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THE EFFECT OF GASEOUS AIR POLLUTANTS AND ASCORBIC ACID ON SOME MINERAL ELEMENTS CONTENT OF BEANS (*PHASEOLUS VULGARIS* L.) PLANT IN RIYADH CITY, KINGDOM OF SAUDI ARABIA

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ABSTRACT

Air pollutants such as ozone, the sulfur dioxide, nitrogen dioxide, the solid particles and organic compounds are considered the most important pollutants that directly affected the plants and lead to changes in the concentration of mineral elements in plant tissues. Identifying the impact of these pollutants is very important in determining the sensitivity of plant species and its tolerance. This study was conducted at three locations varying pollution ozone, sulfur dioxide and nitrogen dioxide gases in Riyadh city.The seeds of beans (*Phaseolus vulgaris* L.) were planted in the greenhouse belonging to Department of Botany and Microbiology, Faculty of Science, King Saud University, where it was put three pots for each concentration of ascorbic acid (zero, 50, 200, 400 mg/L) each of which three seeds of beans. The seeds were cultivated on 20 May 2011, and left until the completion of the growth of primary leaves, then transferred to the study sites, *i.e.* King Saud University, the first industrial city, and the cement factory. The results showed that the concentration of gases contaminated air in the city of Riyadh was gradually increased during the study period. The concentration of ozone and sulfur dioxide gases at the cement factory site were 87 ppb and 27 ppb, respectively. The highest concentration of nitrogen dioxide was 27 ppb at the first industrial city. Our experiment also showed that these three pollutants gases caused as a significant effect on the concentration of some mineral elements, *i.e.* phosphorus, potassium and carbon in beans plants treated with 400 mg/L of ascorbic acid. The concentration of phosphorus, potassium and carbon elements were 2.15,94 mg/L and 35.1%; 1.94, 88 mg/L, 32.6% and 1.89, 83 mg/L and 31.4% in beans plants growing in king Saud university, industrial city and cement factory sites, respectively.This study proved the role of ascorbic acid in resistance of plant to oxidative effects of ozone. The role of ascorbic acid resolved in the elimination of toxicity of reactive oxygen species (ROS), in addition to its ability to withstand of environmental stress.

Keywords: Air pollutants, Ascorbic acid (ASA), Beans plant, phosphorus, potassium and carbon.

INTRODUCTION

Ozone is considered as a gas of oxidizing gaseous air pollutants in the troposphere, which is formed in the air under the influence of the sun and lightning if the air containing nitrogen dioxide or sulfur dioxide concentrations were even a few **(Sandermann *et al*., 1998).**Affects of air pollution on plants through the poisoning of specific parts of the plant tissue due to absorption of the papers to these toxic substances or as a result of chemical reactions of these pollutants above the surface of plant parts.**(Hamawi*et al*., 1999).**

Ozone enters the plant through the stomata as water dissolves in the cell wall and then interacts directly with the plasma membrane through the process of decomposition (Ozonolysis) or turn to active oxygen that interacts with the plasma membrane and the amino acids in the target cell membrane proteins. These interactions change the cellular components may lead to accelerated aging or cell death **(Logan and Naidu, 2002).Fangmeier *et al.* (2002)** pointed out the most studies have focused on the effects of ozone nutrients in the tree species, but to the different nature of the acquisition and distribution of nutrients between the tree and herbal species, perhaps these studies did not give reliable information about the response to herbaceous plants. There are some few studies on this subject in the study. In a study on exposure bean plant (*Phaseolus vulgaris* L.) to ozone, resulting in a reducing concentration of calcium, iron and manganese in the leaves, while increasing the concentration of potassium and phosphorus **(Tingey*et al.*, 1986).**Also the exposure to ozone lead to changes in the concentration of elements within the plant tissue **(Baker *et al.*, 1994).**
In a study conducted by **Fangmeier*et al.* (2002)** to determine the impact of high ozone (68 ppb) during the growing season on the concentration and absorption of elements in the potato

