10.</td>
<td>Mutangia calibra</td>
<td>59.25</td>
<td>0.39</td>
<td>5.7</td>
<td>9.45</td>
<td>11.68</td>
</tr>
<tr>
<td>11.</td>
<td>Bougainvillea</td>
<td>69.56</td>
<td>1.17</td>
<td>5.6</td>
<td>9.45</td>
<td>13.35</td>
</tr>
<tr>
<td>12.</td>
<td>Terminalia capata</td>
<td>83.72</td>
<td>0.47</td>
<td>4.5</td>
<td>4.72</td>
<td>10.71</td>
</tr>
<tr>
<td>13.</td>
<td>Azadirachta indica</td>
<td>91.92</td>
<td>0.15</td>
<td>5.9</td>
<td>47.2</td>
<td>37.74</td>
</tr>
<tr>
<td>14.</td>
<td>Tamarindus indica</td>
<td>50.9</td>
<td>0.07</td>
<td>4.2</td>
<td>9.45</td>
<td>9.12</td>
</tr>
</tbody>
</table>

RWC = Relative water content  
TCH = Total chlorophyll content  
AA = Ascorbic acid  
APTI = Air pollution tolerance index.

Table 2: Air pollution tolerance index (APTI) of plant species growing in control site Kuvempu University (premises of Shankarmatha temple).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Plant species</th>
<th>RWC</th>
<th>TCH</th>
<th>pH</th>
<th>AA</th>
<th>APTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Carica papaya</td>
<td>71.09</td>
<td>0.6</td>
<td>6.2</td>
<td>18.9</td>
<td>19.96</td>
</tr>
<tr>
<td>2.</td>
<td>Calotropis gigantea</td>
<td>57.8</td>
<td>0.18</td>
<td>5.7</td>
<td>14.1</td>
<td>14.11</td>
</tr>
<tr>
<td>3.</td>
<td>Eucalyptus mysoresins</td>
<td>75.54</td>
<td>0.13</td>
<td>5.2</td>
<td>28.3</td>
<td>22.63</td>
</tr>
<tr>
<td>4.</td>
<td>Parthenium hysterophorus</td>
<td>77.92</td>
<td>0.38</td>
<td>6.7</td>
<td>4.72</td>
<td>11.13</td>
</tr>
<tr>
<td>5.</td>
<td>Nerium indicum</td>
<td>78.63</td>
<td>0.06</td>
<td>5.8</td>
<td>9.45</td>
<td>13.4</td>
</tr>
<tr>
<td>6.</td>
<td>Polyalthia longifolia</td>
<td>79.59</td>
<td>0.2</td>
<td>5.9</td>
<td>14.8</td>
<td>16.6</td>
</tr>
<tr>
<td>7.</td>
<td>Mangifera indica</td>
<td>53.14</td>
<td>0.15</td>
<td>4.5</td>
<td>33.1</td>
<td>20.7</td>
</tr>
<tr>
<td>8.</td>
<td>Rcinus communis</td>
<td>75.04</td>
<td>0.18</td>
<td>5.7</td>
<td>14.8</td>
<td>15.84</td>
</tr>
<tr>
<td>9.</td>
<td>Psidium guajava</td>
<td>74.32</td>
<td>0.67</td>
<td>4.9</td>
<td>9.45</td>
<td>12.69</td>
</tr>
<tr>
<td>10.</td>
<td>Mutangia calibra</td>
<td>41.88</td>
<td>0.15</td>
<td>5.5</td>
<td>4.72</td>
<td>6.85</td>
</tr>
<tr>
<td>11.</td>
<td>Bougainvillea</td>
<td>65.85</td>
<td>0.06</td>
<td>5.4</td>
<td>4.72</td>
<td>9.16</td>
</tr>
<tr>
<td>12.</td>
<td>Terminalia capata</td>
<td>70.59</td>
<td>0.29</td>
<td>4.2</td>
<td>4.72</td>
<td>9.14</td>
</tr>
<tr>
<td>13.</td>
<td>Azadirachta indica</td>
<td>77.29</td>
<td>0.15</td>
<td>5.6</td>
<td>37.8</td>
<td>29.46</td>
</tr>
<tr>
<td>14.</td>
<td>Tamarindus indica</td>
<td>44.94</td>
<td>0.07</td>
<td>3.2</td>
<td>4.72</td>
<td>6.03</td>
</tr>
</tbody>
</table>

