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Response of Some Mineral Elements to Gaseous Air Pollutant Exposure in *Glycine max* L.

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Ozone, nitrogen oxides, sulfur oxides, solid particles and organic compounds are some of the most important air pollutants which directly affect plants and lead to shifts or changes in the concentration of elements within the plant tissue. Thus these pollutants have an impact on the sensitivity of plant species and the extent of resistance.The effect of gaseous air pollutants emitted from industries in the city in the city of Jeddah on some mineral elements in (*Glycine max* L), which were planted at distances (1-5 , 500, 1000, 1500, 2000 meters) from industrial city was evaluated. The plants were sown (*Glycine max* L) in an uncontaminated area far from industrial city. The plants were grown in three pots at each site, each pot having five seeds, and left until the completion of the initial growth of leaves and then transferred to the study site. The results of the study showed that concentrations of polluting air gases emitted by the industrial city during the study period, were 82 ppb for ozone, 28 ppb for sulfur dioxide, and 35 ppb for nitrogen dioxide. The results showed that there was a significant effect of these pollutants on the elemental content of the leaves. phosphorus was 1.93 mg /L at 2000 meters, and 1.65 mg / L at 1-5 meters, while potassium was 87 mg / L at 2000 meters, and 79 mg / L at 1-5 meters.

Key words: Air pollutants, *Glycine max* L. , Major mineral elements, Minor mineral elements. industrial city.

The increase in population, industries and traffic has led to a steady increase in tropospheric O_3 concentrations (Houghton *et al*., 2001). They are predicted to continue rising simultaneously in the future (IPCC, 2007). Pollutants, not only contribute to global warming, but also directly influence plant growth. Ozone is a very powerful oxidizing agent. It is known for its negative impact on vegetation. High concentrations of ozone can cause injury in numerous plant species and reduce overall growth and yield (Baier *et al*., 2005).The ozone in the troposphere is formed in the air under the influence of the sun if the air contains gaseous sulfur dioxide or nitrogen dioxide, even at low concentrations Toxic levels of the pollutants are absorbed tissue via leaves (Hamwi *et al*., 199).The negative effect of O_3 on plants results from its highly oxidative properties that damage cell membranes, denature critical enzymes and give rise to other oxidatively active species (Samuelsonand Kelly 2001), (Karnosk *et al*., 2005). Ozone has growth inhibition due to oxidation (Salim *et al*., 2013) and many plants have been found to be affected by elevated levels of this air pollutant (Leitao *et al*., 2007). Ozone enters the plant through the stomata and when it reaches the cell wall it interacts directly with the plasma membrane through the ozonolysis or turns into active oxygen forms that interact with the plasma membrane and amino acids Fangmeier *et al*., (2002) pointe that most studies of the effects of ozone focused on nutrients in the tree species These studies did not give reliable information about the response of herbaceous plants . There are a few studies that addressed this issue In a study in

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Phaseolus vulgaris L. exposure to ozone resulted in a lower concentration of calcium , iron and manganese in the leaves while the concentration of potassium and phosphorus increased in the pods (Tingey *et al*., 1986).Ozone exposure also led to shifts or 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 concentration 68 ppb during the growing season in potato *Solanum tuberosum* L. it was found that there was an increase in the concentration of calcium in the leaves by 4.7% and reduced manganese by 12% in the shoot system while nitrogen increased by 5.3% and the decline in the concentration of manganese was accompanied by premature aging and ulcers .Perhaps old age due to the low concentration of these elements with high ozone, had the potential to cause premature aging of potatoes (Bindi *et al*., 2002; Vandermeiren *et al*., 2005).The current study aims to measure the concentrations of gaseous air pollutants (ozone, sulfur dioxide and nitrogen dioxide) emissions from industrial city in the city of Jeddah and estimate their adverse effects on some of the major and minor mineral elements in *Glycine max* L. plants planted at 1-5, 500,1000,1500 and 2000 meters from the industrial city.

MATERIALS AND METHODS

Site description and experimental procedures

The industrial city in Jeddahcity was selected for the current study. Plants were grown 1-5, 500, 1000, 1500.2000 meters from the city.

Seeds of *Glycine max* L. were planted outdoors in plastic pots (size 20 cm) in sterilized silt sandy soil (1:1 mixture). Three pots were placed at each of the distances 1-5, 500, 1000, 1500 and 2000 meters from the source of air pollutants. Each pots had five seeds, and has agriculture in 2th January 2013, and left until the completion of the initial growth of leaves and then transferred to the study site.

