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THE EFFECT OF AIR POLLUTION ON SOME BIOCHEMICAL FACTORS OF SOME PLANT SPECIES GROWING IN HYDERABAD

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ABSTRACT

In the current research the Air Pollution Tolerance Index (APTI) of Nineteen plant species is found among which four plants are herbs, five are shrubs and remaining are trees. All these plants are growing in highly polluted areas of Hyderabad .The physiological and biochemical parameters ,which are relative to leaf's water content(RWC) ,ascorbic acid content (AA),total leaf chlorophyll(TCH) and leaf extract PH were used to compute the APTI values.On the basis of APTI values, *Acalypha indica ,Euphorbia hirta,* among herbs, *Ricinus communis, Gossypium herbaceum* among shrubs*, Azadiricta indica, Ficus bengalensis* showed tolerance*,* these plants serve as suitable sinks to survive the air pollution and the other plant species *Vinca rosea,Calotropis gigantea, Pithecalobium dulce* act as bio-indicators of air pollution stress as these are intolerant to the air pollution.

KEYWORDS: **Air Pollution Tolerance Index, Industrial Air Pollution,Hyderabad,Chlorophyll Content , Ascorbic Acid and Relative Humidity**

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INTRODUCTION

Plants are the breathing centres of earths respiratory system, which continue to supply unlimited amounts of oxygen .Because of urbanisation and motorisation of human lives our major life source viz,plants are adversely affected .Finding out the APTI values in plants is one of the best and most reliable diagnostic tool to monitor plant's tolerance towards air pollution. The results of these studies showed that the plants with higher APTI values were found to be resistant to air pollution. The rapid rate of urbanization with increased economic activities had encouraged migration and industries in Hyderabad, these changes led to an increase of air pollution.[1]The city is among the 16 most polluted cities of India, transportation vehicles are the main source of air pollution in the city. Every year there are around 1 million vehicle registrations in the city that increase air and sound pollution. Air pollution is a growing problem in Hyderabad due to high rates of growth of motorized transport. The rising levels of air pollution can be attributed mainly due to increasing vehicular population, which had seen an average decade growth of almost 9% during 1991-2001. The number of vehicles have increased from 0.47 million to more than a million during this period. In a recent survey, the andhra pradesh pollution control board estimated that the citizens of Hyderabad breathe in 691 tonnes of air pollutants every day. Of this, CO has a share of 392 tonnes, HC 240 tonnes, NO_X 44 tonnes, SO_2 6 tonnes, and SPM 10 tonns and lead 0.162 tonnes. The pollution levels in hyderabad are increasing over the period. Oxides of nitrogen (NOx) levels have reached the indian standards in 1998 and an increasing trend can be observed there after. Suspended particulate matter (spm) levels are well above the indian Standards since 1990 indicating the alarming levels of pollution.An analysis of this data indicates that the total suspended particulate matter (tspm) and respirable particulate matter (rspm) are very high in comparison to the ambient air quality standards. Various parameters such as average, maximum and minimum concentrations are computed for all the monitoring stations and a summary of results is presented in Table-1. These are compared with the standards prescribed by the central pollution control board (cpcb) for residential and com mercial zones.(*Hyderabad City Development Plan)*

Table 1
Air Quality Statuses at Selected Locations

Location	Average values				Maximum values				Minimum values			
	TSPM	RSPM	Nox	So_2	TSPM	RSPM	No_x	So_2	TSPM	RSPM	No_x	So_2
Abids	251	116	45	12	406	169	65	22	175	76	25	8
Punjagutta	271	128	53	12	452	161	84	17	185	84	34	8
Paradise	279	132	53	9	387	181	188	13	199	92	34	6
Charminar	426	161	67	11	635	205	123	17	268	117	41	8
Zoo Park	162	79	19	8	244	112	48	12	73	35	6	3

