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Pollution tolerance and distribution pattern of plants in surrounding area of coal-fired industries

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Abstract: *Higher concentration of SO_2 and particulate matters was reported in surrounding areas of coal-fired industries which influences the distribution pattern of plants. Sensitive plant species are abolished from such areas, however, only pollution tolerant species survive under stress conditions. The present study was designed to investigate the vegetation composition around coal-fired industries i.e. brick industries. To categorise plants as sensitive or resistant air pollution tolerance index (APTI) value was calculated. Out of 99 plants studied, Ricinus communis with APTI 81.10 was found to be the most resistant wild plant showing uniform distribution at all the polluted sites. On the other hand, Lepidium sativum with APTI 5.27 was recorded as the most sensitive plant and found to be present only at the less polluted sites.*

Key words*: Ascorbic acid, Brick kilns, Resistant, Sensitive, Stack, Toxicity*

Introduction

It is a common observation that none of the plant has been found to be uniformly distributed around the globe, similarly no particular region in the world has been reported to lodge all the plants of the plant kingdom. This disparity of plant distribution depends on interaction of a plant with its surrounding (Kumar and Soodan, 2006). Interaction and establishment of plants in any area also depends upon the sensitivity or resistance of plants to air pollutants (Tripathi and Dwivedi, 2002).

Work have been done in the direction to study the sensitivity or resistance of plants based on the selected parameters such as ascorbic acid content (Keller and Schwagar, 1977), relative water content (Falla *et al.,* 2000), chlorophyll content (Bell and Mudd, 1976), leaf extract pH (Chaudhary and Rao, 1977). Only one particular character recognising sensitivity or resistance of a plant is not justifiable. Therefore, Raza (1985), incorporated the above four characters together to calculate the air pollution tolerance index (APTI) to categorize a plant as sensitive or resistant to the air pollutants. APTI of some plants have been calculated by Karthiyayini *et al.* (2005) using the APTI formula.

Still a paucity exists, where relationship between pollution level in an area, APTI of plants present in the area and actual distribution of plants in the field needs to be explored. To fill the gap, the present work was selected. Vegetation around selected brick kilns were subjected for the analysis. Brick industries were selected as the source of pollution on the basis of reporting of high concentration of SOx, NOx and SPM around the brick industries (Gupta *et al*., 2001).

Materials and Methods

Monitoring of the plants species was done in circular area with diameter of five hundred meter and considering the kiln as center.

During present investigation ascorbic acid content, leaf extract pH, total chlorophyll content and relative water content was taken together in the form of mathematical expression to obtain an empirical value, signifying the air pollution tolerance index (APTI) (Raza *et al*., 1985).

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

where -
A = Ascorbic acid content (mg g^{-1} fresh wt.)
P = Leaf extract pH
T = Total chlorophyll (mg g^{-1} dry wt.) and
R = Percent relative water content of leaf.

Ascorbic acid content was calculated by the formula given by Keller and Schwager (1977). Pigment content were computed by the formulae given by Duxbury and Yentsch (1956) for Carotenoids and Maclachlan and Zalic (1963) for chlorophyll a and b. Leaf sample (0.5 g) was crushed and homogenised in 50 ml deionised water, the mixture was centrifuged and supernatant was collected for detection of pH using pH meter. The percent relative water content (RWC) was calculated by using the initial weight and dry weight of leaf material.

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Table - 1: Details of the research sites