Measurements

Samples were taken from leaves during the late vegetative growth stage before flowering.

Measurement of the concentration of air pollutants were taken daily in the industrial city for the duration of the experiment using the device (AEROQUAL Series Monitor with multyhead) reading were calculated as average monthly concentrations.

Estimatione of the major mineral elements

Determination of phosphorus was done according to (Murphy and Riley 1962) using Atomic Absorption Spectro-photometer (*Spectrophotometer – LKB* – 4050).

Determination of Potassium was according to (Allen 1989) using Atomic Absorption Spectrophotometer (*Spectrophotometer – LKB* – 4050).

Determination of organic Carbone was according to (weilkely and black).

Estimatione the Minor mineral elements

Minor elements (Cu; Fe; Zn; Mn) were determined using an Absorption Spectrophotometer (*Spectrophotometer – LKB* – 4050).

RESULTS

Measurements of the concentrations of polluting gases (ozone, sulfur dioxide and nitrogen dioxide) in industrial city

The results shown in Table (1) demonstrate that, the concentrations of ozone , sulfur dioxide and nitrogen dioxide from the industrial city continued during the study period. It was noted that the concentrations of ozone and sulfur dioxide and nitrogen dioxide at distance (2000 meters) was less than that at distances (1-5, 500, 1000, 1500 meters). The ozone concentration at (2000 meters) during the month of April (61 ppb), and at distances (1-5, 500, 1000, 1500 meters) (82 ppb – 74ppb – 69ppb – 65ppb respectively) also, concentrations of sulfur dioxide at distance (2000 meters)during the month of April (22 ppb), and at distances (1-5, 500, 1000, 1500 meters) (28 ppb – 27 ppb – 25 ppb –25 ppb respectively)also, concentrations of nitrogen dioxide at distance (2000 meters)during the month of April (28 ppb), and at distances (1-5, 500, 1000, 1500 meters) (35 ppb – 34 ppb – 32 ppb – 29 ppb respectively).

Determination of leaves content for certain mineral elements

Results shown in Table (2) show effects of pollutants on the leaf content of some minerals in *Glycine max* L. There were significant differences between the various distances under study. It was noted that the general trend was for increased mineral elements as the distance from the source increased.

The measured mineral fluctuated in concentration according to distances from pollutant source. The minimum values were recorded in the first cultivated area and there was improvement as the distance from the source increased.

The results indicate that, the percentage of all studied elements elements increased with distance from the source. The concentration at 2000 m was higher that at the other distances. At 200 m the percentage of phosphorus, potassium, copper, iron, zinc and manganese were 1.93¡87¡0.11¡1.59¡0.31 and 1.14mg/L respectively, carbon was 32.6 % at 2000 m.

DISCUSSION

In this study the results indicated that the concentration of ozone gas exceeded the allowable limit of global air pollution, for this gas which is 25-30 ppb, while for the other pollutants the concentration were below the global standard.The results showed no difference at distances (1-5 , 500, 1000 and 1500 meters), compared to 2000 meters

Table 1. Monthly changes of pollutants (ozone, sulfur dioxide and nitrogen dioxide)in the industrial city during period of plant growth in the city of Riyadh, Saudi Arabia.

Site	Distance (meter)	Month	Polluting gases conc. (ppb)		
			O_3	SO_2	NO_2
industrial city	1 - 5	January	71	27	34
		February	73	28	35
		March	78	27	34
		April	82	28	35
	500	January	67	25	33
		February	64	26	34
		March	68	27	33
		April	74	27	34
	1000	January	61	24	32
		February	60	25	32
		March	64	26	31
		April	69	25	32
	1500	January	57	22	29
		February	56	24	30
		March	59	25	29
		April	65	25	29
	2000	January	52	21	29
		February	51	23	28
		March	55	24	29
		April	61	22	28
Limit global air pollution (ppb)		25 - 30	30	35	

Table 2. The effect of pollutants emitted from industrial city on the content of the leaves of some minerals in the plant. grown at different distances from the industrial city