were collected from Kuvempu University (premises of Shankarmatha temple) where there is no disturbance. Similarly plant species were collected randomly from experimental site i.e. Shivamogga. The collected leaf samples were immediately brought to lab in a heatproof container. The leaf fresh weight was taken immediately upon getting to the laboratory and then samples were preserved in refrigerator for further analysis.

Analysis part

Relative Leaf Water Content (RWC)

RWC was determined and calculated with the formula as described by Singh (1977),

$$ RWC = \frac{(FW-DW)}{(TW-DW)} \times 100 $$

Where,

FW = Fresh weight  
TW = Turgid weight  
DW = Dry weight

Fresh weight was obtained by weighing the leaves. The leaf samples were then immersed in water overnight blotted dry and then weighed to get the turgid weight. The leaves were then dried overnight in a hot air oven at 70°C and reweighed to obtain the dry weight.

Total Chlorophyll Content (TCH)

This was carried out according to the method described by Arnon (1949). 3gm of fresh leaves were blended and then extracted with 10ml of 80% acetone and left for 15 min. The liquid portion was decanted into another test tube and centrifuged at 2,500 rpm for 3 min. The supernatant was then collected and the absorbance was then taken at 645 nm and 663 nm using a spectrophotometer. Calculations were done by using the formula given below:

Chlorophyll a = 12.7Dx 663 2.69DX 645 *V/ 1000W mg/gm

Chlorophyll b = 22.9 Dx 645 4.68 DX663*V/ 1000W mg/gm

TCh = Chlorophyll a + b mg/gm

Where,

Dx = Absorbance of the extract at the wavelength Xnm

V = Total volume of the chlorophyll solution (ml)

W = Weight of the tissue extracted (g)

Leaf extract using pH tester

5gm of the fresh leaves was homogenized in 10ml deionised water. This was filtered and the pH of the leaf extract determined after calibrating pH-meter with buffer solution of pH 4 and 9.

Ascorbic acid (AA) content

Ascorbic acid contents were determined by the method of Aberg (1958) and Sadasivam and Manickam (1997).
5ml of the working standard solution was pipette out in to a 100 ml conical flask and 10 ml of 4% oxalic acid was added and titrated against the dye (V₅ ml). End point is the appearance of pink color which persists for a few minutes. The amount of the dye consumed is equivalent to the amount of ascorbic acid.

After extracting the sample (0.5-5gm depending on the sample) in 4% oxalic acid, the volume was made up to a known volume and centrifuged. 5ml of this supernatant was taken in the conical flask and 10 ml of 4% oxalic acid was added and titrated against the dye (V₅ ml).

Amount of ascorbic acid mg/100 gm sample was calculated by,

Ascorbic acid = \[0.5 \text{ mg/V₅ ml} \times V₂/5 \text{ ml} \times 100 \text{ ml/wt. of sample}] \times 100

**Calculation of APTI**

The air pollution tolerance indices of fourteen common plants were determined by following the method of Singh and Rao (1983). The formula of APTI is given as:

\[\text{APTI} = \frac{A \times (T + P) + R}{10}\]

Where,
- \(A\) = Ascorbic acid content (mg/gm)
- \(T\) = Total chlorophyll (mg/gm)
- \(P\) = pH of the leaf extract
- \(R\) = Relative water content of leaf (%)

