Journal of
Plant Sciences

ISSN 1816-4951

Academic
Journals Inc.

www.academicjournals.com

Journal of Plant Sciences 4 (4): 122-126, 2009
ISSN 1816-4951

Study of Air Pollution Effects on Some Physiology and Morphology Factors of *Albizia lebbeck* in High Temperature Condition in *Khuzestan*

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Abstract: The main purpose of this study is to determine some physiological and morphological characters of *Albizia lebbek* grown in high temperature condition of Khuzestan in Iran. The location was selected because of high rate of industrial pollution that is caused by petrochemical companies. *Albizia lebbeck* Benth. is a deciduous tree with compound leaves, flat oblong fruits, round cream colored seeds, grows wild and planted in almost south of Iran. The plant is found throughout tropical and subtropical Asia and Africa. The concentrations of chlorophyll A, B total chlorophyll, carotenoid, soluble sugar, proline and morphological effects were examined in the leaves of tree species (*Albizia lebeck*), growing in polluted area in comparison with natural condition. In the polluted regions higher concentrations of soluble carbohydrate, proline, chlorophyl A, B, carotenoid were observed in comparison with trees in the unpolluted regions. The morphological characters such as leaf area showed decrease.

Key words: Air pollution, morphology, soluble sugar, proline

INTRODUCTION

Human activities, both industrial and agricultural, have strongly increased the amount of biologically active nitrogen compounds and sulfur dioxide. Various forms of nitrogen pollute the air, mainly nitric oxide (NO), NO_2 and NH_3 as dry deposition and NO_3-and NH_4 as wet deposition. High concentrations of sulfur dioxide can produce acute injury in the form of foliar necrosis, even after relatively short duration exposure. Sulfur Dioxide (SO_2) formerly viewed as the most important phytotoxic pollutant. As population, urban centers and industries have grown, an increasing number of reports have appeared during the past 25 years regarding O_3-induced foliar injury on sensitive plants in many countries including KSA, Australia, Austria, Belgium, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Mexico, the Netherlands, Pakistan, Peoples Republic of China, Poland, Russia, Spain, Sweden, Switzerland, Taiwan, United Kingdom and Ukraine (Krupa, 1997). Atmospheric pollutants, especially oxidants, phytotoxic metals and acid deposition cause stress in forest trees. Studies on the effect of air pollution due to industrial activities on morphology physiology and biochemistry of plants have been carried out by a number of workers: Air pollutants directly affect the net carbon dioxide exchange rate and dry matter accumulation of many forest tree species (Lorenc-Plucinska, 1982). Elevated CO_2 increased the

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photosynthetic C uptake by the seedlings beginning early in the study (Olszyk *et al*., 2001) and persisting to the end (Olszyk *et al*., 2002). Previous studies also showed the impact of air pollution on ascorbic acid content (Agbaire and Esiefarienrhe, 2009) and chlorophyll content (Flowers *et al*., 2007). Plants provide an enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollutant level in the air environment (Escobedo *et al*., 2008).

In 2007 an investigation showed that air pollution cause structural and micro morphological changes in *Salix alba* (Gostin and Ivanescu, 2007).

It has been suggested that the recent decreases in forest tree growth rate were caused by a combination of stress factors (i.e., drought, pathogens and anthropogenic pollutants). The tolerance of particular tree species to industrial phytotoxic agents varies widely. The aim of this investigation is to determine the effect of industrial emissions on the levels of total and soluble sugars, chlorophyll, carotinoid and proline in the adult leaves *A. lebeck* and to assess the role of these parameters as markers for plant tolerance.

MATERIALS AND METHODS

Site Description

The investigation was carried out in damaged forests (situated around the industrial region of Mahshahr City in Iran) and a forest in about 130 km far from polluted area. The study was conducted between 10 May 2009 to 5 Sep., 2009. The forests studied in two regions consisted of 10 to 15 year-old. The climate in this land is warm and humid that is influenced by the Persian Gulf which is located in South of Iran. The mean annual air temperature was about 35-40°C and about 30°C for the growing season. The average annual precipitation was about 500 mm (200-250 mm for the growing season), with a spring-summer maximum. Prolonged summer droughts and warmthness are typical.

Air Pollution

The main toxicants in the industrial region of pet zone are: nitrogen oxides (NO, NO_3), sulphur dioxide, carbon oxides, HF, NH_3, Cl, HCl, CaO, $CaCO_3$, solid or liquid aerosols and organic compounds, higher amounts of silicon, aluminium, sodium, iron, cadmium and lower concentration of magnesium, calcium, nickel, lead, copper, zinc, manganese, as well as dust. To this add the dust and gases from more distant industrial establishments, from the city and from motor vehicles.

Biochemical Analysis

Ten similarly aged trees of the species were sampled from damaged and control stands. Fresh leaves were collected from the each tree crown in the mornings of sunny days in spring. The leaves were analyzed after mechanical cleaning of the leaf blades. Measuring some morphological factors including (leaf area, length of petiole and etc.) in addition to contents of water soluble sugar, chlorophyll and proline were determined by the biochemical method. Absorption was measured at specific light wave with a spectrophotometer.

Analyze of soluble sugar were done after making hydro alcoholic extract of leaf powder total carbohydrate concentration was determined by the phenol-sulfuric acid procedure (Verma and Deby, 2001). Chlorophyll A, B and total chlorophyll in addition to carotinoid was analyzed by use of acetone 85% (Lichthenthaler, 1987).