Source: APPCB

The observations based on the analysis indicate that the ambient air quality levels for total Suspended particulate matter presently exceed the prescribed limits of 140 g/m3 at all the Stations except at the zoo park location. Rspm concentrations also exceeded the standards at all the locations. The maximum concentrations of rspm were noticed in Charminar area comprising of 635 g/m3, four and half times the specified standards. Even the minimum value recorded at Charminar exceeded the standard by two times. Punjagutta, abids, and paradise recorded Maximum tspm values of 452, 406 and 387 g/m3 respectively, well above the standards. The minimum values at the same locations recorded 185, 175 & 199 g/m3 respectively with the averages at 271, 251 &

279 g/m3 for the same locations. The location at Zoo Park recorded a low value of concentration, which can be attributed due to the presence of green cover in the area. (*Hyderabad City Development Plan)* Awareness of air pollution has increased markedly within the last few decades. We know that the rising concentration of impurities in the air is associated with the increase of population, and of technological and industrial development, that is with the ever increasing consumption of energy .For the evaluation of tolerant capacity of the plant species to air pollution, four physiological and bio-chemical parameters namely leaf Relative Water Content, Ascorbic acid, leaf Chlorophyll content and leaf extract pH were used. By computing these parameters together in a formulation, it signifies the Air Pollution Tolerance Index (APTI) of plants. Air pollution is the effect of unsustainable economic activities of production and Consumption. Burning of fossil and bio-fuels, industrial process and vehicles in the Transport sector- all contribute heavily to air pollution.(Sajal Ghosh, *"Sustainable Energy Policies for Clean Air In India"*7) .Air pollution is aggravated because of four developments: increasing traffic, growing cities, rapid economic development, and industrialization. Effect on health due to air pollution in Hyderabad: a study has been made "Integrated Environmental Strategies (Hyderabad, India) Project: Health Effects Analysis & Economic Valuation of Health Effects" in June 2004 and it is found that in Hyderabad the our door air pollution is taking toll and is affect on health of people specially children's. Air pollutions 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 plants experience physiological changes before exhibiting visible damage to leaves (Dohmen, et al 1990). Studies have also shown the impacts of air pollution on Ascorbic acid content (Hoque, 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 plant species (Singh and Rao, 1993; Yan-Ju and Ding, 2007; Singh et al 1991); Several contributors agrees that air pollutants effect plant growth adversely (Rao, 2006; Bhatia, 2006; Sodhi, 2007; Horsefall, 1998). Air pollution tolerance index is used by landscapers to select plant species tolerant to air pollution (Yan- Ju, 2007). Air pollution tolerance index has also been used to rank plant species in their order of tolerance to air pollution (Raza and Murthy, 1988; Singh and Rao, 1983).

MATERIALS AND METHODS

Area of study

This research is conducted in highly polluted areas of Hyderabad viz., Charminar,Zoopark and Punjagutta in which the air is polluted with various motor vehicle and industrial emissions and the samplles are named C,P,Z respectively. Controlled samples were collected from less polluted selected residential areas and named as N .Care was taken for all plants undergoing investigation should have isoecological conditions with respect to light, water, soil and pollutant exposure. The study was conducted during summer(March,April). To determine the tolerance level of a plant species to industrial air pollution leaf extract pH, ascorbic acid, total chlorophyll and relative water content were analysed and Air pollution tolerance indices of plants were evaluated.

Plants Selected

The selected plant ninteen spiceis areHerbs: Acalypha indica,Euphorbia hirta,Tridax procumbens,Vinca rosea. Shrubs:Calotropis gigantea,Calotropis procera,.Canna indica,Gossypium herbaceum,Ricinus communis. Trees:Azadiricta indica, Butea monosperma,Eugenea jambolana,Ficus bengalensis,Ficus religiosa,Ixora coccinia,Pithecalobium dulce,.Polyalthia longifolia,Tecoma capensis,Tecoma stans.