**Results and Discussion**

The roadside plants in Shivamogga city are continuously exposed to different pollutants which are released in to the environment as a consequence of incomplete combustion in the automobile engines and also
dust particles from the construction work which going to accumulate on the plant leaves. An overview of the results obtained from this study reveals that different plants responded differently to air pollutants (figs. 1 & 2) the variation of the APTI can be attributed to the variation in any of the four physiological factors which governs the computation of the index. The four physiological factors gave conflict result just as reported by Han et al. (1995). A more conclusion deduction can however drawn from the APTI values in experimental area. The results also revealed that fourteen plant species studied Azadirachta indica is most tolerant species in both the experimental and control site. Nrusimha et al. (2005) have studied the APTI of many plant species and established the maximum APTI value for Azadirachta indica and minimum Pongamia glabra the similar kind of observation has also been recorded by Jissy and Jaya (2010) while working on six different plant species, Polyalthia longifolia expressed highest APTI values and proved to tolerant verity and others are sensitive species to air pollutants. The order of the tolerance of our study is as follows Azadirachta indica < Mangifera indica <Camellia sinensis< Carica papaya< Ricinus communis< Polyalthia longifolia< Calotropis gigantea< Nerium indicum< Psidium guajava< Parthenium hysterophorus< Bougainvillea< Muntingia calabura< Terminalia cattapa< Tamarindus indica. In experimental area where in control site the highest APTI found in Azadirachta indica and lowest in Tamarindus indica.

Conclusion

In conclusion APTI determines are of importance because with increase industrialization, there is increasing danger of deforestation due to air pollution. The results of such studies are therefore handy for future planning. And this study is useful for the better understanding and management of air quality as well as in selection of suitable plant species with high APTI for plantation in industrial areas as well as on roadside and this may become one of the strategy for the abatement of cities air pollution. However, this study is considered only commonly growing plants species in Shivamogga city of Karnataka State. Further studies on APTI of various plants in respect to different seasons of Shivamogga city are required to find out.

Acknowledgement

Our sincere thanks to Mr. Suresh and Vinayak, Department of Botany, Kuvempu University, Shankarghatta, Karnataka State for kind co-operation during this work.

References


Singh, S. N. and D. N. Rao (1983). Evaluation of plants for their tolerance to air pollution. In proceedings of Symposium on Air pollution control Vol-1. Indian Association for Air Pollution Control, New Delhi. 218-224.
AIR QUALITY STATUS IN SHIVAMOGGA CITY, INDIA

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Shankarghatta - 577 451, Shivamogga District, Karnataka.
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ABSTRACT

Shivamogga lies in the lap of the Western Ghats and the city is the heartland of Karnataka state. The growing number of vehicles, small scale industries, demolition of buildings for widening the roads, construction of flyovers and diversions coupled with a burgeoning population has significantly raised the air pollution levels. Five different stations in the city were selected for the study and air quality was determined by analyzing the SPM (Suspended Particulate Matter), SO\textsubscript{2} (Sulphur Dioxide), and NO\textsubscript{x} (Oxides of Nitrogen). The study revealed that SPM and NO\textsubscript{x} concentrations exceeded ambient air quality standards of Central Pollution Control Board (CPCB) whereas SO\textsubscript{2} concentration was relatively lower.

KEYWORDS
SPM, SO\textsubscript{2}, NO\textsubscript{x}
Vehicle emissions
Traffic congestion

INTRODUCTION

Air pollution has become a growing problem in cities throughout the globe, and transportation is recognized as the major source of air pollution in many cities. In developing countries the air quality crises in cities is often due to vehicular emission. Because of the transportation sector emissions of CO, O\textsubscript{3}, toxicants and particulates (Davis, 1998) the public health implications (Anon, 1997; Utell et al., 1998) are substantial. Development of urban areas has been reflected in terms of automobile traffic and Industries in the city have substantially increased the level of air contaminant. As per rough estimates 300 vehicles are being registered every day in Mumbai. The other cities of India are also not far behind this myth. It has been found that the vehicular exhaust accounts for more than 50% of the total pollution from all the sources put together in all the major cities in India (Mathur, 1992). Currently, in India, air pollution is widespread in urban areas where vehicles are the major contributors except in a few other areas with a high concentration of industries and thermal power plants (State of the environment, MoEF, 2005, India). Rapid urbanization and modernization has led to an unprecedented increase in the number of vehicles in the city. Although being densely populated and urbanized, no systematic study on ambient air quality of Shivamogga is found in literature. An effort has been made to evaluate the level of air pollutants in Shivamogga city.

