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Assessment of air pollution using air pollution tolerance index (APTI) by two species plant (*Conocarpus lancifolius*) and (*Dodonaea viscosa)* in babylon provinus

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Abstract

Plants play as filters to reduce air pollution that produce from the Brick Factory and also as bio-indicators of air quality can be divided plants for sensitivity or tolerance to air pollutants because the sensitive plants can serve as bio-indicator and the tolerant plants as sink for controlling air pollution in industrial areas. Biochemical parameters namely relative water content, leaf extract pH, ascorbic acid, and total chlorophyll, were estimated Air Pollution Tolerance Index (APTI) for two plants each at the first site (S1) in the direction of predominant winds and the second site (S2) in opposite the direction of predominant winds. The results showed the plant *Conocarpus lancifolius* can be tolerant towards air pollution in comparison with plant *Dodonaea viscosa* that consider as sensitivity to air pollution.

Key words

Air Pollution, Relative Water Content, Air Pollution Tolerance Index APTI, Ascorbic Acid.

Introduction

Air pollution is a major problem plaguing most countries of the world today. Pollution of the environment could be attributed largely to industrial and development. Air pollution is the contamination of the atmosphere, this contamination is generally said to be largely due to increased human activities [1]. Air pollution is therefore the emission of substances into the atmosphere in quantities that would alter the natural composition of air to the extent of causing harm, or discomfort of living things and /or damage to the environmental [2]. Air pollution arises as a fall-out from industrialization and urbanization [2-9]. Plants are known to play a major role in removing pollutant from the environment as part of their normal functioning [2,10,11]. The adaptive strategies include changes in physiological and biochemical processes [12,13]. It is therefore expedient to use plants biochemical parameters as an index of pollution. Several workers had in fact used plant as indication of air pollution [3, 4,8,11,12,14,15]. Air pollution can directly affect plants via the leaves or indirectly via soil acidification [2]. Plants are therefore effective in monitoring and managing air pollution. Parameters that could be used in monitoring air quality includes; Ascorbic acids content, relative water content, chlorophyll content and leaf extract pH [16-19]. Singh and Rao[20] developed the Air Pollution Tolerance Index (APTI).

Materials and Methods

Sampling procedures and methods employed are according to standard methods as described by [22]. Two plants species in one age and place in two site of brick factory region. The first site (S1) in the direction of predominant winds and the second site (S2) in opposite the direction of predominant winds. Leaf Samples of the plants were then collected weekly for six week. Three replicates of fully matured leaves were taken and immediately taken to the laboratory for analysis. can be computed using the formula shown below:-

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

A = Ascorbic acid content (mg/g) T = Total chlorophyll content (mg/g)
P = pH of leaf extract R = Relative water content (%)

Which is based on the above four parameters to assess tolerance/resistance of plants against air pollution. classified plants according to: APTI<10 sensitive, APTI 10-16 intermediate, APTI $\geq$ 16 tolerant [21].

Statistical Analysis

For statistical analysis of the current study Duncan design was used for laboratory experiments and data were analyzed to study the Comparison between the S1 and S2 site for two plants and at least significant difference was used to compare the significant difference between means at $P<0.05$.

