Pak. J. Bot., 47(1): 225-232, 2015.

IMPACT OF SOLID WASTE BURNING AIR POLLUTION ON SOME PHYSIO-ANATOMICAL CHARACTERISTICS OF SOME PLANTS

SAADULLAH KHAN LAGHARI[1*], MUDASSIR ASRAR ZAIDI[1] AND GHULAM RAZAQ[2]

[1]*Department of Botany University of Balochistan Quetta, Pakistan*
[2]*Pakistan, Council for Sciences and Technology, Islamabad*
[*]*Corresponding author's e-mail: saadbotany@yahoo.com and mudassirisrar@hotmail.com*

Abstract

Present study evaluated the effect of solid waste burning pollution on carbohydrate, stomata and chlorophyll contents of seven different plant species. Leaf samples of *Artemisia maritima* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L., *Robinia pseudoacacia* L., and *Sophora mollis* (Royle) Baker, growing in the (1m, 500m and 1000m distance) vicinity of burning points at residential colony, University of Baluchistan Quetta were collected. Results revealed that the carbohydrate, chlorophyll 'a and b' and total chlorophyll contents in the leaves of selected plant species were found to be significantly low at 1m distance, but as the distance from the source of pollution increased (500m & 1000m) these contents increased accordingly. Generally the percentage of completely and partially clogged stomata was found higher near the pollution source (1m distance). The percentage of open stomata in all investigated plant species was noticed lower near the pollution source (1m distance), while with the increase of distance (500m-1000m) the percentage of open stomata increased accordingly. As regard to carbohydrate and chlorophyll contents, the *Artemisia maritima* L., were found most sensitive to air pollution in all four directions at 1m distances as compared to the other species. While plant species, *Cynodon dactylon* L. showed more resistant to air pollution effect as regard to carbohydrate contents and high percentage of open stomata at 1m distances with respect to other species.

Key words: Solid waste, Physio-Anatomical characteristics and Plant species

Introduction

There are potential risks to environment, vegetation and health from improper handling of solid wastes. In many urban areas the residential solid waste disposal practices consist of open-burning using barrels or other similar devices instead of, or in addition to, disposal to municipal landfills or municipal solid waste combustors. The motivations for households that open-burn their garbage may include convenience, habit, or landfill and cost avoidance. Emissions from burning of residential solid waste are released at ground level resulting in decreased dilution by dispersion. Additionally, the low combustion temperature and oxygen-starved conditions associated with solid waste burning may result in incomplete combustion and increased pollutant emissions (Lemieux, 1998). The air pollutants are responsible for plant injuries and great loss of productivity (Joshi & Swami, 2007). Impact of regional air pollution on local plant species is one of the major environmental issues. The air pollutants have long term effects on plants by influencing CO_2 contents, light intensity, temperature and precipitation. Researchers also reported that plants which wre sensitive to air pollutants had shown changes in their morphology, anatomy, physiology and biochemistry (Reig-Armiñana *et al*., 2004; Silva *et al*., 2005). Various authors investigated the effect of pollution on different plant species. A strong correlation between the degree of contamination and concentrations in all plant leaves assessed displayed that plants like *Robinia pseudoacacia* reflect the environmental changes accurately, and they appear as an effective biomonitor of environmental quality (Celik *et al.,* 2005). Leghari & Zaidi (2013) reported that the plants from polluted sites present important morphological changes especially regarding their colors, shapes, leaf length, width, area and petiole length. Any change in the atmospheric environment may also cause the change in the biochemical and physiological attributes of plants (Jaleel *et al.,* 2009). Reduction of dry weight in *Gossypium hirsutum* due to reduced photosynthesis as a result of dust deposition was reported by Armburst, (1986). Jahan & Iqbal (1992) observed reduction in leaf blade area of five tree species as a result of extensive dust and SO_2 pollution. Most of the plants experience physiological alterations before morphological injury and symptoms become visible on their leaves (Liu & Ding, 2008). Exposure to pollutant gases, particularly SO_2, causes stomatal closed. The interactions between plants and different types of pollutants were investigated by many authors: most studies on the influence of environmental pollution focus on physiological and ultra structural aspects (Heumann, 2002; Psaras & Christodoulakis, 1987; Velikova *et al.,* 2000). The major portions of the important physiological processes in plant are concerned with leaf and therefore, the leaf at its various stages of development, serves as a good indicator to air pollutants (Eames & MacDaniels, 1947; Horsefall, 1998; Henry & Heinke, 2005; Silva *et al*., 2005; Sodhi, 2005; Bhatia, 2006; Rao, 2006; and Stevovic, *et al.,* 2010). Rai *et al.* (2010) investigated on ten annual plant species and revealed that the foliar surface was an excellent receptor of atmospheric pollutants leading to a number of structural and functional changes.

The aim of present study was to investigate the effect of air pollutants on the leaf Physio-anatomical characteristics (carbohydrate, chlorophyll 'a', chlorophyll 'b', total chlorophyll and stomata) of some plants species viz., *Artemisia maritima* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L., *Robinia pseudoacacia* L., and *Sophora mollis* (Royle), Baker growing near the solid waste burning points. It is envisaged that the findings of the investigation would provide additional information on the nutritional status of the vegetation.