S.No.	Characters	Site code			
		A	B	C	D
(1)	Location of the brick industry	Sandaha	Kotwan	Salarpur	Chamaraha
(2)	Type of the brick industry	Fixed Chimney	Fixed Chimney	Movable Chimney (Single)	Movable Chimney (Double)
(3)	Coal consumption (Tones per day)	7	6	3	5
(4)	Kiln capacity (Bricks per day)	32,000	24,000	12,000	16,000
(5)	Pollution control device	With settling chambers	Unequipped	Unequipped	Unequipped
(6)	Total emission (m^3hr^{-1})	23,400	12,600	3240	2486 x 2
(7)	Stack height (m.)	29.4	28.8	12.6	10
(8)	Stack diameter (m.)				
	(a) Top	1.5	1.2	0.6	0.6
	(b) Bottom	4.2	3.0	0.9 x 1.8 = 1.27	0.75 x 1.8 =1.16 (each)
(9)	Cross sectional area of the stack (m^2)				
	(a) Top	1.76	1.14	0.28	0.28
	(b) Bottom	13.86	7.06	1.62	1.35
(10)	Specific fuel consumption (Tonn coal per lakh bricks)	21.87	25.00	25.00	31.25
(11)	Stack emission (Annaul mean)				
	SO_2 ($\mu g/m^3$)	198.31	231.42	243.11	256.61
	NO_x ($\mu g/m^3$)	44.02	49.33	53.10	58.78
	SPM ($\mu g/m^3$)	568.23 (750)*	1320.77 (750)*	1890.61 (1000)*	2113.24 (750)*
(12)	Ambient air quality (Annual mean)				
	SO_2 ($\mu g/m^3$) (60)**	130.51	147.28	153.36	172.11
	NO_2 ($\mu g/m^3$) (60)**	24.18	30.60	46.35	51.47
	SPM ($\mu g/m^3$) (140)**	552.32	810.52	893.39	986.74

* Standard of GIO norms for brick industries according to Kiln capacity, ** National ambient air quality standard for rural area (where brick industries are located)

Study sites: The study was conducted around four brick industries in Varanasi district of state Uttar Pradesh in India, which finds its location at $25^0$18' N, $83^0$1' E and 76.19 m. above the sea level. Four brick industries were selected on the ground of their polluting potential, brief of the parameters for consideration is given in Table 1. The sites were not distantly placed geographically such that all the sites were exposed to similar meteorology.

Results and Discussion

On the basis of comparative study of type of brick industry, kiln capacity,stack height, stack emission and ambient air quality analysis of the four sites and the specified standards, the brick industry can be placed into various categories (Table 1).

The brick industry of site A was pointed as least polluting, while that of site D most polluting, however, site B and C were of intermediate type, though B was less polluting than C.

Results of the field study for estimation of APTI and distribution behaviour of the plants is shown in Table 2 and 3 respectively. Plants with higher APTI value were *Carica papaya* L., *Ricinus communis* L., *Cynodon dactylon* (L.) Pers. *etc.* On the other hand plants with lower APTI value were *Lepidum sativum* L., *Anthocephalous chinensis* (L.) A. Rich, *Vitex negundo* L. *etc.*

Rauvolfia serpentina (L.) Benth and *Lepidium sativum* L. which were highly sensitive plants with APTI value 5.82 and 5.27 respectively (Table 2). These plants were recorded only at the less polluted sites *i.e.* at site A and B, however these plants were found absent at the polluted sites such as site C and D. *Vicia hirsuta* L. showed APTI value 11.75 but this plant was also absent from the sites which were more polluted *i.e.* site C and D, though it was present at sites A and B (Table 3).

On the other hand the resistant plants followed a different trend and were present at all the sites. *Achyranthus aspera* L. (APTI value 31.83), *Alternenthera sessilis* (L.) DC. (APTI value 30.18), *Rumex dentatus* L. (APTI value 33.37) and *Xanthium strumarium* L. (APTI value 29.62) were evenly present at all the sites. *Moringa oleifera* L. with high APTI (31.39) was not recorded at site C, this is anthropogenic influenced, as it is a cultivated plant.

There were certain other wild plants which fall under highly resistant category, such as *Ricinus communis* L. (APTI value 65.73), *Cynodon dactylon* (L.) Pers. (APTI value 48.74), *Cyperus rotendus* L. (APTI value 46.77) *etc.,* showed wide distribution at most of the sites irrespective of the pollution level. *Cynodon dactylon* (L.) pers., was the most dominant flora at all the sites (as also reported by Whitmore and Mansfield, 1983).

