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Study of air pollution tolerance Index of plants growing in Pithampur Industrial area sector 1, 2 and 3

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Abstract

Clean air, pure water and nutritious food are basic amenities of life but the quality of air, water and land is deteriorating continuously. Industrial air pollution is more complex than most other environmental challenges. No physical or chemical method is known to ameliorate industrial air pollutation. A suitable alternative way is to grow green plants in and around industries.). Air pollution tolerance level differs from plant to plant. Response of plants towards air pollution was assessed by air pollution tolerance Index (APTI value. We studied air pollution tolerance Index (APTI value) of six plant species i.e Azadirechata indica (Neem) ,Calotropis gigantea, (Aak), Dalbergia sissoo (Shishum), Euginia jambolana(Jamun),Mangifera indica(Aam) and Nerium indicum (Kaner) growing in Pithampur Industrial area sector 1, 2 and 3. The highest APTI was observed in C. gigantea (19.3842) ans lowest in A. indica (7.8796). The highest reduction in APTI was noted in Industrial area sector-3, indicating highest air pollution in that area.

Keywords: Industrial air pollution, Air pollution tolerance index, Pithampur Industrial area.

Introduction

Air pollution is more complex than most other environmental challenges. No physical or chemical method is known to ameliorate air pollution. A suitable alternative is to develop a biological method by growing green plants in and around industrial and urban areas[1,2].

All combustion release gases and particles in to the air which includes Sulphur, NO_x, CO, and soot particle as well as smaller quantities of toxic metals, organic molecules and radioactive isotopes[3]. Industrialization is a major cause of pollution[4]. Plants provide an enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollutants level in the environment, with a various extent[5].

They act as the scavengers for many air borne particulates in the atmosphere[6]. Plants sensitivity and tolerance to air pollutants varies with change in Leaf extract pH, Relative water contents (RWC), ascorbic acid (AA) content and Total Chlorophyll content. Study of single parameter may not provide a clear picture of the pollution induced changes; so air pollution tolerance index (APTI) which was based on these parameters has been used to know tolerance levels of plant species[5,7]. In the present study APTI of six plants i.e. *A. indica.* (Neem), C. *gigantea*. (Aak), *D. sissoo. (*Shishum), *E. Jambolana*.(Jamun), *M. indica* (Aam), *N. indicum*. (Kaner) were calculated.