Materials and Methods

Collection of leaf samples: This study was carried out around the solid waste burning points at University of Balochistan, Quetta Pakistan. For leaf samples collection, 7 different plant species viz., *Artemisia maritima* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L., *Robinia pseudoacacia* L., and *Sophora mollis* (Royle) Baker were selected, because these species were growing abundantly (around the solid waste burning points) in all the four directions; north, south, east and west. From each direction the leaf samples were taken just around the burning point at the distance of 1m, 500m and 1000m. The samples were immediately brought to the laboratory to examine the effect of air pollution on carbohydrate and chlorophyll contents and stomatal clogging.

Carbohydrate analysis: One gram (1g) of macerated leaf sample was placed in 25ml bottle; 10ml of distilled water was then added and shaken vigorously followed by addition of 15cm^3 of 52% perchloric acid. This was stirred continuously for 30minutes and the mixture was later filtered using Whatman No1 filter paper. One milliliter (1ml) of the filtrate was mixed with 4cm^3 of Anthrone reagent in a test tube and the absorbance of the mixture was measured using spectrophotometer at a wavelength of 620nm. The total soluble carbohydrate was then estimated using the standard curve of Glucose (Pearson *et al*., 1976).

Chlorophyll content: The chlorophyll content (Chl) from leaf samples was measured as described by Chutipaijit *et al*. (2012). Quickly, leaf (0.1 g) powder was lyophilized in 80% acetone and centrifuged at 10000×*g* for 10 min. Absorbance was recorded at 646 and 663 nm, and chlorophyll contents calculated.

Anatomical study of leaf epidermis: Anatomical study of leaf epidermis was done by using method given by Salisbury, (1927) revised by Radoglou & Jarvis, (1990). Impression of adaxial (upper) and abaxial (lower) epidermis were taken from the point of maximum leaf width near the central vein of the leaf, using colorless nail polish and adhesive transparent tape. Replica impression were taken from leaf epidermis and examined under a light microscope (Ernst Leitz Gmbh Wetzlar, Type 20-446.023, Germany) at a different magnification of microscope (*50, *125 or *1250) for stomatal cell studies. At least five microscopic fields were randomly selected per replica. Percentage of completely, partially closed stomata and total open stomata were calculated under the microscope and then average was made.

Statistical analysis: The recorded data were subjected to two-way analysis of variance (ANOVA) to assess the influence of different variables (1m, 500m and 1000m distance) on the concentrations of Carbohydrate, Chlorophyll 'a', Chlorophyll 'b', Total chlorophyll, Completely clogged Stomata, Partially clogged stomata and Open stomata in the leaves of different plant species (Steel & Torrie, 1980).

Results and Discussion

Leaf is the most sensitive part to be affected by air pollutants instead of all other plant parts likes roots and stems (Shafiq *et al.,* 2009). Plants have long been known to act as a sink for air pollutants and to face the harmful consequences. Reduction of carbohydrate, pigments, ascorbic acid and protein was noticed by Prasad and Rao, (1981) in petroleum–coke treated plant, *Phaseolus aureus*. This study investigates the impact of air pollutants (produced by solid waste burnings) on various foliar parameters (carbohydrate, chlorophyll 'a', chlorophyll 'b', total chlorophyll and stomata) of *Artemisia maritime* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L., *Robinia pseudoacacia* L., and *Sophora mollis* (Royle) Baker that were growing in the vicinity of solid waste burnings point.

Carbohydrate contents: Carbohydrate is an important storage and structural material for the plants. It is mainly produced in green leaves where mesophyll tissue is full of green pigments called chlorophylls. Carbohydrates constitute more than 50% of the dry weight of most plants (Lehninger, 1993). In present study, Test Statistic indicated that carbohydrate contents increased slightly to highly significantly (p>0.05 & p>0.01) in the leaves of all investigated plant species as the distance increased from pollution source (500m, and 1000m distance), respectively (Table 4). A significant reduction in carbohydrate contents was noted near the pollution source (1m distance). Observations noticed by Mengel *et al.* (1989) are in agreement with these results. They found that in the younger needles of *Picea abies* there was significantly lower concentration of starch, glucose, and fructose near the pollution source. Uaboi-Egbenni *et al*. (2009) described that the plants growing in the urban area were greatly affected by air pollutants. Average contents of carbohydrate at varying distance (1m, 500m, and 1000m) in *Artemisia maritima* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L., *Robinia pseudoacacia* L., and *Sophora mollis* (Royle) Baker was 71.5 -114.1, 166.1-247.2, 84.4-201.1, 224.1 - 346.2 , 113.4-266.6 , 162.9 -278.5 and 96.8 -202.1 mg/g, respectively towards all the four directions; (north, south, east and west). Carbohydrate contents were found highest in the leaves of *C. dactylon* L. and lowest in the leaves of *A. maritima* L. (Table 1). In terms of carbohydrate content the plant specie *A. maritima* L. showed much lower concentration as compared to the other investigated species that indicating their sensitivity to air pollution, whereas *C. dactylon* L. heaving highest carbohydrate contents representing more tolerant species with respect to all other investigated plant species. Leghari *et al.* (2011) obtained that different plant species differently respond to air pollution, hence the different APT indices was obtained in those plants growing in polluted environment.

Table 1. Effect of air pollution on carbohydrate contents of some plant leaves collected from different distance around the solid waste burring points.