(*Solanum tuberosum* L.) Found that there is an increase in the concentration of calcium in the leaves by 4.7%, the reduction rate of 12% manganese in the shoots, while nitrogen increased by 5.3% and the decline in the concentration of manganese accompanied by premature aging and ulcers. Perhaps old age is due to the lower concentration of these elements with high ozone, which has the potential to cause premature aging of potato (**Bindi*et al.*, 2002 and Vandermeiren *et al.*,2005).**

The ascorbic acid (ASA) is considered as a growth factor regulator in which affects on many physiological processes **(Hathout, 1995)**. **Gonzlez*et al. (*1998)** noted that the depletion of ascorbic acid before start of paleness and falling leaves of plant and that if it occurs under the influence of different types of stresses, proving the role of ascorbic acid is effective in resisting stresses. There is a low concentration of ASA in tissues of plants sensitive to ozone, which emphasizes its role in resistance to oxidative stress **(Veljovic-Jovanovic*et al.*, 2001)**. This study aims to identify the concentrations of gaseous air pollutants (ozone, sulfur dioxide and nitrogen dioxide) in three different locations in the city of Riyadh and assess their impact on some mineral elements and study the effect of ascorbic acid in reducing the adverse impact of these gases to plant beans.

MATERIALS AND METHODS

(A)Thestudy sites

Three sites belonging to Riyadh city, *i.e.*King Saud University, the first industrial city and cement factory were selected for this study as a varying places of gaseous air pollutants.

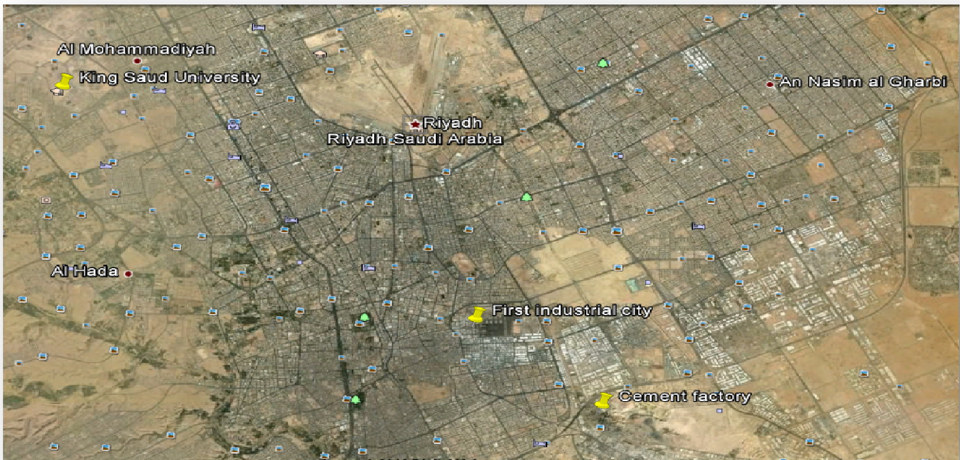


Figure 1.Image of the study sites in the Riyadh city, Kingdom of Saudi Arabia.

B) Experimental procedures

B.1. Cultivation of seeds

Three of dry seeds of beans (*Phaseolus vulgaris*cv. Super Stryke) planted on 20 May, 2011 in a size 20cm-plastic pots containing sterilized sandy:mud (1:1, v/v) soil treated with fungicidefor the prevention of fungal growth. The pots were left until the completion of growth of primary leaves and then transferred in the open air of the study sites (12 pots each site).

B.2. Ascorbic acid (ASA) treatments

ASA concentrations of zero, 50, 200 and400 mg/L H_2O were prepared,and the beans plants (3 pots eachconcentration of ASA) were treated with this solution as irrigation solutionevery 15 daysin the study sitesuntil the end of cultivationseason of beans plants.