Material and Methods

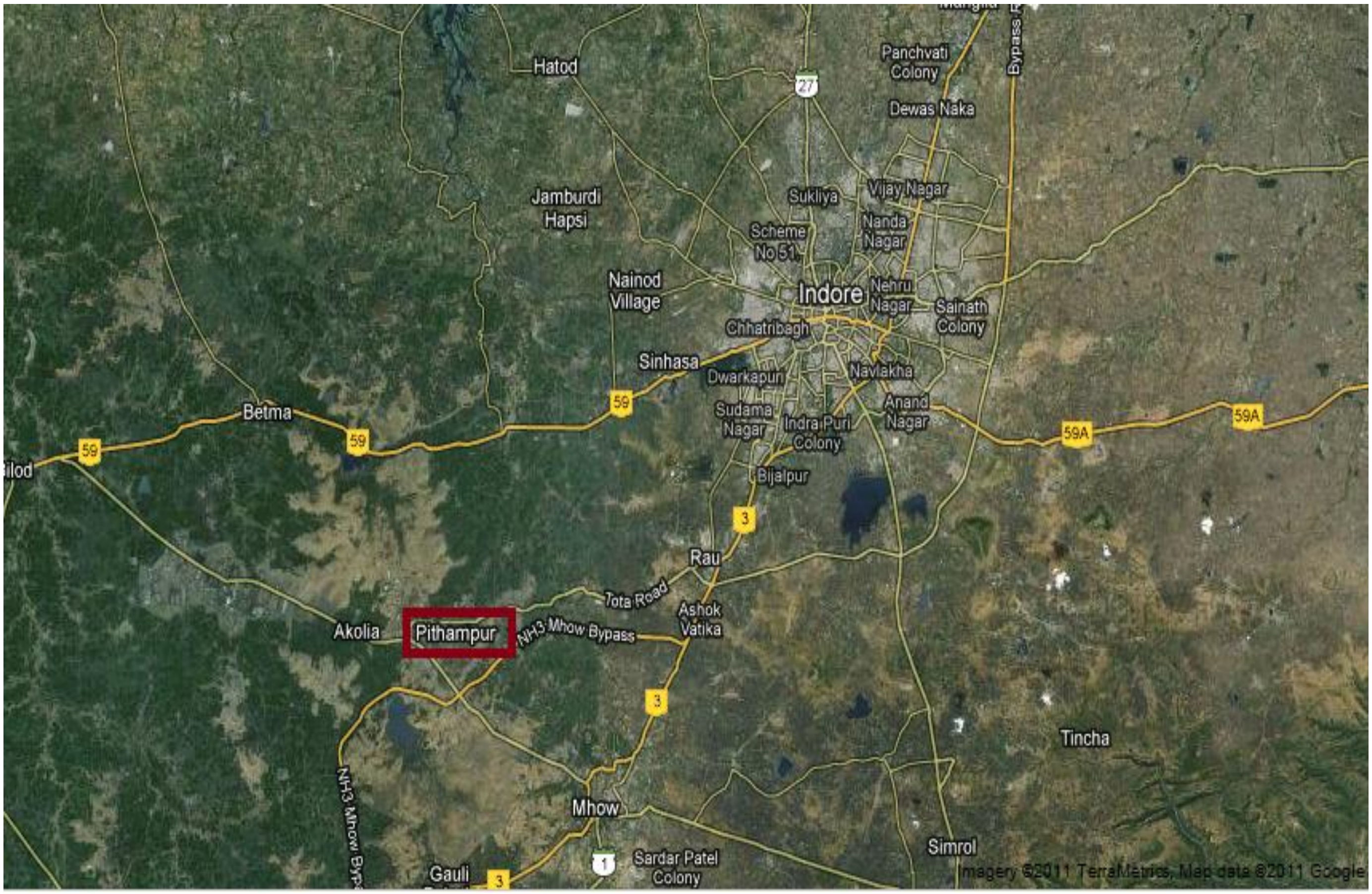
Leaves were collected in triplicate for analysis from Pithampur industrial area sector 1, 2 and 3 and for control leaves were collected from Pattharmundla Gaon which is situated far away from the industries.

Area: Pithampur is located at a latitude 22˚ 37’27” N and longitude 75˚ and 34’58” E at the east central border of Dhar District in M.P. about 45 km from Indore altitude is about 550 meter above mean sea level. Pithampur is located about 16 km away from NH-3. Site plan of studied Pithampur industrial area sector 1, 2 and 3

Plants: Plant species studied were Azadirechata indica, (Neem), Calotropis gigantea (Aak), Dalbergia sissoo (Shishum), Euginia Jambolana (Jamun), Mangifera indica (Aam) and Nerium indicum (Kaner).

Sample collection: Samples were collected in early morning and brought to laboratory in polythene bag kept in ice box to nullify the adverse effect of high light intensity and temperature. The leaves were carried out from a height of 01 to 02 meter from the ground level.

Procedure: Photosynthetic pigment: - The leaves were washed with distilled water and cut into small pieces. 100 mg each fresh leaves were taken for analysis. The samples were crushed with 5ml of 80% acetone in a glass pestle with a pinch of washed sand. The crushed samples along with



washings were collected and sediment was washed with 2ml of 80% acetone and again centrifuged for 3 minutes. The final volume of supernatant was made up to 10ml by adding 80% acetone for analysis. The samples were analyzed with the help of visible spectrophotometer. Absorbance was read in 645 to 663 nm for chlorophyll, 480 and 510 nm for carotenoids.