Plant species	Direction	Carbohydrate contents (mg/kg) at different distance		
		1m	500m	1000m
Artemisia maritima L.	N	70.4	92.6	110.2
	S	72.6	96.4	115.6
	E	70.5	95.0	114.8
	W	72.4	95.7	115.7
	Avg	71.5 ± 2.04	94.9 ± 1.2	114.1 ± 1.5
Fraxinus excelsior L.	N	163.3	198.0	242.4
	S	168.3	202.3	255.0
	E	166.2	201.6	246.1
	W	166.4	201.0	245.4
	Avg	166.1 ± 2.1	200.7 ± 1.9	247.2 ± 5.4
Amaranthus viridis L.	N	82.5	112.4	298.2
	S	85.6	113.1	203.5
	E	85.3	112.8	201.2
	W	84.2	112.7	201.4
	Avg	84.4 ± 1.4	112.8 ± 0.3	201.1 ± 2.2
Cynodon dactylon L.	N	221.1	310.6	344.4
	S	224.7	313.0	347.9
	E	225.3	312.5	346.6
	W	225.4	311.0	346.0
	Avg	224.1 ± 2.0	311.8 ± 1.2	346.2 ± 1.5
Chenopodium album L.	N	112.2	224.3	265.9
	S	115.4	225.3	267.9
	E	112.4	224.9	266.2
	W	113.4	225.0	266.2
	Avg	113.4 ± 1.5	224.9 ± 0.4	266.6 ± 0.9
Robinia pseudoacacia L.	N	161.3	230.2	275.1
	S	165.2	233.3	280.1
	E	162.2	232.4	280.5
	W	165.2	233.4	278.4
	Avg	162.9 ± 2.0	232.31 ± 1.1	278.5 ± 2.4
Sophora mollis (Royle) Baker	N	95.3	124.0	200.2
	S	95.4	125.2	201.3
	E	96.2	126.1	203.2
	W	100.1	126.5	203.5
	Avg	96.8 ± 2.3	125.5 ± 1.1	202.1 ± 1.6

Values are mean of five samples of leaves from each plant species. ± = STEDV. N, S, E & W = North, South, East & West. Ave = Average

Chlorophyll contents: Any change in the atmospheric environment may also cause the change in the biochemical and physiological attributes of plants (Jaleel *et al.*, 2009). In this study the statistical data presented in Table 4 exhibited that the chlorophyll 'a' showed slightly significant variation at $p>0.05$ significant level in all the investigated plants species at varying distance from pollution source. For chlorophyll 'b' contents two plant species (*Artemisia maritima* L., *Fraxinus excelsior* L.) were highly significant at $p>0.01$ level, while other remaining species were slightly significant at $p>0.05$ significant level for different distance from pollution source. While with respect of total chlorophyll contents two plant species (*Amaranthus viridis* L. and *Chenopodium album* L.) exhibited slightly significant and other remaining species showed highly significant variation at 1m, 500m, and 1000m distance from pollution source. Generally all the selected plant species showed significantly low concentration near the pollution point (1m distance) as compared to away from source of pollution (500m and 1000m). Lowest chlorophyll 'a' 'b' contents were also reported by Leghari *et al.* (2011) in the plant species *E. angustifolia* L. from polluted sites of Quetta city. A significant reduction in plant length, cover, number of leaves, leaf area and total chlorophyll contents for *V. vinifera* L. due to dust application was observed by Leghari *et al.* (2014). Results also exhibited that the average contents of Chlorophyll 'a' & 'b' and Total chlorophyll was found 0.1-1.5, 1.8-4.2 and 1.9-6.3 mg/kg, indicating *Artemisia maritima* L. as a lowest and *Chenopodium album* L. showed highest contents, respectively towards all four directions at 1m distance (Table 2). This leads to a decrease in photosynthetic rate and quantum yield near the pollution source. Present findings are also in line with the results recorded by Agbaire & Esiefarienrhe, (2009) and Chauhan, (2010). They explained that the low concentration of total chlorophyll contents in the polluted sites was due to acidic pollutants like SO_2 that cause phaeophytin formation by acidification of chlorophyll. Trag e*t al.* (2001) made a comparative study of the leaves of *Ziziphus mauritiana* L. collected from a non-polluted site and a heavily polluted site. They found out certain morphological, biochemical and physiological changes with respect to pollution. In the present study plant species like *A. maritima* L. were found to be the most sensitive and *C. album* L., more tolerant to air pollution as compared to the other investigated species as indicated by their minimum and maximum Chlorophyll 'a' & 'b' and Total chlorophyll near the pollution source (1m distance) as in Table 2. The findings of this paper confirmed the previous results by Singh & Rao, (1980) on wheat plants, Prasad & Inamdar, (1991) on *Vigna mungo* and Nanos and Ilias, (2007) on olive leave physiology.

Table 2. Effect of air pollution on chlorophyll 'a' & 'b' and total chlorophyll (mg/kg) contents of some plant leaves collected from different directions at different distance around solid waste burring points.