Study area

Shivamogga city (13°55'18" NL, 75°34'12" EL) is heartland of Karnataka state, located at the banks of river Tunga. According to the Shivamogga City Municipal Corporation, the city has a total area of about 50 km\textsuperscript{2} (19.31 square miles). The city is having population about 4,74,105 (as per 2007). Climate of Shivamogga is tropical wet and dry (as per Koppen Climate Classification). This means that the winter and the early part of summer are typically dry periods. Majority of the rainfall occurs between June and early October. Shivamogga is a part of a region vernacularly known as Malnad (land of hills) in Karnataka. Most of these hills are part of Western Ghat, a region famous for plentiful rainfall and lush greenery. The major highways NH-13, NH-206 and other State High ways passes within the city. The heavy traffic on these highways has also been significantly contributed to air pollution in the city. Apart from this the city has no effective mean of mass transport system. Therefore there is tremendous increase in number of two wheelers during the last five years. The two wheelers and three wheelers are the only means of main transportation system in the city.

MATERIALS AND METHODS

Ambient air quality was monitored for major air pollutants viz Suspended Particulate Matter (SPM), Sulphur dioxide (SO\textsubscript{2}) and Oxides of Nitrogen (NO\textsubscript{x}). High volume sampler (Envirotech APM-410-411) was used for sampling of gaseous and particulate pollutants. West and Gaekke method was used to estimate the SO\textsubscript{2} present in air. Griess - Saltzman method was used to estimate NO\textsubscript{x} content in air.
SPM was collected on pre-weighed glass fiber filter (Whatman). Filter paper was again weighed after sampling and the difference in weight were used to calculate concentrations of SPM in respective areas and expressed as \( \mu g/m^3 \) of air. The monitoring was done for 24 hrs a day from February 2009 to August 2009. Five sampling stations were selected to represent 5 different traffic volumes and activities. The sampling stations are MRS, Gandhi Bazaar, A.A. Circle, Bus Stand, Mandli. At each of these places monitoring was done for 3 consecutive days to get the average concentration of pollutants. A questionnaire was prepared and survey was conducted particularly in case of suspected allergic population by inquiring the recurrence of the type of allergic symptoms. The occasions of this onset was recorded with each individual to assess the allergic status Table 2.