Table - 2: Air pollution tolerance index of plants at the study sites

Sl No	Plants	Family	A	P	T	R	APTI
1	*Abutilon indicum* (L.) Sweet	Malvaceae	1.00	6.50	21.70	65.0	9.32
2	*Acacia nilotica* (L.) Del. Subsp. *indica* (Benth) Brenan	Mimosaceae	5.98	6.50	4.54	79.0	14.50
3	*Acalypha indica* L.	Euphorbia	3.57	6.50	2.76	73.0	10.61
4	*Achyranthus aspera* L.	Amaranthaceae	17.90	6.00	7.20	82.0	31.83
5	*Adhatoda vasica* Mees.	Acanthaceae	1.00	7.00	5.60	65.0	7.76
6	*Aegle marmelos* (L.) Corea	Rutaceae	3.57	7.00	17.30	69.0	15.58
7	*Aerva lanata* (L.) Juss.	Amaranthaceae	1.00	7.00	10.30	71.0	8.83
8	*Ageratum conyzoides* L.	Asteraceae	6.35	4.00	7.20	62.0	13.31
9	*Ageratum houstonianum* Mill.	Asteraceae	6.16	4.00	7.00	63.0	13.08
10	*Alternanthera sessilis* (L.) DC	Amaranthaceae	12.80	6.10	11.70	74.0	30.18
11	*Amaranthus spinosus* L.	Amaranthaceae	6.25	6.00	6.67	74.0	15.32
12	*Amaranthus viridis* L.	Amaranthaceae	6.20	6.00	6.67	70.0	14.86
13	*Anisomilis ovata* R. Br.	Labiatae	8.70	6.00	2.30	83.0	15.52
14	*Anthocephalus chinensis* (L.) A. Rich	Rubiaceae	3.40	5.20	8.34	8.5	5.45
15	*Antigonon leptopus* Hook.f.	Polygonaceae	4.50	8.40	6.36	55.0	12.14
16	*Argemone mexicana* L.	Papaveraceae	6.25	6.10	6.61	75.0	15.44
17	*Asclepias curassavica* L.	Asclepediaceae	12.30	5.10	7.70	76.0	23.34
18	*Azadirachta indica* A. Juss.	Meliaceae	10.20	6.30	7.50	79.0	21.98
19	*Blepharis* sp.	Acantheceae	2.00	6.40	6.27	53.0	7.83
20	*Blumea membreneacea* DC.	Asteraceae	1.90	6.40	4.20	50.0	7.01
21	*Boerhaavia diffusa* L.	Nyctaginaceae	1.90	6.40	6.27	45.0	6.91
22	*Calatropis gigantia* (L.) R.Br.	Asclepediaceae	8.50	6.20	5.27	88.0	18.55
23	*Calatropis procera* Ait. Hort.	Asclepediaceae	8.50	6.20	5.27	96.0	19.35