Plant species	Direction	1m			500m			1000m		
		Chl'a'	Chl'b'	Total chl.	Chl'a'	Chl'b'	Total chl.	Chl'a'	Chl'b'	Total chl.
Artemisia maritima L.	N	0.07	1.5	1.3	1.3	3.4	4.7	2.3	5.4	7.5
	S	0.11	1.9	2.2	1.6	3.9	5.3	2.7	5.8	8.6
	E	0.10	2.0	2.0	1.4	3.7	5.1	2.8	5.7	8.4
	W	0.09	1.8	1.9	1.4	4.1	6.2	3.5	5.9	9.2
	Ave	0.1±0.02	1.8±0.2	1.9±0.4	1.4±0.1	3.8±0.3	5.3±0.6	2.8±0.5	5.7±0.2	8.4±0.7
Fraxinus excelsior L.	N	0.55	2.84	3.40	1.23	4.37	5.70	1.98	5.76	7.85
	S	0.58	2.87	3.45	1.43	4.40	5.81	2.42	5.87	8.18
	E	0.59	2.88	3.44	1.26	4.46	5.74	2.32	5.85	8.17
	W	0.59	2.86	3.46	1.42	4.47	5.89	2.22	5.86	8.08
	Ave	0.6±0.02	2.9±0.02	3.4±0.03	1.3±0.2	4.4±0.1	5.8±0.1	2.2±0.2	5.8±0.1	8.1±0.2
Amaranthus viridis L.	N	0.63	3.40	4.02	1.25	3.74	5.01	2.31	4.36	6.67
	S	0.65	3.43	4.08	1.30	3.96	5.26	2.42	4.54	6.92
	E	0.65	3.44	4.11	1.35	3.92	5.27	2.34	4.52	6.87
	W	0.65	3.44	4.07	1.46	4.79	6.23	2.42	4.50	6.96
	Ave	0.7±0.01	3.4±0.02	4.1±0.04	1.3±0.1	4.1±0.5	5.4±0.5	2.5±0.1	4.5±0.1	6.9±0.1
Cynodon dactylon L.	N	0.18	2.30	2.50	0.90	2.66	3.56	1.22	3.67	4.89
	S	0.20	2.35	2.54	1.76	4.33	6.09	1.67	4.45	6.12
	E	0.24	2.33	2.55	1.23	4.35	5.58	2.12	5.10	7.22
	W	0.23	2.39	2.53	0.98	3.63	4.60	1.55	4.37	5.92
	Ave	0.2±0.03	2.3 ±0.04	2.5±0.02	1.2±0.4	3.7 ±0.8	5.0±1.1	1.6 ±0.4	4.4 ±0.6	6.0±1.0
Chenopodium album L.	N	1.50	4.20	5.70	1.74	4.75	6.54	2.65	5.63	8.40
	S	1.55	4.24	5.74	2.12	4.80	6.99	3.77	5.72	8.49
	E	1.53	4.22	5.72	2.84	4.87	6.60	2.81	5.80	8.44
	W	1.52	4.23	5.75	2.15	4.77	6.92	2.76	5.64	8.45
	Ave	1.5±0.02	4.2±0.02	6.3±0.02	2.2±0.2	4.8±0.1	7.6±0.2	3.75 ±1.1	5.7±0.1	8.5±0.1
Robinia pseudoacacia L.	N	1.17	3.40	4.61	1.67	4.55	6.22	2.72	5.54	7.42
	S	1.23	3.45	4.65	1.72	4.65	6.37	2.87	5.59	8.46
	E	1.20	3.47	4.65	2.20	4.63	6.84	3.86	5.57	8.29
	W	1.20	3.47	4.63	1.73	4.60	6.38	2.87	5.83	8.70
	Ave	1.2±0.02	3.4 ±0.03	4.6±0.02	1.8±0.3	4.6±0.1	6.5±0.3	3.08 ±0.5	5.6±0.1	8.2±0.6
Sophora mollis (Royle) Baker	N	0.75	3.65	4.44	2.04	3.95	6.13	2.88	5.88	7.77
	S	0.84	3.69	4.48	2.09	4.77	6.85	3.13	5.96	8.08
	E	0.79	3.67	4.46	2.18	4.77	6.86	2.92	6.05	8.90
	W	0.82	3.68	4.50	2.09	4.73	6.78	2.94	5.97	8.98
	Ave	0.8±0.04	3.7±0.02	4.5±0.03	2.1±0.1	4.6±0.4	6.7±0.4	2.97 ±0.1	6.0±0.1	8.4±0.6

Chl'a' = Chlorophyll 'a', Chl'b'= Chlorophyll 'b', Total chl.= Total chlorophyll , Values are mean of five samples of leaves from each plant species. ± = STEDV. N, S, E & W = North, South, East & West. Ave = Average

Table 3. Effect of air pollution on plant leaf stomata at different distance around solid waste burring points.