### RESULTS AND DISCUSSION

The present study reveals that the concentration of SPM varied from 834.65 - 1386 \( \mu g/m^3 \). SPM concentration exceeded the limits prescribed by CPCB in all five sampling areas. The average \( \text{SO}_2 \) concentration varied from a minimum of 12.10 \( \mu g/m^3 \) to 19.24 \( \mu g/m^3 \) at Mandli and Bus Stand area respectively. The \( \text{NOx} \) concentration varied from a minimum of 54.23 to 93.2 \( \mu g/m^3 \), the highest concentration was recorded in Bus Stand area and minimum at MRS. Both SPM and \( \text{NOx} \) concentrations exceeded ambient air quality standards of Central Pollution Control Board (CPCB) at MRS. High traffic volume in this region is major reason for these high values. But \( \text{SO}_2 \) is well within the standards of CPCB. At Gandhi Bazaar area, both SPM and \( \text{NOx} \) concentrations exceeded the standards of CPCB. High vehicular density in this sampling station is the major reason for these high values of both SPM and \( \text{NOx} \), whereas concentrations of \( \text{SO}_2 \) within the prescribed limits. At A. A. Circle SPM and \( \text{NOx} \) concentration exceeded the standards, whereas \( \text{SO}_2 \) were within the limits prescribed by CPCB. The high levels of SPM and \( \text{NOx} \) were due to slow movement of large number of vehicles. As vehicles move slowly, they emit more smoke. The existing poor road conditions might have been increased the emissions from automobiles. While at Bus stand area the concentration of SPM and \( \text{NOx} \) are exceeded the standards of CPCB. High vehicular density in this sampling stations is the major reasons for these high values of both SPM and \( \text{NOx} \) where as concentration of \( \text{SO}_2 \) within prescribed limits. At Mandli area only the concentration of SPM is high where as \( \text{NOx} \) and \( \text{SO}_2 \) is less below the prescribed ambient air quality standards of CPCB, the main reason for the such values might be the wide roads and fast movements of vehicles in this area the concentration of SPM is high because of small scale industries. The problem of high SPM can be overcome by adapting advance ecofriendly transport systems, usage of biofuels and Mass urban transport may be helpful to minimise the vehicular emission load. Study also revealed that Exposure to indoor and outdoor air quality is different because they always change with time and diurnal pattern (TERI, 1995). Exposure to SPM is also an equally serious risk to health SPM includes all air-borne particles in the size range of 0.5\( \mu \) to 100\( \mu \). The data generated from the survey were analysed to assess the allergic population and the suspected allergy causing agents. The results are shown in Table 2.

### ACKNOWLEDGEMENT

We authors would like to thanks all the staff members of Department of Environmental Science, for providing facilities to carry out this work.

### REFERENCES


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### Table 1: Average concentration of SPM, \( \text{SO}_2 \), and \( \text{NOx} \) (\( \mu g/m^3 \)) at five different sampling stations from February 2009 to August 2009.

<table>
<thead>
<tr>
<th>Sampling Areas</th>
<th>SPM</th>
<th>( \text{SO}_2 )</th>
<th>( \text{NOx} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRS</td>
<td>1051.4</td>
<td>16.00</td>
<td>54.23</td>
</tr>
<tr>
<td>Gandhi Bazar</td>
<td>834.65</td>
<td>13.32</td>
<td>59.4</td>
</tr>
<tr>
<td>Aamir Aheamad Circle</td>
<td>1210.2</td>
<td>17.23</td>
<td>74.3</td>
</tr>
<tr>
<td>Bus Stand</td>
<td>1386</td>
<td>19.24</td>
<td>93.2</td>
</tr>
<tr>
<td>Mandli</td>
<td>742.4</td>
<td>12.10</td>
<td>20.2</td>
</tr>
</tbody>
</table>

### Table 2: Diseases due to ambient air in the city

<table>
<thead>
<tr>
<th>Name of the disease</th>
<th>Total no of cases</th>
<th>Total no of persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Sneezing</td>
<td>29</td>
<td>19</td>
</tr>
<tr>
<td>Allergy</td>
<td>25</td>
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</tr>
<tr>
<td>Hyperacidity</td>
<td>21</td>
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</table>
A Study on Estimation of APTI in Some Selected Plants in Shivamogga, Karnataka, India

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ABSTRACT

The plant foliar surface is the most important receptor of atmospheric pollutants. It undergoes several structural and functional changes when particulate-laden air strikes it. The study examined air pollution tolerance indices (APTI) of nine plant species around the Shivamogga city of Karnataka State India. Four physiological and biochemical parameters, leaf relative water content (RWC), ascorbic acid content (AA), total leaf chlorophyll (TCh) and leaf extract pH were used to compute the APTI values. The result showed that combining variety of these parameters gave a more reliable result than those of individual parameter.