Table 2
Details of the plants taken

S.N	NAME OF THE PLANT	COMMON NAME	FAMILY
1	Herbs: *Acalypha indica*	Indian copper leaf	Euphorbiacea
2	*Euphorbia hirta*	Asthma plant	Euphorbiacea
3	*Tridax procumbens*	Coat buttons	Compositae
4	*Vinca rosea*	Periwinkle	Apocyanacea
5	Shrubs: *Calotropis gigantea*	Milk weed	Asclepiadaceae
6	*Calotropis procera*	Apple of sodam	Asclepiadaceae
7	Gossypium *herbaceum*	Cotton	Malvacea
8	*Canna indica*	Indian shot	Cannacea
9	*Ricinus communis*	Castor bean	Euphorbiacea
10	Trees: A*zadiricta indica*	Neem	Meliacea
11	*Butea monosperma*	Flame of the forest	Fabacae
12	*Euginea jambolana*	Jambul	Myrtacea
13	*Ficus bengalensis*	Banayan tree	moracea
14	*Ficus religiosa*	Peepal	Moracea
15	*Pithecellobium dulce*	Madras thorn	fabacea
16	*Polyalthia longifolia*	False ashoka	Annonacea
17	*Tecomaria capensis*	Cape honeysukle	Bignonacea
18	*Tecoma stans*	Yellow trumpetbush	Bignonacea
19	*Ixora coccinia*	Flame of the woods	Rubiace

Sample collection

Samples were collected in early morning and brought to the laboratory in polythene bag kept in ice box to reduce the adverse effect of high light intensity and temperature. The leaf fresh weight was taken immediately upon getting to the laboratory. Samples were preserved in refrigerator for further studies.

Procedures

Estimation of total chlorophyll (TCh)

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

Chlorophyll a = 12-7DX 643 – 2.69DX645 X vmg mg/g 1000w
Chlorophyll b = 22-9DX 645 – 24.68DX665 X vmg mg/g 1000w
TCh = Chlorophyll a + b mg/g
Dx = Absorbance of the extract at the wavelength xnm.
V = Total volume of the chlorophyll solution (ml)
W = Weight of the tissue extracted (g)

Estimation of relative water content(RWC)

With the method as described by Singh 1997, leaf relative water content was determined and calculated with the formula.
RWC= (FW—DW) / (TW- DW) * 100
FW = Fresh weight
DW = Dry weight
TW = Turgid weight

Fresh weight was obtained by weighing the fresh Leaves. The leaves were then immensed in water over night, blotted dry and then weighed to get the turgid weight. The leaves were than dried overnight in an oven at 70oC and reweighed to obtained the dry weight.

Estimation of ascorbic acid

Ascorbic acid content (expressed in mg/g) was measured using spectrophotemetric method (Bajaj and Kaur, 1981). 1g of the fresh foliage was put in a test-tube, 4ml oxalic acid – EDTA extracting solution was added; then 1ml of orthophosphoric acid and then 1ml 5% tetraoxosulphate (vi) acid added to this mixture, 2ml of ammonium molybdate was added and then 3ml of water. The solution was then allowed to stand for 15 minutes. After which the absorbance at 760nm was measured with a spectrophotometer. The concentration of ascorbic acid in the sample were then extrapolated from a standard ascorbic acid curve.

Estimation of pH

Five grams of the fresh leaves were homogenised in 10ml deionised water.This was then filtered and the pH of leaf extract was determined after calibrating pH meter with buffer solution of pH 4 and 9 (Agbaire 2009).

Determination of APTI

The determination of Air pollution tolerance index gives an imperical value for tolerance of plants to air pollution

$$APTI = \frac{A(T+P)+R}{10} \quad \text{(Singh \&Rao 1983)}$$

A=Ascorbic acid(mg/g)
T = Total Chlorophyll(mg/g)
P = pH of leaf extract
R = Relative water content of leaf extract
The air pollution effects are high in sensitive plant species and low in tolerant plant species.
Normally, these tolerant plant species help in abatement of air pollutants and the sensitive plant species help in indicating air pollution (S.M. Seyyednjad *et. al.,* 2011).