Plant species	Direction	Percentage of open and clogged stomata								
		1m			500m			1000m		
		Completely	Partially	Open	Completely	Partially	Open	Completely	Partially	Open
Artemisia maritima L.	N	7.8	7.6	84.6	4.9	4.9	90.2	2.8	2.6	94.6
	S	7.5	7.1	85.4	4.7	4.2	91.1	2.4	2.2	95.4
	E	7.4	7.0	85.6	4.8	4.1	91.1	2.5	2.1	95.4
	W	7.5	7.2	85.3	4.5	4.3	91.2	2.2	2.2	95.6
	Ave	7.6±0.2	7.3±0.3	85.2±0.4	4.7±0.2	4.4±0.36	90.9±0.5	2.5±0.25	2.3±0.2	95.3±0.4
Fraxinus excelsior L.	N	7.1	6.9	86.0	5.9	3.9	90.2	1.66	2.9	95.44
	S	6.3	5.6	88.1	5.4	3.8	90.8	1.35	2.3	96.35
	E	6.4	5.9	87.7	5.4	3.6	91.0	1.32	2.4	96.28
	W	6.1	6.7	87.2	5.4	3.7	90.9	1.32	2.2	96.48
	Ave	6.5±0.4	6.3±0.6	87.3±0.9	5.5±0.3	3.8±0.1	90.7±0.4	1.4±0.2	2.5±0.3	96.1±0.5
Amaranthus viridis L.	N	11.4	6.8	81.8	7.4	5.5	87.1	3.6	2.9	93.5
	S	10.4	6.2	83.4	6.5	4.6	88.9	2.5	2.7	94.8
	E	10.2	6.2	83.6	6.4	4.6	89.0	2.5	2.6	94.9
	W	10.3	6.3	83.4	6.4	4.5	89.1	2.5	2.9	94.6
	Ave	11±0.6	6.4±0.3	83.1±0.8	6.7±0.5	4.8±0.5	88.5±1.0	2.8±0.6	2.8±0.2	94.5±0.7
Cynodon dactylon L.	N	1.8	2.8	95.4	0.65	2.1	97.25	0.09	0.6	99.31
	S	1.1	2	96.9	0.54	1.23	98.23	0.02	0.4	99.58
	E	1.2	2.1	96.7	0.55	1.1	98.35	0.03	0.5	99.47
	W	1.3	2.1	96.6	0.5	1.1	98.40	0.06	0.5	99.44
	Ave	1.4±0.3	2.3±0.4	96.4±0.7	0.6±0.1	1.4±0.5	98.1±0.5	0.05±0.03	0.5±0.1	99.5±0.1
Chenopodium album L.	N	8.6	7.7	83.7	5.6	4.8	89.6	2.6	2.5	94.9
	S	8.2	7.4	84.4	5.21	3.8	90.99	2.2	2.1	95.7
	E	8.2	7.3	84.5	5.24	4.6	90.16	2.22	2.1	95.68
	W	8.3	7.4	84.3	5.3	4.5	90.20	2.21	2.3	95.49
	Ave	8.3±0.2	7.5±0.2	84.2±0.4	5.3±0.2	4.5±0.4	90.2±0.6	2.3±0.2	2.3±0.3	95.4±0.4
Robinia pseudoacacia L.	N	7.9	8.9	83.2	5.8	4.8	89.4	2.9	2.6	94.5
	S	7.6	7.8	84.6	5.5	4.5	90.0	2.5	2.3	95.2
	E	7.5	7.9	84.6	5.4	4.6	90.0	2.5	2.3	95.2
	W	7.6	7.8	84.6	5.4	4.5	90.1	2.6	2.3	95.1
	Ave	7.7±0.2	8.1±0.1	84.3±0.6	5.5±0.2	4.6±0.1	89.9±0.3	2.6±0.2	2.4±0.1	95.0±0.3
Sophora mollis (Royle) Baker	N	12.5	11.4	76.1	6.6	5.9	87.5	3.8	1.7	94.5
	S	11.3	10.4	78.3	6.2	5.7	88.1	3.7	1.2	95.1
	E	11.3	10.4	78.3	6.3	5.8	87.9	3.5	1.3	95.2
	W	11.5	10.5	78.0	6.2	5.7	88.1	3.6	1.2	95.2
	Ave	11.7±0.6	10.7±0.5	77.7±1.1	6.3±0.2	5.8±0.1	87.9±0.28	3.7±0.1	1.4±0.2	95.0±0.3

Values are mean of five samples of leaves from each plant species. ± = STEDV. N, S, E & W = North, South, East & West. Ave = Average