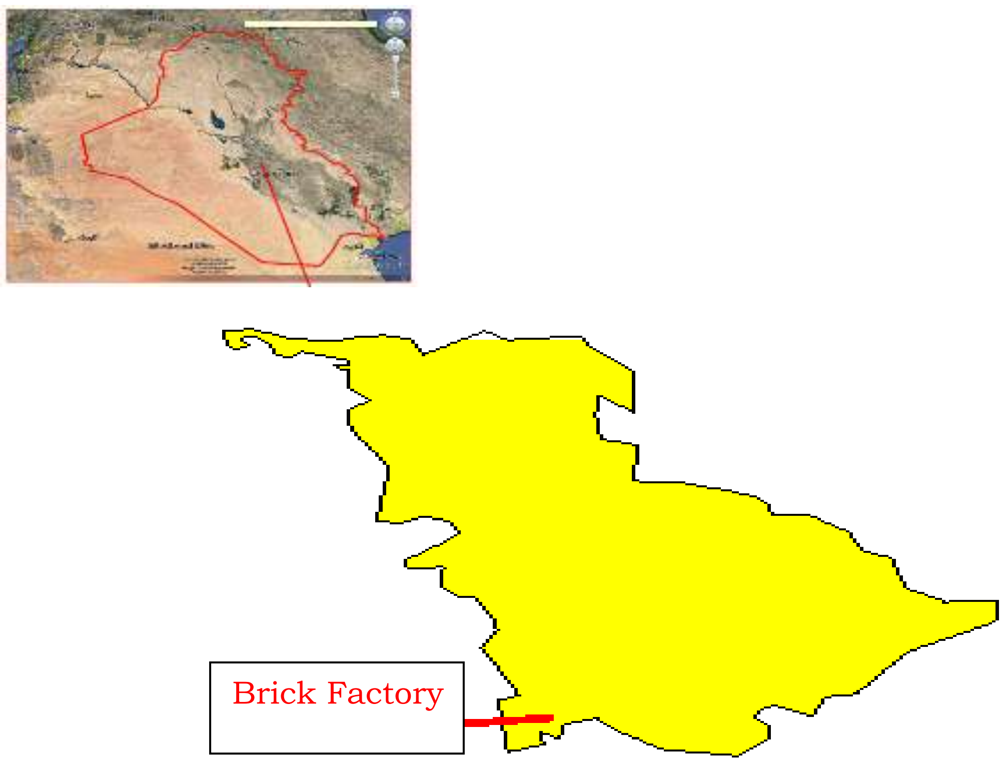

Fig.1 Map of the brick factory in Babylon Provinous

Result and Discussion

Results are presented in the Table (1) and (2). That show the Air Pollution Tolerance Index (APTI) in the plants *Conocarpus lancifolius* and *Dodonaea viscosa*. The pH of leaf extracts ranged from 4.60 – 4.86 in (*Conocarpus lancifolius*) of S1 and ranged from 4.60– 4.63 in S2. While the pH of leaf extracts ranged from 5.10 – 5.12 (*Dodonaea viscosa*) of S1 and ranged from 4.73 –5.20 in S2. These pH values for two plants are indicator of an acidic medium. The acidic nature of the leaf is indicator of the nature to the air pollutants present. It indicates the acidic nature of the pollutants in the brick factory. Acidic pollutants such as SO_2 and NO_x diffuse and forms acid radical in the leaf matrix. Chlorophyll content which is an index of productivity is adversely affected by acidic pH. In this study, the chlorophyll content range from 1.31 – 2.41 in (*Conocarpus lancifolius*) of S1 and ranged from 0.26 – 0.49 in S2. while the chlorophyll content ranged from 0.83 – ١.٧٥ in (*Dodonaea viscosa*) in S1 and ranged from 0.28 –0.70 in S_2. This indicates that productivity were higher in S1 Compared with S2. Ascorbic acid is a stress reducing factors and a strong reducing agent. The pH value affects the ascorbic acid content since it affects the efficiency of conversion of Hexose sugar to ascorbic acid [23]. A high acidic pH increases this conversion. The ascorbic acid ranged from 1.60 - 3.30 in (*Conocarpus lancifolius*) of S1 and ranged from 3.10 – 3.70 in S2. While it ranged from 2.66 – 2.80 in (*Dodonaea viscosa*) in S1 and ranged from 3.10 - 3.30 in S2. High ascorbic acid content is usually associated with tolerant plant species. The Relative water content (R) ranged from 82.88 - 89.93 in (*Conocarpus lancifolius*) of S1 and ranged from 77.49 – 90.51 in S2. While (R) ranged from 61.62 – 65.83 in (*Dodonaea viscosa*) in S1 and ranged from 64.65-65.62 in S2. That ranged from (R) is an index of the hydration condition in plant species. The (R) usually affects the leaf extract pH. The higher (R) the more dilute the solution. biochemical parameters in the plants, there are a very close relationship of these factors since these parameters affect the plant anatomical and physiological, or biochemistry, it is therefore linked to air quality. The combination of these factors to give the air pollution tolerance index in (*Conocarpus lancifolius*) ranged from 9.38 to 11.03 in S1 and ranged from 9.26 -10.93 in S2. while that of (*Dodonaea viscosa*) ranged from 8.02 -8.24 in S1 and ranged from 7.98 to 8.51 in S2. The Statistical analysis showed a significant difference between the two sites for two plants.