RESULTS

Table 3
Showing Air pollution tolerance index (APTI) of studied plants (Control vs three polluted areas)

S.NO	NAME OF THE PLANT	AIR POLLUTION TOLERANCE INDEX (APTI)			
		CONTROL (N)	CHARMINAR SITE(C)	PUNJAGUTTA SITE(P)	ZOO SITE (Z)
1	*Acalypha indica*	25.3	23.1(8.69%)	22.8(9.98%)	24.7(2.37%)
2	*Euphorbia hirta*	11.53	10.42(9.54%)	10.8(6.25%)	11.3(1.90%)
3	*Tridax procumbens*	11.99	11.14(7.08%)	11.36(5.25%)	11.68(2.58%)
4	*Vinca rosea*	12.79	11.36(11.18%)	11.47(10.32%)	11.79(7.81%)
5	*Calotropis gigantea*	23.32	19.11(18.05%)	20.55(11.49%)	22.01(5.61%)
6	*Calotropis procera*	21.12	18.41(12.83%)	19.37(8.28%)	20.06(5.01%)
7	Gossypium herbaceum	13.14	11.59(11.79%)	12.43(5.40%)	12.24(1.52%)
8	*Canna indica*	10.95	9.51(13.15%)	10.22(6.66%)	10.53(3.83%)
9	*Ricinus communis*	19.1	17.45(8.63%)	17.36(9.10%)	18.54(2.92%)
10	*Azadiricta indica*	23.4	20.55(12.1%)	21.99(6.02%)	22.65(3.2%)
11	*Butea monosperma*	20.15	17.94(10.96%)	18.5(8.18%)	18.91(6.15%)

12	*Euginea jambolana*	12.28	10.47(14.73%)	10.84(11.72%)	11.17(9.03%)
13	*Ficus bengalensis*	25.85	22.48(13.03%)	23.4(9.47%)	24.35(5.8%)
14	*Ficus religiosa*	23.19	20.99(9.48%)	21.58(6.94%)	22.12(4.61%)
15	*Pithecalobium dulce*	14.81	11.93(19.44%)	12.39(16.34%)	13.14(11.27%)
16	*Polyalthia longifolia*	15.46	12.63(18.30%)	13.63(11.83%)	14.37(7.05%)
17	*Tecoma capensis*	11.07	9.86(10.93%)	10.29(7.04%)	10.65(3.79%)
18	*Tecoma stans*	12.02	10.85(9.81%)	10.53(12.39%)	11.03(8.23%)
19	*Ixora coccinia*	12.76	17.5(11.34%)	17.84(9.62%)	18.04(8.7%)

Table 4
Showing Air pollution tolerance index (APTI) of studied plants in Zoo area

S.N	Name of the plant	Total Chlorophyll (mg/g)		Ascorbic acid (mg/g)		Relative Water content (%)		Leaf pH		APTI	
		C	P	C	P	C	P	C	P	C	P
1	*Acalypha indica*	1.45	1.36	23.42	23.1	86.5	87	5.7	5.6	25	24.7
2	*Euphorbia hirta*	1.9	1.34	4.6	4.54	84.4	81	5.6	5.7	11	11.3
3	*Tridax procumbens*	2.99	2.56	2.45	2.39	95.7	95	6.9	6.8	11	11.6
4	*Vinca rosea*	1.78	1.45	5.56	5.54	83.4	75	6.2	6.3	12	11.0
5	*Calotropis gigantea*	11.6	10.4	7.98	7.89	92.3	86	6.1	6.0	23	22.0
6	*Calotropis procera*	8.6	7.9	8.4	8.43	87.2	81	6.2	6.2	21	20.0
7	Gossypium herbaceum	1.78	1.56	6.7	6.5	79.1	81	6.0	6.3	13	12.2
8	Canna indica	1.24	1.12	7.4	7.3	54.5	51	6.2	6.3	10	10.5
9	*Ricinus communis*	14.0	13.33	6.23	6.21	65.4	62	6.1	6.4	19	18.5
10	Azadiricta indica	12.3	11.9	8.1	8.09	75.6	72	7.2	7.2	23	22.6
11	*Butea monosperma*	9.98	9.24	7.12	7.14	79.9	72	7.1	7	20	18.9
12	*Euginea jambolana*	2.59	2.09	5.8	5.7	74.8	67	5.7	5.7	12	11.1
13	*Ficus bengalensis*	10.4	9.98	8.9	8.8	77.89	72	6.9	6.0	23	22.1
14	*Ficus religiosa*	13.2	12.21	8.45	8.34	87.6	82	7.0	7.0	25	24.0
15	*Pithecalobium dulce*	1.97	1.67	7.6	7.5	85.67	72	6.2	6.2	14	13.0
16	*Polyalthia longifolia*	10.4	9.98	5.45	5.43	66.7	58	5	5.0	15	14.3
17	*Tecoma capensis*	1.54	1.45	8.2	8.19	50.56	47	5.8	5.7	11	10.6
18	*Tecoma stans*	1.94	1.89	6.9	6.8	67.9	58	5.6	5.0	12	11.0
19	*Ixora coccinia*	13.2	12.67	6.19	6.13	79.9	67	5.7	5.7	19	18.0