B.3. Measurements

B.3.1. Leaf samples were taken from the beans plant (*Phaseolus vulgaris* cv. Super Stryke) in the end of vegetative growth and before the flowering stage of beans plant.

B.3.2. The gas concentrations of ozone, sulfur dioxide and nitrogen dioxide were measured per day for each study site for the duration of cultivation of beans plant, *i.e.* June, July and August months using an AEROQUAL Series Monitor with multi head. The average of data were calculated and recorded.

B.3.3. Determination of some elements

B.3.3.1 – A phosphorus element was determined according to the method of **Murphy and Riley (1962)** using the absorption spectrophotometer (Spectrophotometer - LKB - 4050).

B.3.3.2 - A potassium element was determined according to the method of **Allen (1989)** using a spectral analysis Flame photometer.

B.3.3.3 - Organic carbon was determined depending on the method of **Weilkely and Black**, as described by **Tandon (1993).**

RESULTS

A. Measurements of concentrations of gaseous air pollutants (ozone, sulfur dioxide and nitrogen dioxide) in the study sites

Results shown in **Table (1)** and illustrated by **Figure (2; A, B and C)** indicate that the concentrations of ozone, sulfur dioxide and nitrogen dioxide were on the rise at the study sites, where it was observed that the concentrations of ozone, sulfur dioxide and nitrogen dioxide at thesite of King Saud University were less compared with the first industrial city and cement factory. As the concentration of ozone at the site of King Saud University, the first industrial city and cement factory during the month of August was 56, 83 and 87 ppb, respectively **(Figure 2; A).** The concentration of sulfur dioxide at the site of King Saud University, the first industrial city and cement factory during the month of August was9, 25 and 27 ppb, respectively **(Figure 2; B).**The results also showed that the concentration of nitrogen dioxide at the site of King Saud University, the first industrial city and cement factory during the month of August was 12, 27 and 26 ppb, respectively **(Figure 2; C).**

B. Determination of some mineral elements

Results shown in **Table (2)** proved there is effect of air pollutants on the phosphorus, potassium and carbon elements in beans plant, where there were significant differences between the three sites under study. As evidenced by the impact of the treatment plant with different concentrations of ascorbic acid on the mineral elements. It was noted that the general trend is to increase the mineral elements by increasing of ascorbic acid concentration. The results indicate that the phosphorus, potassium and carbon in the developing plant at the site of the King Saud University were higher than at the site of the first industrial city and the location of the cement factory **(Table 2 and Figure 3; A, B and C).**

The highest rates of phosphorus, potassium and carbon at ASA concentration of 400 mg/L were 2.15, 94 mg/L and 35.1% **(Table 2**and **Figure 3; A)**, 1.94, 88 mg/L and 32.6% **(Table 2**and**Figure 3; B)** and 1.89, 83 mg/L and 31.4% **(Table 2**and**Figure 3; C)** at the sites of King Saud University, the first industrial city and cement factory, respectively.

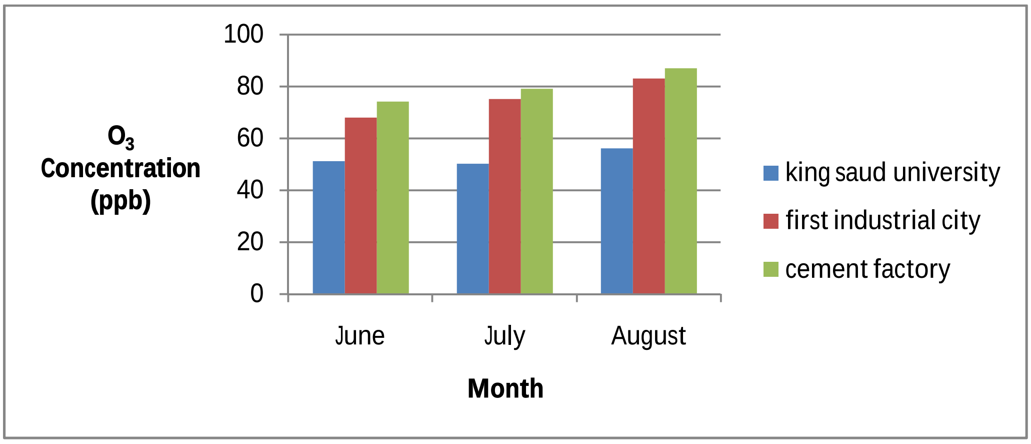
Table 1. Average monthly reading of gaseous air pollutants (ozone, sulfur dioxideand nitrogen dioxide) in the study sites.