24	*Cannabis sativa* L.	Cannabinaceae	0.35	7.00	4.20	68.0	7.19
25	*Capparis zeylanica* L.	Capparidaceae	10.40	8.00	9.96	70.0	25.68
26	*Carica papaya* L.	Caricaceae	32.60	7.50	15.20	71.0	81.10
27	*Cassia alata* L.	Caesalpinaceae	5.96	6.50	4.54	78.0	14.38
28	*Cassia fistula* L.	Caesalpinaceae	5.94	6.50	4.56	79.0	14.47
29	*Centella asiatica* (L.) Urban	Apiaceae	2.10	6.40	4.20	69.0	9.13
30	*Chenopodium album* L.	Chenopodiaceae	4.20	6.00	11.60	75.0	14.89
31	*Cleome viscosa* L.	Cleomaceae	5.05	6.90	9.51	78.0	16.09
32	*Clerodendron viscosum* vent.	Verbinaceae	1.00	6.00	10.00	82.0	9.80
33	*Coccinia indica* Wt. and Arn.	Cucurbitaceae	7.14	7.00	12.30	79.0	21.68
34	*Commelina bengalensis* L.	Commelinaceae	1.00	7.50	4.69	84.0	9.62
35	*Croton bomplandianum* Baill	Euphorbiaceae	8.78	6.00	11.40	79.0	23.18
36	*Cuscuta reflexa* Roxb.	Convolvolaceae	6.32	6.00	7.11	69.0	15.19
37	*Cynodon dactylon* (L.) Pers.	Poaceae	20.60	8.00	11.38	88.0	48.72
38	*Cyperus rotendus* L.	Cyperaceae	20.40	7.80	10.96	85.0	46.77
39	*Dactyloctenium aegyptium* (L.) O.P.	Poaceae	9.50	7.90	10.88	85.0	26.34
40	*Datura metal* L.	Solanaceae	5.40	6.30	4.58	87.0	14.58
41	*Desmostachya bipinnata* (L.) Stap.	Poaceae	9.60	7.80	10.86	84.0	26.31
42	*Digiteria adscendens* Henr.	Poaceae	9.60	7.70	10.81	86.0	26.37
43	*Dolichos lablab* L.	Fabaceae	8.76	7.50	11.20	76.0	23.98
44	*Eclipta alba* L.	Asteraceae	8.50	6.00	5.29	79.0	17.50
45	*Emblica officinalis* Gaertn.	Euphorbiaceae	7.14	3.00	6.51	78.0	14.59
46	*Eragrostis tenella* (L.) Baeuv	Poaceae	8.61	7.20	9.41	80.0	22.30
47	*Eucalyptus citriodora* Hook.	Myrtaceae	14.50	5.00	4.25	80.0	21.41
48	*Euphorbia hirta* L.	Euphorbiaceae	4.00	6.00	11.20	72.0	14.08
49	*Euphorbia thymifolia* L.	Euphorbiaceae	4.00	6.00	10.60	71.0	13.74