Effect on stomata: Solid waste (released by household, hospital and Industrial plants) are the combination of number of different things on burning gives rise to CO_2, CO, SO_2 (sulfur dioxide), NO_x (NO and $NO_{2)}$ in varying proportions and C_2H_4 (ethylene), as well as a variety of other hydrocarbons. These gases pollutants such as SO_2 and NO_x enter leaves through stomata, following the same diffusion pathway as CO_2. NO_x dissolves in cells and gives rise to nitrite ions (NO_2^-, which are toxic at high concentrations) and nitrate ions (NO_3^-) that enter into nitrogen metabolism as if they had been absorbed through the roots. In some cases, exposure to these pollutant gases, particularly SO_2, causes stomatal closed (David *et al*., 1981). Statistical data listed in Table 4 exhibited that one plant specie (*Robinia pseudoacacia* L.) showed slightly significant variation at $p>0.05$ significant level for its completely clogged stomata, while all other remaining species [*Artemisia maritima* L., *Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L., *Chenopodium album* L. and *Sophora mollis* (Royle) Baker] were highly significant at $p>0.01$ significant level at varying (1m, 500m and 1000m) distance from the pollution source. Where as for partially clogged stomata four species (*Fraxinus excelsior* L., *Amaranthus viridis* L., *Cynodon dactylon* L. and *Chenopodium album* L.) were slightly significant ($p>0.05$) and other three species (*Artemisia maritima* L., *Chenopodium album* L. and *Sophora mollis* (Royle) Baker] were highly significant at $p>0.01$ significant level for varying (1m, 500m and 1000m) distance from the pollution source. The results also revealed that the relative percentage of completely, partially clogged stomata in all the selected plant species were higher (1.4 - 11.7%, 2.3 - 10.7%) near the pollution source (1m distance), respectively. The observation reported by David *et al*. (1981) are the agreement with these results as they found that the air pollutants particularly SO_2 and NO_x induced stomatal closure and injury. Carlos & Lorenzo, (2001) indicated that NO and others derived compounds was responsible for the induction of stomatal closure. The interactions between plants and different types of pollutants were investigated by many authors: most studies on the influence of environmental pollution focus on physiological and ultrastructural aspects (Heumann, 2002; Psaras & Christodoulakis, 1987; Velikova *et al*., 2000). In the present study the percentage of completely, partially clogged stomata became lower (0.6 - 6.7%, 1.4 - 5.8% at 500m & 0.05 - 3.7%, 0.5 - 2.8% at1000m distance) as the distance increased from the pollution source. The high percentage of completely, partially clogged stomata in all the plant species near the pollution source might be release of different air pollutants like heavy metals. Heavy metals released from automobiles, solid waste burning are extremely toxic metal and reduces plant growth, morphological and Physio-anatomical parameters. The observation made by Keskin & Ili, (2012), Gielwanowska *et al*. (2005) and Makbul *et al*. (2006) also supported these views. They found that the plants growing close to the busy road of the city are highly affected by auto-emission. The inhibitory effects on the morphological, Physio-anatomical parameters and growth of plants are due to the presence of toxic material in the solid waste burning and auto-emission. The study conducted by Ahmad *et al*. (2012) is agreement that the Cadmium had toxicity at 5 mg L -1 in case of root and shoot growth. In plant specie like *C. dactylon* L. the percentage of completely, partially clogged stomata was found to be low to wards all the four directions at varying distances (Table 3). The stomata of this plant were found to be resistant to air pollution effect as compared to other species. The percentage of completely, partially clogged stomata in the leaves of different plants towards north was higher than to the other direction. A large number of stomata were found to be completely, partially clogged in the leaves of *S. mollis* (Royle) Baker and *A. viridis* L., as compared to other plant species near the pollution source indicating their sensitivity to air pollution. A significant large number of leaf stomata's were found to be closed and abnormal/injured from polluted sites plants species as reported by Leghari, (2013). Other workers (Iqbal & Shafiq, 1999; Shafiq & Iqbal, 2003; 2005) also reported that plants growing adjacent to roadsides of Karachi city exhibited considerable damage in response to automobile exhaust emission. They also reported that atmospheric pollutants after making their entry through stomata of leaf causes reduction in leaf size of plants due to damage of photosynthetic tissues.

Open stomata: Statistical data illustrated in Table 4 exhibited that except one plant specie (*C. dactylon* L.) which showed non-significant variation, all the other plant species showed slightly significant (p>0.05) difference in their percentage of open stomata between varying distance. The percentage of open stomata in all the plant species was lower (77.7 - 96.4 %) at 1m distance near the pollution source. While it became increased (87.9 - 98.06%) with the increase of the distance (500m & 1000m) away from the pollution source correspondingly. Alireza *et al*. (2010) investigated and found that the leaves of plane trees (*Platanus orientalis*) of urban area are damaged by traffic pollution. In plant like *C. dactylon* L. the percentage of open stomata towards all the four directions was found to be (96.4 - 99.45%) more than 90% at varying distances (Table 3). Stomata of this plant were found to be more resistant to air pollution effect as compared to other species. Comparatively lower percentage of open stomata in the leaves of *S. mollis* (Royle) Baker indicates their sensitivity to air pollution.

Table 4. Analysis of variance (ANOVA) to assess the influence of different variables (1m, 500m and 1000m distance) on the concentrations of carbohydrate, chlorophyll 'a', chlorophyll 'b', total chlorophyll, completely, partially clogged stomata and open stomata in the leaves of different plant species.

Plant species	Carbohydrate	Chl'a'	Chl'b'	Total chl	Clogged stomata		Open Stomata
					Completely	Partially	
Artemisia maritima L.	**	*	**	**	**	**	*
Fraxinus excelsior L.	**	*	**	**	**	*	*
Amaranthus viridis L.	**	*	*	*	**	*	*
Cynodon dactylon L.	**	*	*	**	**	*	n. s
Chenopodium album L.	**	*	*	*	**	**	*
Chenopodium album L.	**	*	*	**	**	*	*
Robinia pseudoacacia L.	**	*	*	**	*	**	*
Sophora mollis (Royle) Baker	**	*	*	**	**	**	*

*, ** & $^{n.s}$ = Significant at (p>0.05), (p>0.01) and Non-significant, Chl'a' = Chlorophyll 'a', Chl'b'= Chlorophyll 'b', Total chl. = Total chlorophyll

Conclusion

This study concentrated on the influence of solid waste burning air pollution on Physio-anatomical characteristics of some plants. The plant leaves of different investigated species growing near the pollution sources contain significantly less carbohydrates Chlorophyll 'a', Chlorophyll 'b' and Total chlorophyll contents as compared to the plant leaves away from pollution sources. Undoubtedly, the anatomical and ultra structural changes in the leaf structure (Completely & Partially clogged Stomata and Open Stomata) were noticed, measured and described, taking into consideration all stress factors. The possible positive human influence on the environment could be to decrease the pollutions and to improve the vegetation of pollution sites urban environment. The present study provides a good basis for further research on impact of the all types of urban solid waste burning to morphological and Physio-anatomical structure of the plants.