C-Control, P-Polluted

Table 5
Showing Air pollution tolerance index (APTI) of studied plants in Punjagutta area

S.N	Name of the plant	Total chlorophyll (mg/g)		Ascorbic acid (mg/g)		Relative Water content(%)		Leaf pH		APTI	
		C	P	C	P	C	P	C	P	C	P
1	*Acalypha indica*	1.45	1.2	23	21	86.5	*84*	5.7	5.5	25.3	22.8
2	*Euphorbia hirta*	1.9	1.2	4.6	4.3	84.4	*80*	5.6	5.5	11.5	10.8
3	*Tridax procumbens*	2.99	2.2	2.45	2.3	95.7	*93*	6.9	6.5	11.9	11.3
4	*Vinca rosea*	1.78	1.3	5.5	5.4	83.4	72	6.2	6.2	12.7	11.4
5	*Calotropis gigantea*	11.62	10.	7.9	7.7	92.3	75	6.1	6.3	23.3	20.5
6	*Calotropis procera*	8.6	7.4	8.4	8.3	87.2	81	6.2	6	21.1	19.3
7	Gossypium *herbaceum*	1.78	1.3	6.7	6.4	79.1	76	6.0	6.1	13.1	12.
8	Canna *indica*	1.24	1.0	7.4	7.2	54.5	50	6.2	6.2	10.9	10.2
9	*Ricinus communis*	14.02	11.	6.2	6.1	65.4	61	6.1	6.7	19.1	17
10	Azadiricta *indica*	12.34	11.	8.1	7.9	75.6	70	7.2	7.0	23.4	21.9
11	*Butea monosperma*	9.98	8.9	7.1	7.1	79.9	70	7.1	7.1	20.1	18.5
12	*Euginea jambolana*	2.59	1.9	5.8	5.6	74.8	65	5.7	5.6	12.2	10.8
13	*Ficus bengalensis*	10.41	9.9	8.9	8.7	77.8	71	6.9	6.5	23.1	21.5
14	*Ficus religiosa*	13.21	11.	8.4	8.3	87.6	76	7.0	7.1	25.8	23.4
15	*Pithecalobium dulce*	1.97	1.4	7.6	7.4	85.6	67	6.2	6.1	14.8	12.3
16	*Polyalthia longifolia*	10.45	9.9	5.4	5.2	66.7	54	5.6	5.6	15.4	13.6
17	*Tecoma capensis*	1.54	1.3	8.2	8.1	50.5	42	5.8	5.2	11	10
18	*Tecoma stans*	1.94	1.8	6.9	6.7	67.9	55	5.6	5.5	12.0	10.5
19	*Ixora coccinia*	13.21	12	6.1	6.1	79.9	6	5.7	5.6	19	17.8

Table 6
Showing Air pollution tolerance index (APTI) of studied plants in Charminar area