Sl No	Plants	Family	A	P	T	R	APTI
50	*Evolvolus alsinoidis* L.	Convolvolaceae	7.16	7.00	8.13	79.0	18.73
51	*Ficus bengalensis* L.	Moraceae	7.49	8.00	6.95	79.0	19.10
52	*Ficus religiosa* L.	Moraceae	7.69	7.10	11.40	55.0	19.73
53	*Gnephalium indicum* Pers.	Asteraceae	3.57	7.50	13.42	76.0	15.07
54	*Heliotropium indicum* L.	Boraginaceae	2.49	7.50	11.36	79.0	12.60
55	*Hibiscus rosa-sinensis* L.	Malvaceae	9.70	6.50	7.36	79.0	21.34
56	*Ipomoea fistulosa* Mart.	Convolvolaceae	11.00	6.50	6.20	74.0	21.37
57	*Lantana indica* Roxb.	Verbenaceae	4.63	7.60	7.51	65.0	13.50
58	*Lathyrus aphaca* L.	Fabaceae	3.98	7.00	4.69	68.0	11.45
59	*Lawsonia inermis* L.	Lythraceae	3.21	5.50	5.37	81.0	11.59
60	*Lepidium sativum* L.	Brassicaceae	1.00	6.70	6.00	40.0	5.27
61	*Madhuca indica* J.F. Gmet.	Sapotaceae	12.74	5.80	5.26	64.0	20.49
62	*Malvestrum tricuspidatum* L.	Malvaceae	4.77	7.00	6.52	81.0	14.55
63	*Mangifera indica* L.	Anacardiaceae	3.78	5.40	4.28	87.0	12.36
64	*Medicago lupulina* L.	Fabaceae	3.40	6.60	4.70	70.0	10.84
65	*Medilotus indica* Des v.	Fabaceae	2.60	6.40	6.27	68.0	10.09
66	*Mimosa pudica* L.	Mimosaceae	2.90	7.00	5.22	70.0	10.54
67	*Moringa oleifera* L.	Moringaceae	15.40	5.90	8.77	88.0	31.39
68	*Morus alba* L.	Moraceae	6.42	5.40	3.45	60.0	11.68
69	*Nepeta hindostana* (Roth.) Hains	Lamiaceae	3.23	6.20	5.56	76.0	11.40
70	*Nicotiana plumbaginifolia* Viv.	Solanaceae	8.60	6.40	2.50	84.0	16.05
71	*Ocimum basilicum* L.	Lamiaceae	3.41	6.30	5.66	82.0	12.28
72	*Ocimum sanctum* L.	Lamiaceae	3.43	6.20	5.64	81.0	12.16
73	*Oxalis corniculata* L.	Oxalidaceae	8.30	4.10	3.75	70.0	13.52
74	*Parthenium hysterophorus* L.	Asteraceae	10.70	8.00	10.50	81.0	27.90
75	*Phalaris minor* Rets.	Poaceae	7.50	7.00	9.98	85.0	21.24
76	*Phyla nodiflora* (L.) Greene	Verbenaceae	4.27	6.00	10.00	75.0	14.33
77	*Polygonum plebajum* R. Br.	Polygonaceae	5.31	6.30	11.00	68.0	15.99
78	*Portulaca oleracea* L.	Portulaceae	4.76	5.50	4.50	74.0	12.16
79	*Psidium guajava* L.	Myrtaceae	7.87	6.30	7.20	73.0	17.92
80	*Punica granatum* L.	Punicaceae	3.56	6.50	8.81	67.0	12.15
81	*Rauvolfia serpentina* (L.) Benth	Apocynaceae	0.35	7.40	4.50	54.0	5.82
82	*Ricinus communis* L.	Euphorbiaceae	25.10	6.20	17.20	70.0	65.73
83	*Rumex dentatus* L.	Polygonaceae	15.22	6.90	10.56	68.0	33.37
84	*Rungia pectinata* (L.) Nees	Acanthaceae	6.05	6.80	4.61	77.0	14.60
85	*Saccharum munja* Roxb.(Munj.)	Poaceae	8.31	8.00	11.21	75.0	23.46
86	*Sida cordifolia* L.	Malvaceae	1.00	7.50	10.39	74.0	9.19
87	*Solanum nigrum* L.	Solanaceae	4.31	6.70	10.50	86.0	16.01
88	*Spilanthus indicus* Wall.	Asteraceae	5.11	7.00	11.25	81.0	17.43
89	*Syzygium cumini* (L.) Skeels.	Myrtaceae	2.90	4.60	6.27	72.0	10.35
90	*Tamarindus indica* L.	Caesalpinaceae	7.90	6.10	4.85	78.0	16.45
91	*Thevetia peruviana* (Pers.)	Apocynaceae	2.51	6.50	5.86	76.0	10.70
92	*Tridax procumbens* L.	Asteraceae	1.26	6.50	6.11	82.0	9.79
93	*Trifolium alexendrium* L.	Fabaceae	4.61	7.50	7.50	70.0	13.92
94	*Vernonia ciuria* L.	Asteraceae	4.00	6.00	11.20	72.0	14.08
95	*Vicia hirsuta* L.	Fabaceae	4.75	5.50	4.50	70.0	11.75
96	*Vitex negundo* L.	Verbenaceae	0.35	7.40	4.50	54.0	5.82
97	*Vitis veniferea* L.	Vitaceae	4.75	5.50	4.50	74.0	12.15
98	*Xanthium strumarium* L.	Asteraceae	20.35	7.40	4.50	54.0	29.62
99	*Zizyphus mauritiana* Lamk.	Rhamnaceae	10.50	8.00	10.25	70.0	26.16