To determined proline, ninhydrin and acetic acid were used in order to this measurement fresh leaves were used (Irigoyen *et al*., 1992).

At least, three readings of samples were taken, each sample was replicated twice and the entire experiment was repeated once. The results were analyzed statistically by using the standard MSTATC in order to determine the significant differences between polluted and control stands.

RESULTS AND DISCUSSION

The plant in Mahshahr city are continuously exposed to different pollutants (carbon monoxide, oxides of nitrogen and sulphur, particulate matter, lead etc.) which are released into the environment as a consequence of petrochemical companies activities. The morphological study reveals that *Albizia lebeck* investigated showed significant different in length and breath of leaflets and leaf area no visible morphological injuries changes in length of vein, compound leaf and petiole (Table 1). Main vein, length of compound leaf and length of petiole didn't showed significant changes. Otherwise length of leaflets increase from 3.25 to 3.75 cm, breathe of leaflets in increase from 1.33 to 1.62 cm, in addition to leaf are that significantly decrease from 6.5 to 3.9 cm^2.

In the case of biochemical changes the plant showed clear different in content of some characters; increase in amount of chlorophyll A from 15.7 to 19.6, chlorophyll B from 5.0 to 5.7 total chlorophyll from 20.8 to 25.4, carotinoid from 7.0 to 8.4, soluble sugar from 48.3 to 57.3 and proline 0.032 to 0.333 significantly occurred (Table 2).

However, some hidden injury or physiological disturbance might have occurred in morphological characters of all the plants.

Increase in length, breath of leaflets and decrease in area of leaf is shown in this study, another characters length of compound leaf, petiole and vein had no significant differentiation. Other workers in the previous years also showed significant reduction in different leaf variables in the polluted environment in comparison with clean atmosphere (Jahan and Zafar Iqbal, 1992). In their study on *Platanus acerifolia* showed changes in leaf blade and petiole size in the polluted air. Significant reduction in length and area of leaflets and length of petiole of *G. officinale* of polluted plants was recorded (Jahan and Zafar Iqbal, 1992).

Table 1: Effect of air pollution on the leaf characteristics of *Albizia lebeck*

Characteristics	Unpolluted	Polluted
Main vein (cm)	10/33A	10/46A
Length of leaflet (cm)	3/25A	3/57B
Breath of leaflets (cm)	1/33A	1/62B
Length of petiole (cm)	1/81A	1/61A
Length of compound leaf (cm)	10/94A	11.86A
Leaf area (cm^2)	6.564A	3.934B

Existence of same letters in every row showed no significant difference in 5% level

Table 2: Effect of air pollution on biochemical characteristics of *Albizia lebeck*

Biochemical characteristics	Polluted	Unpolluted
Chl A	15/783A	19/667B
Chl B	5/092A	5/764B
Chl T	20/820A	25.430B
Car	7/080A	8/447B
Soluble sugar	48.33A	57.33B
Proline	0.032A	0.333B

Existence of same letters in every row showed no significant difference in 5% level

Reduction in dimension of leaf blade of five tree species in the vicinity of heavy dust and SO_2 pollution was also observed (Jahan and Zafar Iqbal, 1992). Significant effects of automobile exhaust on the phenology, periodicity and productivity of roadside tree species was also reported (Bhatti and Iqbal, 1988). Decrease in leaf area in drought stress have been observed because tolerance of water content of tissue possible by decrease in leaf area. (Maynard and Orcutt, 1993). Beside the morphology studies there are lots of biochemical researches have been recorded. In this case increase in content of pigments, soluble sugar and proline is revealed. Another investigation is reported previously the effect of air pollution on *Recinus communis* showed increase in carbohydrate metabolism (Rucell *et al*., 1999). Following ozone exposure, soluble sugars in pine needle decreased (Wilkinson and Barnes, 1973). Subsequently, they increased, frequently in association with foliar injury (Dugger *et al*., 1966; Miller *et al*., 1969). The increase of soluble sugars was also observed following chronic exposure (Miller *et al*., 1969). Present data establish a decrease in concentration of soluble sugar content of damage leaves which is probably corresponded with the photosynthetic inhibition or stimulation of respiration rate (Tzvetkova and Kolarov, 1996). In present investigation undamaged leaves have been used.

Though some workers has been published on the increase in free proline content in response to various environmental stresses in plants (Levitt, 1972). In addition to free proline content increase with the increasing water stress. The increase in content of proline with increasing SO_2 concentration (Tankha and Gupta, 1992).

According to existence of SO_2 and CO in the industrial area as the result of chemical activities. These results probably indicate that it has been clearly inconceivable to designate a harmless threshold toxic so_2 concentration for level of particular species since other environmental factors during pollution profoundly affect the degree of damage.

Proline is a universal osmolytic accumulated in response to several stress (Oncel *et al*., 1996) and may have a role in plant defense reactions (Khattab, 2007).

Changes in concentration of pigments were also determined in leaves of six tree species expose to air pollution due to vehicle emissions in 2009 (Joshi and Swami, 2009). However, despite these changes, plants were survived well at the polluted environment. Resistance to air pollution occurs as a dominant genetic trait that seems to have evolved relatively recently with varying importance in plant populations located various distances from pollution sources. High tolerance to air pollution is not without metabolic costs, however, such as restricted growth.

These results showed the importance of morphological and biochemical data for precocious diagnosis injury and to determine the sensitivity of *Albizia lebbeck* to the action of air pollutants. After this study, we can consider *Albizia lebbeck* a resistant species, which is moderately affected by the pollutants from the investigated area.

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