S.N	Name of the plant	Total chlorophyll (mg/g)		Ascorbic acid (mg/g)		Relative Water content(%)		Leaf pH		APTI	
		C	P	C	P	C	P	C	P	C	P
1	*Acalypha indica*	1.45	1.24	23	22.3	86.5	83.1	5.7	5.4	25.3	23.1
2	*Euphorbia hirta*	1.9	1.05	4.6	3.98	84.4	79	5.6	5.3	11.5	10.4
3	*Tridax procumbens*	2.99	2.08	2.4	2.26	95.7	91.1	6.9	6.6	11.9	11.1
4	*Vinca rosea*	1.78	1.23	5.5	5.53	83.4	72	6.2	6.2	12.7	11.3
5	*Calotropis gigantea*	11.62	9.45	7.9	7.67	92.3	71	6.1	6.2	23.3	19.1
6	*Calotropis procera*	8.6	7.2	8.4	8.25	87.2	75	6.2	6	21.1	18.4
7	*Gossypium herbaceum*	1.78	1.21	6.7	6.2	79.1	71	6.0	6.0	13.1	11.5
8	*Canna indica*	1.24	0.98	7.4	7.1	54.5	44	6.2	6.1	10.1	9.51
9	*Ricinus communis*	14.02	12.6	6.2	6.03	65.4	60	6.1	6.2	19.1	17.4
10	*Azadiricta indica*	12.34	10.0	8.1	7.98	75.6	69	7.2	7.0	23.4	20.5
11	*Butea monosperma*	9.98	8.67	7.1	7.01	79.9	68	7.1	7.1	20.1	17.9
12	*Euginea jambolana*	2.59	1.89	5.8	5.4	74.8	64	5.7	5.6	12.2	10.4
13	*Ficus bengalensis*	10.41	9.34	8.9	8.67	77.8	69	6.9	6.8	23.1	20.9
14	*Ficus religiosa*	13.21	11.2	8.4	8.21	87.6	75	7	7	25.8	22.4
15	*Pithecalobium dulce*	1.97	1.28	7.6	7.5	85.6	63	6.2	6.1	14.8	11.9
16	*Polyalthia longifolia*	10.45	9.65	5.4	5.34	66.7	45	5.6	5.4	15.4	12.6
17	*Tecoma capensis*	1.54	1.23	8.2	8.09	50.5	44	5.8	5.4	11	9.86
18	*Tecoma stans*	1.94	1.76	6.9	6.6	67.9	59.2	5.6	5.6	12	10.8
19	*Ixora coccinia*	13.21	11.5	6.1	6.09	79.9	71.2	5.7	5.1	19	17.5

DISCUSSION

Air Pollution Tolerance Index (APTI) of plants plays major role in determining the resistivity and susceptibility. In urban areas, air pollutants may get absorbed or accumulated by plant body, if these are toxic in nature, may injure the plants in various ways. The air pollution effects are high in sensitive plant species and low in tolerant plant species as discussed in Table-7

Table 7
Impact of selected air pollutants on plants

S.N.	POLLUTANT	THRESHOLD DOSE	PLANT INJURY/SYMPTOMS
1	Sulphur dioxide	0.70 ppm(1820µg/m^{-3}) for 1 hr,0.008-0.017 ppm for growing season	Inter vienal necrotic blocthes .red brown dieback or bands in pines.
2	Nitrogen dioxide	20ppm(38*10^{3})for1hr,1ppm(1900µg/m^{-3}) for 100 hr.	Inter vienal necrotic blocthes .red brown dieback or bands in pines
3	Fluoride	< 100µg/m^{-1} Fluoride	Red brown distal necrosis in pines
4	Ammonia	55 ppm (38*10^{3} µg/m^{-3}) for 1 hr	Chlorosis,necrosis,abscission dwarfing., premature defoliation.
5	Chlorine	0.5-1.5ppm(1400-4530µg/m^{-3})for 0.5-3 hr.	Tip & margin necrosis
6	Ethylene	Variable, undermined	Chlorosis,necrosis,abscission dwarfing,premature defoliation.

Total photosynthetic pigment

Photosynthetic pigment degradation has been widely considered as an indication of air pollution (Ninave et al., 2000). At Zoo site Total Chlorophyll content is high but in other areas different chlorophyll content levels were observed. Present study revealed that Total Chlorophyll content in all the urban plants varies with the pollution status of the area. Total chlorophyll was found maximum in *Acalypha indica* mg/g fr. wt.among herbs.Among shrubs *Ricinus communis* showed maximum. Among trees *Azadiricta indica*.,*Ficus bengalensis* mg/g fr.wt.had maximum.Thus plants having high chlorophyll content in their natural habitat are normally tolerant to air pollution.The decrease in foliar chlorophyll in plants may be due to the destruction of chlorophyll[2] reversible swelling of thyllakodis[3]. Inhibition of RuBp carboxylase[4]. Here the inhibitory effect of SO_2 on photosynthetic CO_2 exchange has been well presented.