References

Agbaire, P.O. and E. Esiefarienrhe. 2009. Air pollution tolerance indices (APTI) of some plants around Otorogun Gas Plant in Delta State, Nigeria. *J. Appl. Sci. Environ. Manage.*, 13(1): 11-14.

Ahmad, I., M.J. Akhtar, Z.A. Zahir and A. Jamil. 2012. Effect of cadmium on seed germination and seedling growth of four wheat (*Triticum aestivum* L.) cultivars. *Pak. J. Bot*., 44: 1569-1574.

Alireza, P., R. Nayerah, O. Andrea, L. H. Rosemarie and P. Andrea. 2010. Influence of environmental pollution on leaf properties of urban plane trees, *Platanus orientalis* L. *Bull Environ Contam Toxicol*., 85: 251-255.

Armbrust, D.V. 1986. Effect of particulates (dust) on cotton growth, photosynthesis, and respiration. *Agronomy Journal*, 78: 1078-1081.

Bhatia, S.C. 2006. Environmental Chemistry, *CBS publishers and Distributors.*

Carlos, G.M. and L. Lorenzo. 2001. Nitric oxide induces stomatal closure and enhances the adaptive plant responses against drought stress[1]. *Plant Physiol*., 126: 1196-1204.

Celik, A., A. Kartal, A. Akdogan and Y. Kaska. 2005. Determining the heavy metal pollution in Denizli (Turkey) by using *Robinia pseudoacacia* L. *Environ. Int.,* 31(1):105-112.

Chauhan, A. 2010. Tree as bio-indicator of automobile pollution in Dehradun city: A case study. *New York Sci. J.,* 3: 88-95.

Chutipaijit, S., S. Cha-um and K. Sompornpailin. 2012. An evaluation of water defficit tolerance screening in pigmented indica rice genotypes. *Pak. J. Bot*., 44: 65-72.

David, K., S. Warre and K. John. 1981. ELISA: An enzyme antibody immunoassay for detection of *Brucella abortus* antibodies in milk: Correlation with *Brucella* ring test and with shedding of viable organism. *J. Clin. Microbiol.*, 14: 396-403.

Eames, A.J. and L.H. Macdaniels. 1947. An introduction to plant anatomy, 2nd ed. McGraw-Hill, New York, New York, USA.

Gielwanowska, I., E. Szczuka, J. Bednara and R. Gorecki. 2005. Anatomical features and ultra-structure of *Deschampsia antarctica* (*Poaceae*) leaves from different growing habitats. *Ann. Bot.,* 96: 1109-1119.

Henry, G.J. and G.W. Heinke. 2005. *Environmental Science Engineering*. Second Edition Prentice –Hall of India Private Limited New Delhi.

Heumann, H. G. 2002. Ultrastructural localization of zinc in zinc-tolerant *Armeria maritime* ssp. *halleri* by autometallography. *Journal of Plant Physiology*, 159(2):191-203.

Horsefall, Jnr. M. 1998. *Principles of Environmental Pollution with Physical, Chemical and Biological Emphasis.* Port Harcourt, Metropolis Ltd., pp: 62-124.

Iqbal, M.Z. and M. Shafiq. 1999. Impact of vehicular emission on germination and growth of Neem (*Azadirachta indica*) tree. *Hamdard Medicus.,* XLII: 65-69.

Jahan, S. and M.Z. Iqbal. 1992. Morphological and anatomical studies on leaves of different plants affected by motor vehicle exhausted. *Journal of Islamic Academy of Sciences*, 5: 21-23.

Jaleel, C.A., P. Manivannan, A. Wahid, M. Farooq, R. Somasundaram and R. Panneerselvam. 2009. Drought stress in plants: a review on morphological characteristics and pigments composition. *Int. J. Agric. Biol.*, 11: 100-105.

Joshi, P.C. and A. Swami. 2007. Physiological responses of some tree species under roadside automobile pollution stress around city of Haridwar, India. *Environmentalist,* 27: 365-374.

Keskin1, N. and P. Ili. 2012. Investigation of Particular Matters on The Leaves of *Pinus nigra* Arn. Sub sp. *Pallasiana* (Lamb.) Holmboe In Denizli (Turkey), *Pak. J. Bot*., 44:1369-1374.

Laghari, S.K. 2013. Effects of toxic gases and seasonal variation in plants leaves and stomata, a case study of Quetta city, Pakistan Ph.D Thesis (Chapter 7). pp 137-157.

Leghari, S. K., M.A. Zaidi, M. Ahmed and K Nazim. 2011. Air pollution tolerance index (Apti) of various plant species growing in quetta city, Pakistan. *Fuuast J. Biol*., 1(1): 81-86.

Leghari, S.K and M.A. Zaidi. 2013. Effect of air pollution on the leaf morphology of common plant species of Quetta city. *Pak. J. Bot*., 45(S1): 447-454.