The concentration of chlorophyll and carotenoid were calculated with the help of absorption coefficient of Arnon [8]. Following formulae are used: Photosynthetic pigment mg/gm of leaves = Chl.a + Chl.b+ Carotenoid

Chl.a (mg/gm) = 22.7× OD 663-2.69 ×OD 645
Chl.b (mg/gm) =12.9× OD 645-4.68 ×OD 663
Carotenoied (mg/gm) =7.6 × OD 480 – 1.49 × OD 510

Relative water content (RWC): RWC= [FW-DW)/ (TW-DW)] x100 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 over night, blotted dry and weighed to get turgid weight. Now the leaves were dried over in an oven at 70 ˚C and reweighed to obtain the dry weight [9].

Leaf extract pH: 5 grams of the leaves were homogenized in 50 ml deionized water, and then filtered and the pH of filtered leaf extract was determined by using pH meter.

Ascorbic acid content (AA): Ascorbic acid content was measured by using spectrophotometric method. 1 g of the fresh foliage was put in a test-tube, 4 ml oxalic acid - EDTA extracting solution was added, then 1 ml of orthophosphoric acid and then 1 ml 5% tetraoxosulphonic(VI) acid added to this mixture, 2 ml of ammonium molybdate was added and then 3 ml of water. The solution was then allowed to stand for 15 minutes. Then the absorbance was measured at 760nm with a spectrophotometer[10].

APTI**:** APTI calculated as:
APTI = [AA (T + P) + R] / 10

Where R stands for is relative water content in mg/g AA stands for the ascorbic acid in mg/g T stands for the total chlorophyll in mg/g P stands for pH of leaf sample On the basis of APTI values plants were categorized into three groups[11].

i) Sensitive species <10 ii) Intermediate species among10-16 iii) Tolerant species >17

Table-1
Showing Relative water content of studied plants
(Control vs Pithampur Industrial Area sector – 1, 2 and 3)

S.No.	Name of Plants	Relative water content (mg/gm)			
		Control	Sector-1	Sector-2	Sector-3
1	*A. indica.* (Neem)	78.8732	48.9795	50.0000	42.1875
2	*C. gigantea*.(Aak)	80.6666	99.1329	98.8439	98.8338
3	*D. sissoo.(*Shishum)	71.6535	72.7272	71.0937	60.0000
4	*E.Jambolana*.(Jamun)	83.4254	80.6451	77.7777	71.6777
5	*M. indica.* (Aam)	58.5714	59.7866	60.0000	58.6923
6	*N. indicum*. (Kaner)	64.0449	66.6666	67.4418	65.8823

Table- 2
Showing pH of studied plants
(Control vs Pithampur Industrial Area Sector -1, 2 and 3)

S.No.	Name of Plants	Leaves Extract PH			
		Control	Sector-1	Sector-2	Sector-3
1	*A. indica.* (Neem)	5.05	5.03	5.04	5.02
2	*C. gigantea*.(Aak)	7.41	7.40	7.39	7.39
3	*D. sissoo.(*Shishum)	5.27	5.25	5.23	5.20
4	*E.Jambolana*.(Jamun)	5.00	4.98	4.92	4.89
5	*M. indica* (Aam)	5.12	5.11	5.08	5.06
6	*N. indicum*. (Kaner)	4.95	4.85	4.83	4.08

Table-3
Total Photosynthetic Pigment of studied plants and % reduction
(Control vs Pithampur Industrial area Sector 1, 2 and 3)