Table 1. Air Pollution Tolerance Index (APTI) in plant *Conocarpus lancifolius*

Parameters	Site	First Week M ± SD	Second Week M ± SD	Third Week M ± SD	Four Week M ± SD	Fifth Week M ± SD	Six Week M ± SD
Chlorophyll mg/g	**S1**	1.31 ± 0.78 a	1.90 ± 1.57 a	2.04 ± 1.47 a	2.12 ± 1.45 a	2.21 ± 1.49 a	2.41 ± 1.50 a
	S2	0.49 ± 0.04 c	0.39 ± 0.08 bc	0.27 ± 0.07 ab	0.26 ± 0.07 ab	0.25 ± 0.05 a	0.26 ± 0.07 ab
	Sig	0.14	0.17	0.10	0.09	0.08	0.06
pH	**S1**	4.86 ± 0.05 c	4.73 ± 0.05 bc	4.50 ± 0.10 b	4.20 ± 0.10 a	4.60 ± 0.10 b	4.60 ± 0.26 b
	S2	4.60 ± 0.10 b	4.60 ± 0.10 b	4.30 ± 0.10 a	4.46 ± 0.05 ab	4.50 ± 0.10 b	4.63 ± 0.15 b
	Sig	0.01	0.11	0.07	0.01	0.28	0.85
Ascorbic Acids mg/g	**S1**	3.30 ± 0.10 cd	3.20 ± 0.10 c	2.80 ± 0.10 b	1.80 ± 0.10 a	3.60 ± 0.10 d	1.60 ± 0.43 a
	S2	3.70 ± 0.10 bc	3.60 ± 0.10 b	3.56 ± 0.15 b	3.20 ± 0.10 a	3.86 ± 0.05 c	3.10 ± 0.10 a
	Sig	0.00	0.00	0.00	0.00	0.01	0.00
Relative Water Content %	**S1**	89.93 ± 0.07 d	89.14 ± 0.10 c	87.23 ± 0.10 b	95.20 ± 0.02 e	95.87 ± 0.10 e	82.88 ± 0.93 a
	S2	90.51 ± 0.26 e	68.82 ± 0.12 a	89.45 ± 0.08 d	89.05 ± 0.09 d	72.36 ± 0.10 b	77.49 ± 0.67 c
	Sig	0.02	0.00	0.00	0.00	0.00	0.00
APTI	**S1**	11.03 ± 0.31 b	11.04 ± 0.53 b	10.55 ± 0.43 b	10.65 ± 0.27 b	12.03 ± 0.53 c	9.38 ± 0.25 a

	S2	10.93 ± 0.10 f	8.68 ± 0.09 a	10.57 ± 0.08 e	10.41 ± 0.03 d	9.07 ± 0.06 b	9.26 ± 0.08 c
	Sig	0.62	0.00	0.95	0.20	0.00	0.48

Singh and Rao **[**20**]** developed the air pollution tolerance index based on four biochemical parameters. These parameters are the plant extract pH, relative water content, the ascorbic acid content and the total chlorophyll. All these parameters that effect on the productivity of the plant species.

pH is an indicator of pollution since it affects the conversion of a hexose sugar of ascorbic acid. High pH increases the efficiency to conversion of a hexose sugar to ascorbic acid [23]. Low pH that reported to show a good correlation with sensitivity to air pollution [24]. pH is also indicator of the type of pollutant in the site. Acid pollutants would give a lower (more acidic) pH values.

Chlorophyll content in plants that is indicator to photosynthetic activity. It significant to growth and development of the biomass [25]. Total Chlorophyll is also related to the ascorbic acid productivty and ascorbic acid is concentrated mainly in the chloroplast. It should be noted that the leaf extract pH affects the photosynthetic efficiency of the plant, thus in the Formular the pH is added to the total chlorophyll and them multiplied with the ascorbic acid. It has been reported that total chlorophyll reduces under stress condition [26].