Leghari, S.K., M.A. Zaid, A.M. Sarangzai, M. Faheem, G.R. Shawani and W Ali. 2014. Effect of road side dust pollution on the growth and total chlorophyll contents in *Vitis vinifera* L. (grape). *African, Journal of Biotechnology*, 13(11): 1237-1242.

Lehninger, A. 1993. *Principles of Biochemistry*, 3rd edition. Worth Publishers, New York. pp. 184-185.

Lemieux, P.M. 1998 Evaluation of emissions from the open burning of house hold waste in barrels, *Environmental Protection* Research Laboratory volume 1.Technical Report.

Liu, Y.J. and H. Ding. 2008. Variation in air pollution tolerance index of plants near a steel factory: implication for landscape plant species selection for industrial areas. *WSEAS Transactions on Environment and Development*, 4: 24-32.

Makbul, S., K. Coskuncelebi., Y. Turkmen and O. Beyazoglu. 2006. Morphology and anatomy of *Scrophularia* L. (Scrophulariaceae) taxa from NE Anatolia. *Acta Biol. Cracov*., 48: 33-43.

Mcngcl, K., A.H.I.R. Hogrcbc and A. Esch. 1989. Iiffcct of acidic fog on nccdlc surfacc and watcr relations of I'icecz ahie.7. *Pllysiol. Plant*., 75: 20 1-207.

Nanos, G.D. and I.F. Ilias. 2007. Effect of inert dust on olive (*Olea europaea* L.) leaf physiological parameters, *Environ. Sci. Pollut. Res.*, 14(3): 212-214.

Pearson, D., H.K. Melon and S. Ronald. 1976. Chemical analysis of Food, 8th edition. Churchill Livingstone, pp 5-63.

Prasad, B.J. and D.N. Rao. 1981. Growth responses of *Phaseolus aureus* plants to petro-coke pollution. *Journal of Experimental Botany* 32: 1343-1350.

Prasad, M.S.V. and J.A. Inamdar. 1991. Effect of cement kiln dust pollution on growth and yield of Vignas. *Ind. J. Ecol*., 18: 91-94.

Psaras, G.K. and N.S. Christodoulakis. 1987. Air pollution affects on the ultrastructure of *Phlomis fruticosa* mesophyll cells. *Bulletin of Environmental Contamination and Toxicology*, 38(4): 610-617.

Radoglou, K.M. and P.G. Jarvis. 1990. Effect of atmospheric CO_2 enrichment on four poplar clones.11. Leaf surface properties. *Annals of Botany,* 65: 627-632.

Rai, A., K. Kulshreshtha, P.K. Srivastava and C.S. Mohanty. 2010. Leaf surface structure alterations due to particulate pollution in some common plants. *Environmentalist*, 30: 18-23.

Rao, C.S. 2006. Environmental Pollution Control Engineering. New Age Int. Publ. Revised Second Edi.

Reig-Armiñana, J., V. Calatayud, J. Cerveró, F.J. García-Breijo, A. Ibars and M.J. Sanz. 2004. Effects of ozone on the foliar histology of the mastic plant (*Pistacia lentiscus* L.). *Environmental Pollution,* 132: 321-331.

Salisbury, E.J. 1927. On the causes and ecological significance of stomatal frequency, with special reference to woodland flora. *Plant Cell Physiol*., 50: 756-772.

Shafiq, M. and M.Z. Iqbal. 2003. Effects of automobile pollution on the phenology and periodicity of some roadside plants. *Pak. J. Bot.,* 35: 931-938.

Shafiq, M. and M.Z. Iqbal. 2005. The impact of auto emission on the biomass production of some roadside plants. *Int. J. Biol. Biotechnol.*, 2: 93-97.

Silva, L.C., M.A. Oliva, A.A. Azevedo, J.M. Araújo and R. Aguiar. 2005. Micromorphological and anatomical alterations caused by simulated acid rain in Restinga plants: Eugenia uniflora and Clusia hilariana. *Water Air and Soil Pollution*, 168: 129-143.

Singh, S.N. and D.N. Rao. 1980. Growth on wheat plants exposed to cement dust pollution. Water, Air and Soil Pollution 14, 241-249.

Sodhi, G.S. 2005. Fundamental Concepts of Environmental Chemistry. Alpha Science IntL. Ltd., Second Edi.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and Procedures of Statistics*: A Biometric Approach, McGraw-Hill, New York, pp: 633.

Stevovic, S., V.S. Mikovilovic and D. Calic-Dragosavac. 2010. Environmental impact on morphological and anatomical structure of Tansy. *Afr. J. Biotech.,* 9(16): 2413-2421.

Trag, A.R., A.S. Tamir, M. zafar, S. Tariq and M. Iqbal. 2001. Foliar responses of *Zizyphus mauritiana* L. to emissions of coal fired thermal power plant. *Adv Plant Sci.,* 14: 229-235.

Uaboi-Egbenni, P.O., P.N. Okolie, O.E. Adejuyitan, A.O. Sobande and O. Akinyemi. 2009. Effect of industrial effluents on the growth and anatomical structures of *Abelmoschus esculentus* (Okra). *Afr. J. Biotechnol.,* 8: 3251-3260.

Velikova, V., I. Yardanov and A. Edreva. 2000. Oxidative stress and some antioxidant systems in acid rain-treated bean plants. *Plant Science*, 151(1): 59-66.

(Received for publication 23 September 2013)