pH of leaf extract

According to Scholz and Reck (1977), the leaf pH is lowered in presence of acidic pollutants and decline is greater in sensitive species. The development of detoxification mechanism which is necessary for the tolerance in the plant species can be indicated by its alkalinity (Ninave et al., 2000). 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 air16. 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[4]. The pH ranged between 5.4 and 8.8 lies in both intermediately tolerant and sensitive plant species[5]. The leaf extract pH was found maximum in *Tridax procumbens* .Among shrubs *Ricinus communis* showed maximum.Among trees *Azadiricta indica* showed maximum .Leaf extract pH plays a significant role in regulating SO2 sensitivity of plants[6,7] . A shift in cell sap pH towards the acid in 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 give tolerance to plants against pollution[8].

Change in relative water content (RWC)

RWC of a leaf is the water present in it relative to its full turgidity. Water is a crucial prerequisite for plant life[9]. 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[3]. Plants with high relative water content under polluted condition may be tolerant to pollutants. The relative water content was found maximum in *Euphorbia hirta* among herbs .Among shrubs *Ricinus communis* shows maximum among trees *ficus bengalensis* showed maximum. Relative water content is associated with protoplasmic permeability in cells causes loss of water and dissolved nutrients, resulting in early senescence of leaves[10]. More water in a leaf will help to maintain it’s physiological balance under stress conditions of air pollution. When the transpiration rates are usually high[11].

Changes in Ascorbic acid content

Ascorbic acid plays important role in cell division, defense and cellwall synthesis. It is a natural detoxicant, which may prevent the effects of air pollutants in the plant tissues (Mohammed Kuddus et. al., 2011). According to Chaudhary and Rao (1977) and Varshney and Varshney (1984), the higher Ascorbic Acid content in the plants is an indication of its tolerance against sulphur dioxide pollution. Lower Ascorbic Acid contents in the plant species support the sensitive nature towards the pollutants particularly automobile exhausts. Ascorbic acid (vitamin C) is a familiar molecule because of its dietary significance, it is not only an important antioxidant, it also appears to link flowering time, developmental senescence, programmed cell death and responses to pathogens through a complex signal transduction network[12,13]. Total levels of ascorbic acid were found to be maximum in acalypha indica among herbs. Of the shrubs *Gossypium herbaceum* showed maximum. Among trees *Ficus bengalensis* showed maximum. It is a strong reducer and plays an 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[13,14]. Production of reactive oxygen species (ROS) such as SO3-2, HSO3,-2 OH- and O2_ during photo-oxidation of SO3- 2 to SO4-2 where sulphites are generated from SO2 absorbed. The free radical production under SO2 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[13,15]. 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 species13. In the present study the ascorbic acid content of all the plant species varies from 3.45 to 8.60mg/gm. Thus, plant maintaining high ascorbic acid under pollutant conditions are considered to be tolerant to air pollution[16].

Air Pollution Tolerance Index (APTI value)

In this study it was found that *Ficus bengalensis* exhibited the highest APTI value in all the sites . The highest reduction in APTI was observed at Charminar site. Lowest reduction was observed in Zoo site which might be due to the presence of green belt.

CONCLUSION

Plants with some economic value can be selected. Plants should not have any damaging role to play like release of allergic pollen in large amount like *Parthenium hysterophorus*. Plants selected must help to increase of beautification process and also tolerant to increasing vehicular emissions.Charminar area which is having a high impact of air pollution must be taken care by increasing the plantation with pollution tolerant plants. In Punjagutta area the traffic areas are padded with green plants so that some of emissions are absorbed by green plants. Plants vary considerably with their susceptibility levels to air pollutants. It was found that plants with low index values were generally sensitive to air pollutants and vice versa. Cultivation of tolerant plants helps to scavenge the air pollutants along with increase in green belt along road sides. Present study the results revealed that plant species like *Ficus bengalensis, Azadiricta indica* can be planted as tolerant and *Pithecalobium dulce*, *Polyalthia longi folia* sensitive species to bio- monitor air pollution.

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