Key Words: ambient air quality, air pollution tolerance indices (APTI), ascorbic acid (AA), total leaf chlorophyll (TCh),

INTRODUCTION

The atmosphere is a complex, dynamic natural gaseous system that is essential to all living things. Air pollution may be broadly defined as the presence of one or more contaminants like dust, smoke, mist and odour to the atmosphere which are injurious to human beings, plants, and animals or which unreasonably interfere with the comfortable enjoyment of life or property. It may be described as "The imbalance in quality of air so as to cause adverse effect on the living organism existing on the earth. Air pollutants can directly affect plants via leaves or indirectly via soil acidification (Steubing et al., 1989). It has also been reported that when exposed to air pollutants, most plant experience physiological changes before exhibiting visible damage to leaves (Dohmen et al., 1990). Previous studies also showed the impact of air pollution on ascorbic acid content (Haque et al., 2007), chlorophyll content (Flowers et al., 2007), leaf extract pH (Klumpp et al., 2000), and relative water content (Rao, 1979). These separate parameters gave conflicting results for same species (Han et al., 1995). However, the air pollution tolerance index (APTI) based on all four parameters has been used for identifying tolerance levels of plants species (Singh and Rao, 1993; Singh et al., 1991). Several contributors agree that air pollutants effect plant growth adversely (Rao, 2006; Bhatia 2006; Sodhi, 2005; Henry and Heinke, 2005; Horsfall, 1998). Air pollution tolerance index is used by landscapers to select plant species tolerance to air pollution (Yan-Ju, 2007). The objective of this study is to determine the APTI values of different plant species within Shivamogga city of Karnataka State, India.

MATERIALS AND METHODS

Study area

As Shivamogga Figure 1A,1B. It is situated in the picturesque Malnad region, literally on the Lap of the Sahyadri Western Ghats Karnataka State of India. The geographical location of the city is 13°55'18" N, 75°34'12" E. Its height is 584 m above MSL (Mean Sea Level) survey was done for the selection of site by analyzing the traffic volumes and ambient air monitoring. Plants are randomly selected from the premises of city. This is designated as experimental site (ES) leaf samples of the various plants were then collected. Three replicates of fully matured leaves were taken and immediately taken to the laboratory for analysis. A site nearby with similar ecological conditions was selected as the control site (CS). The plants used for the study were those available in the experiment site. The leaf fresh weight was...
taken immediately upon getting to the laboratory. Samples were preserved in a refrigerator for other analyses.

Relative leaf water content (RWC)
Following the method described by Singh (1977), leaf RWC was determined and calculated with the formula: 

$$RWC = \frac{(FW - DW)}{(TW - DW)} \times 100$$

where FW = Fresh weight, DW = dry weight, and TW = turgid weight. Fresh weight was obtained by weighing the fresh leaves. The leaves were then immersed in water overnight, blotted dry and then weighed to get the turgid weight. Next, the leaves were dried overnight in an oven at 70°C and reweighed to obtain the dry weight.

Total chlorophyll content (TCH)
This was done according to the method described by Arnon (1949). 3 g of fresh leaves were blended and then extracted with 10 ml of 80% acetone and left for 15 min. The liquid portion was decanted into another test-tube and centrifuged at 2,500 rpm for 3 min. The supernatant was then collected and the absorbance was then taken at 645 nm and 663 nm using a spectrophotometer. Calculations were made using the formula below:

Chlorophyll a = 12.7DX663 - 2.69DX645 x V/1000W mg/g
Chlorophyll b = 22.9DX645 - 4.68DX663 x V/1000W mg/g

$$TCh = \text{chlorophyll a + b mg/Dx} = \text{Absorbance of the extract at the wavelength Xnm, V = total volume of the chlorophyll solution (ml), and W = weight of the tissue extract (g).}$$

Leaf extract pH
5 g of the fresh leaves was homogenized in 10 ml deionised water. This was then filtered and the pH of leaf extracted determined after calibrating pH meter with buffer solution of pH 4 and pH 9.