Site	Month	Concentration (ppb)		
		O_3	SO_2	NO_2
King Saud University	June	51	8	10
	July	50	7	11
	August	56	9	12
First industrial city	June	68	19	22
	July	75	23	25
	August	83	25	27
Cement factory	June	74	24	22
	July	79	26	24
	August	87	27	26
Limit global air pollution (ppb)		**25-30**	**30**	**35**

Table 2. Effect of ascorbic acid on content of phosphorus, Potassium and carbon in beans (*Phaseolus vulgaris* cv. Super Stryke) plants developing in gaseous air pollutants sites.

Site	**Ascorbic acid (mg/l)**	**Phosphorus ((mg/L**	**Potassium (mg/L)**	**Carbon (%)**
King Saud University	Zero	1.81	88	32.3
	50	1.95	91	33.4
	200	2.11	93	34.2
	400	2.15	94	35.1
First industrial city	Zero	1.69	85	31.4
	50	1,81	86	31.6
	200	1.89	87	31.9
	400	1.94	88	32.6
Cement factory	Zero	1.65	79	29.5
	50	1.76	81	29.8
	200	1.88	82	30.3
	400	1.89	83	31.4
L.S.D (0.05)		**0. 031**	**0.236**	**0.028**

(A)



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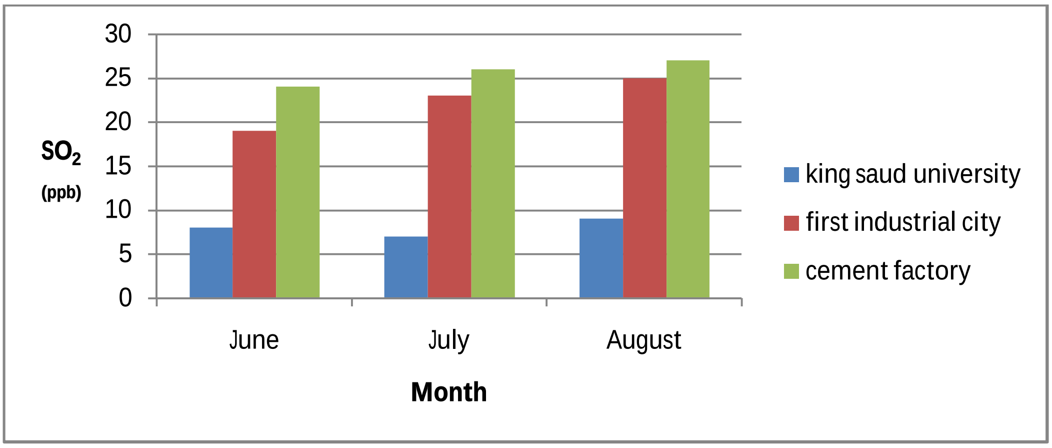