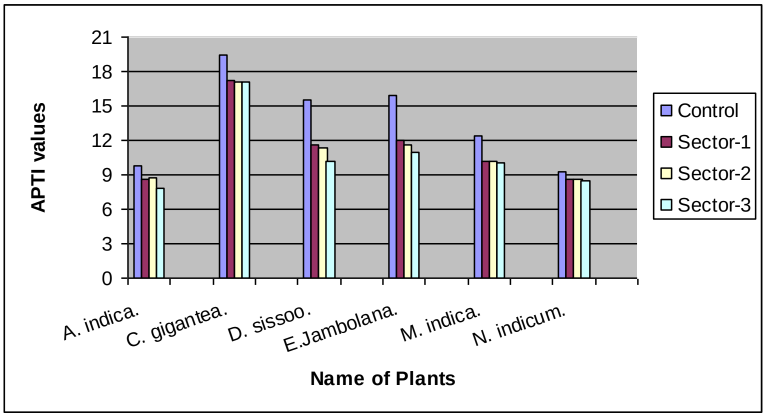
S. No.	Name of Plants	Total Photosynthetic Pigment (mg/gm)			
		Control	Sector-1	Sector-2	Sector-3
1	*A. indica.* (Neem)	7.15+0.03	0.55±0.04	0.51±0.04	0.51±0.20
2	*C. gigantea*.(Aak)	5.75±0.01	1.09±0.07	1.06±0.08	0.99±0.07
3	*D. sissoo.(*Shishum)	7.18±0.03	1.14±0.18	1.15±0.18	1.07±0.16
4	*E.Jambolana*.(Jamun)	6.17±0.02	0.89±0.13	0.84±0.11	0.79±0.10
5	*M. indica.* (Aam)	4.52±0.02	1.14±0.22	1.12±0.0.23	1.11±0.26
6	*N. indicum*. (Kaner)	3.06±0.01	0.72±0.06	0.67±0.06	0.65±0.05

Table-4
Showing Ascorbic acid content of studied plant
(Control vs Pithampur Industrial Area sector -1, 2 and 3)

S.No.	Name of Plants	Ascorbic Acid Content(mg/gm)			
		Control	Sector-1	Sector-2	Sector-3
1	*A. indica.* (Neem)	6.67 ± 0.02	6.65 ± 0.01	6.63 ± 0.20	6.62 ± 0.02
2	*C. gigantea*.(Aak)	8.60 ± 0.06	8.58 ± 0.01	8.51 ± 0.01	8.56 ± 0.02
3	*D. sissoo.(*Shishum)	6.73 ± 0.15	6.72 ± 0.01	6.71 ± 0.01	6.70 ± 0.00
4	*E.Jambolana*.(Jamun)	6.77 ± 0.02	6.73 ± 0.01	6.72 ± 0.01	6.70 ± 0.00
5	*M. indica* (Aam)	6.82 ± 0.04	6.80 ± 0.00	6.79 ± 0.01	6.76 ± 0.01
6	*N. indicum*. (Kaner)	3.57 ± 0.03	3.50 ± 0.00	3.48 ± 0.01	3.45 ± 0.01

Table-5
Air pollution tolerance index (APTI) of studied plants
(Control vs Pithampur Industrial Area sector -1, 2 and 3)

S.No.	Name of Plants	Air pollution tolerance index			
		Control	Sector-1	Sector-2	Sector-3
1	*A. indica.* (Neem)	9.7743	8.6086 (11.92%)	8.6796 (11.19 %)	7.8796 (19.38 %)
2	*C. gigantea*.(Aak)	19.3842	17.1548 (11.50%)	17.1260 (11.66 %)	17.0566 (12.02%)
3	*D. sissoo.*(Shishum)	15.5442	11.5668 (25.61 %)	11.3903 (26.70 %)	10.2009 (34.26 %)
4	*E.Jambolana*.(Jamun)	15.9046	12.0150 (24.46 %)	11.6484 (26.79 %)	11.0188 (30.75 %)
5	*M. indica* (Aam)	12.4316	10.2286 (17.77 %)	10.2098 (17.94 %)	10.0401 (19.22 %)
6	*N. indicum*. (Kaner)	9.2640	8.6161 (7.01 %)	8.6477 (6.69 %)	8.4684 (8.63%)



Graph
Showing comparison of air pollution tolerance Index of studied plants
(Control vs Pithampur Industrial. area Sector 1, 2 and 3)