A = Ascorbic acid content (mg g^{-1} fresh wt.) T = Total chlorophyll (mg g^{-1} dry wt.)

P = Leaf extract pH R = Percent relative water content of leaf

Table - 3: Plants performance at various sites

Sl No.	Plants	Site A	Site B	Site C	*Site D*
1	*Abutilon indicum* (L.) Sweet	+	+	-	-
2	*Acacia nilotica* (L.) Del. Subsp. indica (Benth) Brenan	-	+	-	-
3	*Acalypha indica* L.	+	+	+	-
4	*Achyranthus aspera* L.	+	+	+	+
5	*Adhatoda vasica Mees.*	+	+	+	+
6	*Aegle Marmelos* (L.) Corea	-	+	-	+
7	*Aerva lanata* (L.) Juss.	+	-	-	+
8	*Ageratum conyzoides* L.	+	+	+	-
9	*Ageratum houstonianum* Mill.	+	+	-	+
10	*Alternanthera sessilis* (L.) DC	+	+	+	+
11	*Amaranthus spinosus* L.	+	+	-	+
12	*Amaranthus viridis* L.	-	+	+	+
13	*Anisomilis ovata* R. Br.	+	+	+	+
14	*Anthocephalus chinensis* (L.) A. Rich	+	-	-	+
15	*Antigonon leptopus* Hook.f.	+	+	+	-
16	*Argemone mexicana* L.	+	+	+	+
17	*Asclepias curassavica* L.	-	+	+	+
18	*Azadirachta indica* A. Juss.	+	-	-	+
19	*Blepharis* sp.	+	-	+	+
20	*Blumea membreneacea* DC.	+	+	+	-
21	*Boerhaavia diffusa* L.	+	+	+	+
22	*Calatropis gigantia* (L.) R.Br.	+	+	-	+
23	*Calatropis procera* Ait. Hort.	+	-	+	+
24	*Cannabis sativa* L.	-	+	-	+
25	*Capparis zeylanica* L.	-	+	+	-
26	*Carica papaya* L.	+	+	+	+
27	*Cassia alata* L.	+	+	+	+
28	*Cassia fistula* L.	+	-	+	+
29	*Chenopodium album* L.	+	+	+	+
30	*Cleome viscosa* L.	+	+	+	+
31	*Clerodendron viscosum vent.*	+	+	+	-
32	*Coccinia indica* Wt. and Arn.	+	-	+	+
33	*Commelina bengalensis* L.	+	+	-	+
34	*Croton bomplandianum* Baill	+	+	+	+
35	*Cuscuta reflexa* Roxb.	-	+	-	+
36	*Cynodon dactylon* (L.) Pers.	+	+	+	+
37	*Cyperus rotendus* L.	+	+	+	+
38	*Dactyloctenium aegyptium* (L.) O.P.	+	+	+	+
39	*Datura metal* L.	+	+	-	-
40	*Desmostachya bipinnata* (L.) Stap.	+	+	+	+
41	*Digiteria adscendeno* Henr.	+	+	+	+
42	*Dolichos lablab* L.	-	-	+	+
43	*Eclipta alba* L.	+	+	-	-
44	*Emlica afficinalis* Gaertn.	+	-	+	-
45	*Eragrostis tenella* (L.) Baeuv	+	+	+	+
46	*Eucalyptus citriodora* Hook.	+	-	+	+
47	*Euphorbia hirta* L.	+	+	+	+
48	*Euphorbia thymifolia* L.	+	+	+	+
49	*Evolvolus alsinoidis* L.	+	+	+	+
50	*Ficus bengalensis* L.	+	+	-	+
51	*Ficus religiosa* L.	-	+	+	+