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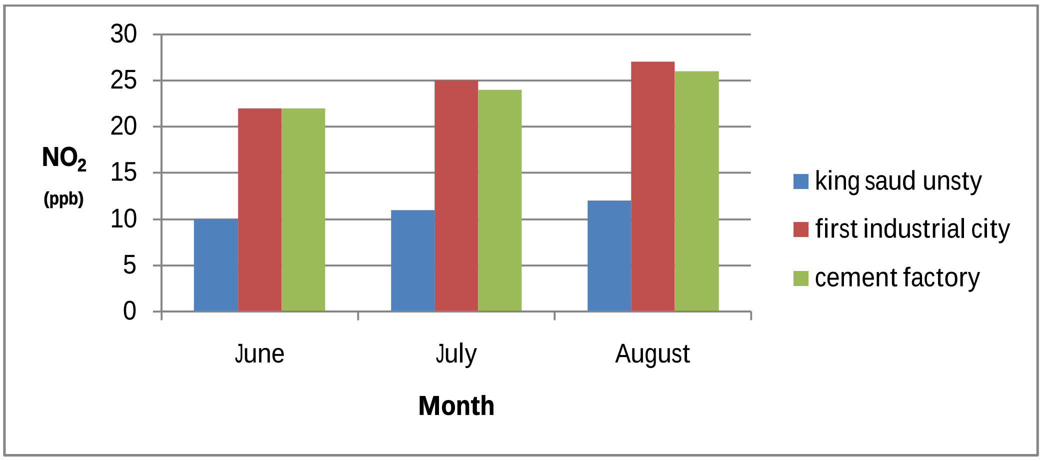
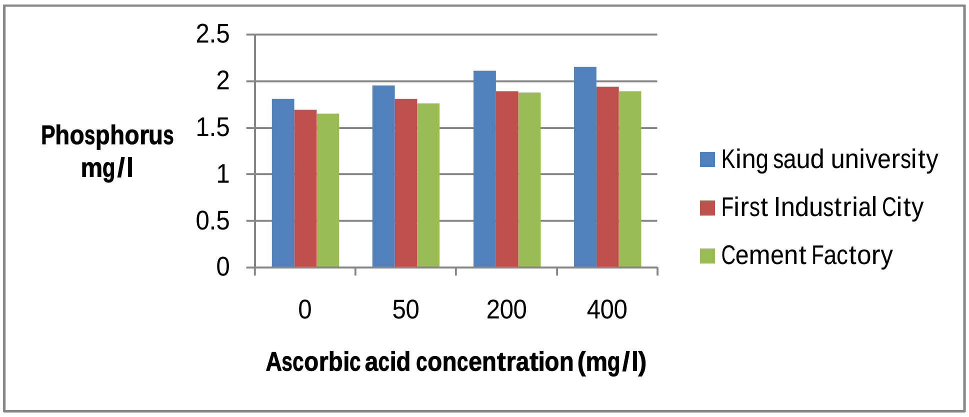


Figure 2. Average monthly reading of gaseous air pollutants [ozone,(Fig. A), sulfur dioxide(Fig. B)and nitrogen dioxide(Fig. C)] in sites of King Saud University, First industrial city and Cement factory.

(A)



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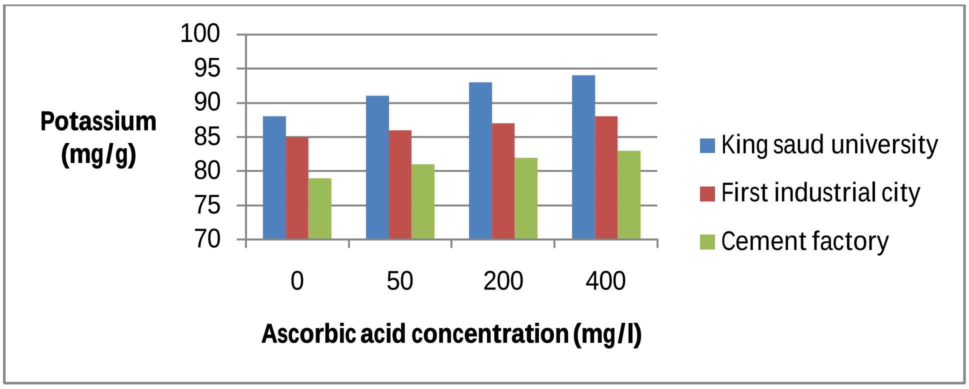