Results and Discussion

Total photosynthetic pigment: There are so many factors controlling tolerance in plants. .Plants with lower pH are more susceptible, while those with pH around 7 are more tolerant[7]. Total chlorophyll (TCH) is related to Ascorbic Acid productivity and Ascorbic acid is concentrated mainly in chloroplast. Photosynthetic efficiency was strongly dependent on leaf pH. Photosynthetic rate was reduced in plants at low leaf pH. A considerable loss in total chlorophyll in the leaves of plants exposed to air pollution stress supports the argument that the chloroplast is the primary site of attack by air pollutants[12]. The plants having Chlorophyll content between 4 to 16 mg/gm are categorized as intermediately tolerant plant species[13]. Thus, all plant species undertaken for study were intermediately tolerant plants species against pollution load and dust particulates.

Ascorbic acid (AA): It is a strong reducer and plays important role in photosynthesis (carbon-dioxide fixation). Its reducing power is directly proportional to its concentration. High pH may increase the efficiency of conversion of hexose sugar to ascorbic acid and it is related to the tolerance to pollution[5,14]. Production of reactive oxygen species (ROS) such as SO_3^{-2}, HSO_3,$^{-2}$ OH^- and O_2^- during photo-oxidation of SO_3^{-2} to SO_4^{-2} where sulphites are generated from SO_2 absorbed. The free radical production under SO_2 exposure would increase the free radical scavengers, such as ascorbic acid, super oxide dismutase (SOD), and peroxidase based on dosage and physiological status of plant. The increase level of ascorbic acid reported may be due to the defense mechanism of the respective plants[12,15]. The ascorbic acid content ranged between 7.52 to 11.05 mg in intermediately tolerant species and 1.61 to 8.23 mg/gm among the sensitive plant species[13]. In the present study the ascorbic acid content of all the plant species varies from 3.45 to 8.60mg/gm

Change in leaf extract pH: All the samples collected from polluted site exhibited change in pH of leaf sap towards acidic side, which may be due to the presence of SO_2 and NOx in the ambient air[16]. The change in leaf extract pH might influence the stomatal sensitivity due to air pollution. The plants with high sensitivity to SO_2 and NOx closed the stomata faster when they are exposed to the pollutants[17]. The pH ranged between 4.4 and 8.8 lies in both intermediately tolerant and sensitive plant species[13].

Change in relative water content (RWC): RWC of a leaf is the water present in it relative to its full turgidity. Water is crucial prerequisite for plant life.7 High water content within a plant body will help to maintain its physiological balance under stress condition such as exposure to air pollution when the transpiration rates are usually high. High RWC favor drought resistance in plants. Due to the air pollution there is reduction in transpiration rate and damage to the leaf engine that pulls water up from the roots. (1-2% of the total) consequently the plants neither bring minerals nor cool the leaf. Reduction in relative water content of plant species is due to impact of pollutants on transpiration rate in leaves[16]. According to Lakshmi *et .al.,* (2009), RWC ranged between 58% to73% in intermediately tolerant species and 51.3% to 84% in sensitive plant species and thus, in the present study some plant species are intermediately tolerant species. Plants with high relative water content under polluted condition may be tolerant to pollutants. The present study results support the findings of 18[, 19, 20, and 21].

Air Pollution Tolerance Index (APTI value): In this study it was found that *C.gigantea* exhibited the highest APTI value at all the sectors and our study results of air pollution tolerance index was supported by [22]. In the present study APTI value was found to be less than 10 for two plants i.e of A. *indica* and *N. indicum*. The highest reduction in APTI was observed in *D. sissoo* (34.26 %) in sector- 3 and lowest reduction was observed in *N. indicum* (6.69 %) in sector- 2.

Conclusion

The present study suggests that plantation of *C .gigantea*. (Aak), *D. sissoo. (*Shishum), *E .Jambolana*. (Jamun), *M. indica* (Aam) is useful for biomonitoring , the development of green belts as well as to reduce industrial air pollution.

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