Ascorbic acid (AA) content analysis
Ascorbic acid content (expressed as mg/g) was measured using spectrophotometric method (Bajaj and Kaur, 1981). 1 g of the sample was measured into a test-tube, 4ml oxalic acid - EDTA extracting solution was added. Then 1 ml of orthophosphoric acid followed by 1 ml 5% tetraoxosulphate (vi) acid. To this 2 ml ammonium molybate was added and then 3 ml of water. The solution was then allowed to stand for 15 min, after which the absorbance at 760 nm was measured with a spectrophotometer. The concentration of ascorbic acid in the samples was then extrapolated from a standard ascorbic acid curve.

APTI determination
The air pollution tolerance indices of ten common plants were determined following the method of Singh and Rao, 1993. The formula of APTI is given as 

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

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

RESULT AND DISCUSSION
From the result obtained from this study reveals that different plants responded differently to air pollutants. The variation of the APTI can be attributed to the variation in any of the four physiological factors which governs the computation of the index. The four physiological factors gave conflicting result just as reported by Han et al. (1995). A more conclusion deduction can however be drawn from the APTI values. The result also revealed that of the ten species studied APTI is observed in Neem 18.32 The experimental valley and control is about 14.99 Table land fallowed by Bougainvillea, Narium, Vinca robia, Banyan, Musa paradissiace, Psidium guajava, Ashoka, Mangifera indica.

CONCLUSION
From the result it is concluded that neem plant are most tolerant species for the air pollution fallowed by the bougainilla. The air pollution tolerance index determination is improtent because with the the increase in vehicular movements and rapidly increasing in small scalce industries around the city.

ACKNOWLEDGEMENT
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Adamsab et al.,

glutathione cycle enzymes activities, and praline improves salt tolerance more than glycinebetaine in tobacco bright yellow -2 suspension – cultured cells. J.plant physiol. 164: 1457 – 1468.


Figure 1A: Shown India Political Map- Arrow Mark highlight light green- Karnataka


Adamsab et al.,
Table 1: Air pollution tolerance index (APTI) of some plant species around the Shivamogga city of Karnataka State

<table>
<thead>
<tr>
<th>S.No</th>
<th>Species Name</th>
<th>Site</th>
<th>TCh</th>
<th>AA</th>
<th>RWC</th>
<th>pH</th>
<th>APTI</th>
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<tbody>
<tr>
<td>1</td>
<td><em>Musa paradissiace</em></td>
<td>Experimental</td>
<td>69.21</td>
<td>1.123</td>
<td>85.1</td>
<td>7.43</td>
<td>17.11</td>
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<td></td>
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<td>Control</td>
<td>66.42</td>
<td>1.170</td>
<td>78.8</td>
<td>5.45</td>
<td>16.28</td>
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<tr>
<td>2</td>
<td><em>Psidium guajava</em></td>
<td>Experimental</td>
<td>70.52</td>
<td>1.171</td>
<td>79.4</td>
<td>5.75</td>
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<td>Control</td>
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<td>71.4</td>
<td>5.75</td>
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<td>46.3</td>
<td>6.9</td>
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<td>1.212</td>
<td>45.7</td>
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<td>13.23</td>
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<td>4</td>
<td><em>Banyan</em></td>
<td>Experimental</td>
<td>70.93</td>
<td>1.230</td>
<td>74.3</td>
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<td>17.57</td>
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<td>Control</td>
<td>63.2</td>
<td>1.140</td>
<td>74.0</td>
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<td>11.79</td>
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<td>74.3</td>
<td>5.60</td>
<td>16.76</td>
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<td>Control</td>
<td>63.2</td>
<td>1.140</td>
<td>74.0</td>
<td>5.40</td>
<td>15.25</td>
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<td>6</td>
<td><em>Vinca rosia</em></td>
<td>Experimental</td>
<td>71.01</td>
<td>1.151</td>
<td>88.0</td>
<td>5.50</td>
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<td>78.9</td>
<td>6.83</td>
<td>15.44</td>
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<td>83.5</td>
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<td><em>Bougainvillea</em></td>
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<td>1.257</td>
<td>65.2</td>
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