Site	Distance (meter)	Mineral elements						
		Phosphore (mg/L)	Potassium (mg/L)	Copper (mg/L)	Iron (mg/L)	Zinc (mg/L)	Manganese (mg/L)	Carbon (%)
industrial city	Control	2.15	94	0.14	1.85	0.35	1.34	35.1
	1 – 5	1.65	79	0.05	1.10	0.24	0.88	29.5
	500	1.76	81	0.06	1.21	0.25	0.94	29.8
	1000	1.88	82	0.07	1.23	0.27	0.99	30.3
	1500	1.89	83	0.09	1.38	0.28	1.05	31.4
	2000	1.93	87	0.11	1.59	0.31	1.14	32.6
L.S.D (0.05)	0. 031	2.36	0.021	0.011	0.023	0.020	0.028	

due to a rise in the concentration of pollutants closer to the source. This result is consistent with finding by Fangmeier *et al*., (2002) in which he pointed out that exposure to high ozone ledad to shifts or changes in the concentration of elements within the plant tissue, due to the impact of ozone on the cell membrane, Fiscus *et al*., (2005) indicated that ozone entereds the plant through the stomata where it dissolves in the water cell wall and then interacts directly with the plasma membrane or turns to images of active oxygen that interact with the plasma membrane and amino acids in the cell membrane proteins. Phosphorus ratios fell under the influence of high ozone levels had the potential to cause premature aging of potatoes from tables 4 and 5 the result shows the significant correlation coefficient of treated plant minerals was reversely proportioned with ozone concentration while there is no any significant correlation between plant minerals and other measured atmospheric pollutants (Al Sahli *et al*., 2013; Al-Muwayhi *et al*., 2014). Table 4 showed the distribution of data measured for mineral and atmospheric pollutants and describe the maximum concentration of atmospheric pollutants was recorded in the first distance (1-5m) while the minimum concentration of minerals was recorded in the same area which clear the impact of ozone gas on plant metabolic absorption and bio-function deficiency because Ground-level ozone interferes with the ability of plants to produce and store food, so that growth, reproduction and overall plant health are

Table 3. Statisticalanalysis for some minerals in treated plants

Statistical parameters	Phosphore (mg/L)	Potassium (mg/L)	Cupper (mg/L)	Iron (mg/L)	Zinc (mg/L)	Manganese (mg/L)	Carbon (mg/L)
Mean	1.877	84.333	0.087	1.393	0.283	1.057	31.450
Standard Error	0.069	2.216	0.014	0.115	0.017	0.067	0.866
Median	1.885	82.500	0.080	1.305	0.275	1.020	30.850
Standard Deviation	0.169	5.428	0.034	0.281	0.041	0.165	2.121
Sample Variance	0.029	29.467	0.001	0.079	0.002	0.027	4.499
Range	0.500	15.000	0.090	0.750	0.110	0.460	5.600
Minimum	1.650	79.000	0.050	1.100	0.240	0.880	29.500
Maximum	2.150	94.000	0.140	1.850	0.350	1.340	35.100
Sum	11.260	506.000	0.520	8.360	1.700	6.340	188.700

Table 4. Statistical analysis for the air pollutants

Statistical parameters	O3 µg/m^3	SO_2 µg/m^3	NO_2 µg/m^3
Mean	58.625	25.875	32.083
Standard Error	6.463	1.087	1.116
Median	61.375	25.625	32.625
Standard Deviation	15.831	2.663	2.733
Sample Variance	250.619	7.094	7.467
Range	46.000	7.500	6.500
Minimum	30.000	22.500	28.500
Maximum	76.000	30.000	35.000
Sum	351.750	155.250	192.500

Table 5: Correlation coefficient for plant minerals and gaseous pollutants

	Phosphor	Potassium	Copper	Iron	Zinc	Manganese	Carbon	O_3	SO_2	NO_2
Phosphor	1.000									
Potassium	0.950	1.000								
Copper	0.952	0.976	1.000							
Iron	0.938	0.986	0.995	1.000						
Zinc	0.965	0.987	0.993	0.990	1.000					
Manganese	0.969	0.994	0.991	0.992	0.995	1.000				
Carbon	0.943	0.990	0.991	0.993	0.991	0.995	1.000			
O_3	-0.977	-0.987	-0.966	-0.968	-0.976	-0.990	-0.979	1.000		
SO_2	0.226	0.353	0.177	0.225	0.221	0.285	0.300	-0.373	1.000	
NO_2	-0.063	0.075	-0.126	-0.065	-0.070	-0.010	0.000	-0.080	0.939	1

compromised. by weakening sensitive vegetation, ozone makes plants more susceptible to disease, pests, and environmental stresses so thatGround-level ozone has been shown to reduce agricultural yields for many economically important.

CONCLUSION

The results showed an increase in leaf minerals as distance from the source increased while the concentration of ozone gas decreased. The correlation coefficient of ozone was negatively related to minerals concentration and directly responsible for mineral concentration deficiency.

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