Table 2. Air Pollution Tolerance Index (APTI) in Plant *Dodonaea viscosa*

Parameters	Site	First Week M ± SD	Second Week M ± SD	Third Week M ± SD	Four Week M ± SD	Fifth Week M ± SD	Six Week M ± SD
Chlorophyll mg/g	**S1**	0.83 ± 0.09 a	1.10 ± 0.14 ab	1.30 ± 0.25 ab	1.47 ± 0.35 b	1.63 ± 0.53 b	1.75 ± 0.41 b
	S2	0.70 ± 0.12 a	0.60 ± 0.25 a	0.49 ± 0.34 a	0.45 ± 0.33 a	0.45 ± 0.30 a	0.28 ± 0.03 a
	Sig	0.23	0.04	0.03	0.02	0.02	0.00
pH	**S1**	5.12 ± 0.06 b	5.14 ± 0.14 b	5.03 ± 0.05 b	4.72 ± 0.10 a	5.20 ± 0.10 b	5.10 ± 0.10 b
	S2	5.20 ± 0.10 b	5.40 ± 0.10 c	4.89 ± 0.09 a	4.73 ± 0.11 a	4.80 ± 0.10 a	4.73 ± 0.11 a
	Sig	0.33	0.06	0.07	0.94	0.00	0.01
Ascorbic Acids mg/g	**S1**	2.80 ± 0.10 d	2.30 ± 0.10 b	2.80 ± 0.10 d	1.80 ± 0.10 a	2.50 ± 0.10 c	2.66 ± 0.15 cd
	S2	3.30 ± 0.10 b	3.60 ± 0.10 c	4.30 ± 0.10 d	3.20 ± 0.10 ab	3.70 ± 0.10 c	3.10 ± 0.10 a
	Sig	0.00	0.00	0.00	0.00	0.00	0.01
Relative Water Content %	**S1**	65.83 ± 0.13 b	73.49 ± 0.04 c	75.53 ± 0.13 d	80.84 ± 0.11 e	94.23 ± 0.08 f	61.62 ± 0.09 a
	S2	65.62 ± 0.09 c	64.43 ± 0.08 a	75.12 ± 0.08 e	73.24 ± 0.09 d	79.41 ± 0.03 f	64.65 ± 0.12 b
	Sig	0.08	0.00	0.01	0.00	0.00	0.00
APTI	**S1**	8.24 ± 0.05 b	8.78 ± 0.02 c	9.32 ± 0.07 d	9.19 ± 0.01 d	11.13 ± 0.16 e	8.02 ± 0.15 a
	S2	8.51 ± 0.10 b	8.60 ± 0.17 b	9.82 ± 0.09 d	8.98 ± 0.03 c	9.88 ± 0.04 d	7.98 ± 0.07 a
	Sig	0.02	0.16	0.00	0.00	0.00	0.75

Ascorbic acid is important to cell wall synthesis, photosynthetic, carbon fixation and cell division [27]. Also that is a natural toxicant known to be able to prevent the damaging effect of air pollutant in plant tissues[28]. The high amount of ascorbic acid that favors pollutant tolerance in plants species [29,30]. It is a very important indicator of pollution that it is given a top priority and so used as a multiplication factor in the APTI Formulary. Plants with high ascorbic acid content are generally resistant/tolerant to air pollution while those with low ascorbic acid content are sensitive/non tolerant species. Water in the plant is necessary for the physiological activities in the plant. A high water content within the plant helps to maintain its physiological balance under stress condition. This parameter can also be used as an indicator of pollutant. Although all these four parameters can indicate air quality of an environment, results from individual parameter is not as reliable as those of the combination of all four as APTI.

Conclusions

APTI determination is importance because with increased industrialization, there is increasing danger of deforestation due to air pollution. the basic information on APTI values for these plants will be of important value, as with increase in air pollution there will be an increase in damage to flora. The present study indicates that plant species *Conocarpus lancifolius* can be used as sink towards air pollutants. Therefore, more work should be carried out on the APTI determination of many more plants globally, since air pollution is a global menace.

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