(c)

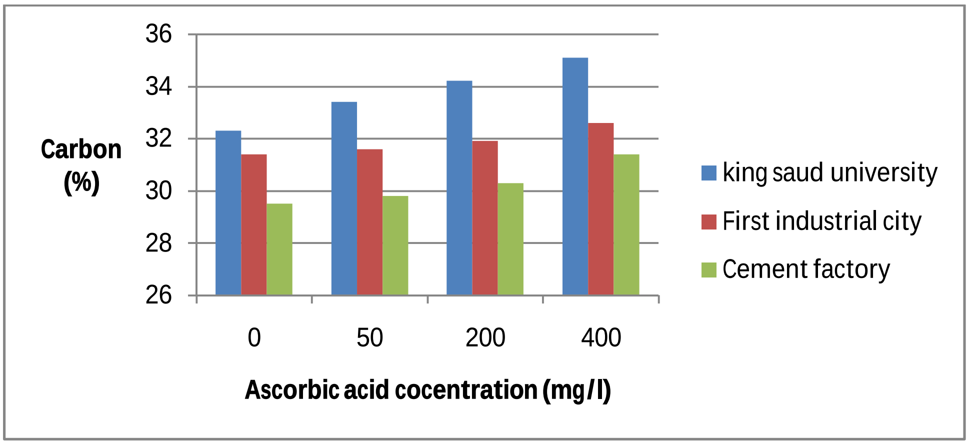

Figure 3. Effect of ascorbic acid concentration on content of Phosphorus (Fig. A), Potassium (Fig. B), and carbon (Fig. C), in beans (*Phaseolus vulgaris*cv. Super Stryke) plants developing in gaseous air pollutants sites.

DISCUSSION

The city of Riyadh in recent decades, industrial development has had a negative impact on the environment. It was also the increase in population which exceeded four million almost in the city of Riyadh significant impact on increasing the number of transport and the need for energy and the different services and thus increase in the amount of fuel consumed and burned. This leading to an excessive increase in the rates of emission of pollutants that affect a negative effect on the plant. The results of this study indicate that the concentration of ozone gas in the three locations under study exceeded the allowable limit global air pollution (25-30 ppb), and that the concentration at the site of King Saud University, less than the sites of first industrial city and the cement factory. On the other hand, the concentration of sulfur dioxide and nitrogen dioxide not exceed limit global air pollution **(Castnet, 2004**).

Data revealed that there are a significant differences in the content of leaves from phosphorus, potassium and carbon elements among study sites. These elements were significantly reduced in the leaves of plants in sites of the first industrial factory and cement compared with those plants at the site of the University of King Saud due to an increase in the concentration of ozone. This result agrees with that found by **Fangmeier*et al.* (2002)**where pointed outthat exposure to high level of ozone lead to changes in the concentration of elements within the plant tissue. Also, the lack of the elements may be is due to the impact of ozone on the cell membrane where **Fiscus*et al.*, (2005)** indicated that ozone enters the plant through the stomata and it dissolves in the water of cell wall then interacts directly with the plasma membrane or turn to active oxygen that interacts with the target amino acids in the proteins of cell membrane. Also, this result agrees with **Vandermeiren*et al.*, (2005)** where the phosphorus ratios in the leaves of potato (*Solanumtuberosum* L.) have been fallen under the influence of high levels of ozone, which pointed out that the high ozone has the potential to cause premature aging of potato. The results indicated also that the content of plant leaves from the elements increased with increasing the concentration of ascorbic acid, and that there was in the wall of the cell where represents the first line of defense against ozone **Smirnoff, (1996)**. This results compatible with **Foyer (1993),** where pointed out that ascorbic acid had a main role in various physiological processes in plants, and with a few concentrations, it considered as a growth regulator **(Hathout, 1995).**

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