Sl No.	Plants	Site A	Site B	Site C	Site D
52	*Gnephalium indicum* Pers.	+	+	+	+
53	*Heliotropium indicum* L.	+	+	+	+
54	*Hibiscus rosa-sinensis* L.	+	-	+	-
55	*Centella asiatica* (L.) Urban	+	+	-	-
56	*Ipomoea fistulosa* Mart.	+	-	+	+
57	*Lantana indica* Roxb.	+	+	+	+
58	*Lathyrus aphaca* L.	+	+	-	-
59	*Lawsonia inermis* L.	+	+	+	+
60	*Lepidium sativum* L.	+	+	-	-
61	*Madhuca indica* J.F. Gmet.	-	+	-	+
62	*Malvestrum tricuspidatum* L.	+	+	+	+
63	*Mangifera indica* L.	+	+	+	+
64	*Medicago inpuliva* L.	+	+	-	-
65	*Medilotus indica* Des v.	+	+	+	+
66	*Mimosa pudica* L.	+	+	+	+
67	*Moringa oleifera* L.	+	+	-	+
68	*Morus alba* L.	-	-	+	+
69	*Nepeta hindostana* (Roth.) Hains	+	+	-	-
70	*Nicotiana plumbaginifolia* Vi.v.	+	+	+	+
71	*Ocimum basilicum* L.	+	+	+	+
72	*Ocimum Sanctum* L.	+	-	+	+
73	*Oxalis corniculata*	+	+	-	-
74	*Parthenium hysterophorus* L.	+	+	+	+
75	*Phalaris minor* Rets.	+	+	+	+
76	*Phyla nodiflora* (L.) Greene	+	+	+	+
77	*Polygonum plebajum* R. Br.	+	+	+	+
78	*Portulaca oleracea* L.	+	+	+	+
79	*Psidium guajava* L.	+	-	+	+
80	*Punica granatum* L.	-	+	+	-
81	*Rauvolfia serpentina* (L.) benth	+	+	-	-
82	*Rungia pectinata* (L.) Nees	+	+	-	-
83	*Ricinus communis* L.	-	+	+	+
84	*Rumex dentatus* L.	+	+	+	+
85	*Saccharum munja* L.	+	+	-	+
86	*Sida cordifolia* L.	+	+	+	+
87	*Solanum nigrum* L.	+	+	+	+
88	*Spilanthus indicus* Wall.	+	+	+	+
89	*Syzygium cumini* (L.) Skeels.	-	+	-	+
90	*Tamarindus indica* L.	+	-	+	-
91	*Thevetia peruviana* (Pers.)	+	+	+	+
92	*Tridax procumbens* L.	+	+	+	+
93	*Trifolium alexendrium* L.	+	+	+	+
94	*Vernonia ciuria* L.	+	+	+	+
95	*Vicia hirsuta* L.	+	+	-	-
96	*Vitex negundo* L.	+	+	+	+
97	*Vitis veniferea* L.	-	-		+
98	*Xanthium strumarium* L.	+	+	+	+
99	*Zizyphus mauritiana* Lamk.	-	+	-	+

+ : The plant is present

- : The plant is absent

Ricinus communis L. was present predominantly at all the sites except site A. *Parthenium hysterophorus* L. having APTI value 27.90, was noted as a prominent resistant plant with wide distribution irrespective of the pollution load.

Carica papaya L. is a cultivated plant, its APTI value was 81.1 which proves it to be one of the most resistant plants. This plant was recorded at all the study sites including the most polluted site (site D). Its viability at all the sites is an indication of its resistant nature, parallel to its APTI value.

In addition to the biochemical parameters, prevailing meteorology and quality of ambient air can not be ignored, as these are the factors which ultimately regulate the internal atmosphere of plants and also the cells. Since, all the sites were subjected to the same meteorological variable. The observed variation in plant distribution was contributed due to the air pollutants and sensitivity of the plant. Reports by Dwivedi *et al.* (2000) and Waugh *et al*. (2006), where abnormality in plant distribution or plant response respectively, in response of fossil fuel pollution supports our finding.

Conclusively, it was found that the plants with low APTI value were found only at the less polluted sites. The plants with higher APTI value were found to be resistant and were present at most of the sites. Resistant plants also act as a bioaccumulator for air pollutants as also reported by Karthiyayini *et al.* (2005); Prasanna *et al.* (2005). It is suggestible that the resistant plants marked in the investigation can be employed in abatement and control of air pollution. They can be grown in and around the coal fired industries to reduce the pollutants in air. Secondary benefit can be derived from them, as some are of high medicinal importance or fruit yielding.

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