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EFFECT OF ZIRCONIUM IN NUTRIENT SOLUTION ON GROWTH AND UPTAKE OF SOME ELEMENTS BY MAIZE PLANT.

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ABSTRACT

A pot experiment (sand culture) was carried out to investigate the effect of zirconium supply, with the nutrient solution on maize dry matter yield, nutritional status in maize plant (Giza 10 v.). The pots were irrigated by ¼ Hoagland solution containing zirconium as ($Zr\ OCL_2.\ 8H_2O$), at the rates of 0.0, 10, 20, 50 , 100, 200 and 500 mg/L.

Results show that the means of dry matter (shoot, root and whole plant) were decreased with increasing zirconium rates. Also, phosphorus content and uptake by maize plants (shoot and root) were decreased with increasing zirconium in nutrient solution. The potassium content was increased gradually with increasing zirconium rates up to 20 mg Zr/L and decreased after that. The shoots always contained extra potassium (K) content more than roots and the highest potassium (K) content and uptake were found with the least zirconium concentration in the growth media. The Fe concentration in roots was more than in shoots. Zinc (Zn) and copper (Cu) contents and uptake by maize (shoot and root) were decreased with increasing zirconium, and Zinc (Zn) , Copper (Cu) content and uptake of roots were higher than that found in shoots. The amount of zirconium in maize roots was increased with increasing zirconium levels in the nutrient solution, the opposite trend was observed in maize shoots.

Keywords: Zirconium supply in nutrient solution; P, K, Fe, Zn, and Cu, contents and uptake index.

INTRODUCTION

Zirconium occurs in nature as five stable isotopes. Zirconium naturally radioactive zirconium isotopes, only one- zirconium -93 has a half- life 1.5 million years., which is found in alluvial deposits in streambeds, ocean beaches, or old lake beds(Jaworska and Dabkowska ,2006).

Zirconium is generally one of the less mobile radioactive metals in soil; it corns taken into the body by eating food, drinking water, or breathing air. Zirconium is a health hazard if it is taken into the body, it can be taken into the body by food, drinking water, or breathing air and in contaminated sites, zirconium retarded shoot and root growth of plant, also it inhibition of plant germination. The effect of zirconium on plants was retarded root and shoots growth, and increased activities of antioxidant enzymes(Fodor *et al.,* 2005) .

The objective is a study the inhibitory effect of zirconium (as a health hazard) on maize plant growth, dry matter yield, Zr, p, Fe, Zn, and Cu. Contents and uptake.

MATERIALS AND METHODS

A complete randomized design pot experiment was carried out using sand culture technique. The experiment was conducted during the summer session of year 2006 to study the effect of zirconium presence in nutrient solution on maize dry matter (shoot and root), P, K, Fe, Zn, Cu and zirconium content and uptake twenty one plastic bots, 12 cm diameter and 10 cm height packed with one kg. portions of washed dried sand.

Each pot was planted with five seeds of maize (Giza 10 variety). Which had been soaked in water for 12 hour their seedling three replicates were conducted for each treatments . After 15 days from planting , maize plants were thinned to three plants per pot. Then, the pots were irrigated by using a 1\4 Hoagland solution containing zirconium as $ZrOCl_2$. 8 H_2O, at rates 0.0, 10, 20, 50, 100, 200, and 500 mg/L. plants were harvested offer 45 days from planting. Both shoots and roots were washed distilled water and dried at 70^0C, portions from then were digested using H_2SO_4 and $HClO_4$ mixture. The extractants were analyzed for P, K, Fe, Zn, and Cu according to Jackson, 1973.

For Zirconium determination, 0.5 g. ash was digested by using 20 ml 1:1 HClO4 : H2SO4 mixture, 5 ml from the sample in a 50 ml volumetric Flask, add 1 ml of gum arabic (1% solution), 5 ml of Alizrin S(0.05 aqueous solution) and add 0.1M HCl to the mark. mix and let the solutionstostand for 15 minute The resulting mixture was analyzed spectrophotomtrically for Zirconium at 520 nm (Marchzinnko , 1976).

RESULTS AND DISCUSSION

Regarding the effect of zirconium concentration on shoot dry matter, data indicate that the intergraded increasing zirconium in nutrient solution decreased the shoot dry matter, Compared with control

The highest and least values of shoot dry matter were found at control and (500mg /L), zirconium levels, respectively. With regard to root dry matter yield, the data of Table 1 show that the means of root and shoot dry matter were decreased with increasing zirconium; also, root values were relatively lower than that obtained by the plant shoot, one, the highest and least root values were found in the control and (500 mg/L) treatments, respectively.

Table 1*:* Effect of increasing zirconium in nutrient solution on maize dry matter (shoot, root and whole plant) g/pot.

Plant parts	Zirconium in nutrient solution(mg/L)						
	0	10	20	50	100	200	500
Shoot	15.05	15.00	14.50	9.35	7.45	6.35	3.30
Root	9.96	9.93	9.90	5.90	2.97	2. 50	2.35
Whole plant	25.01	24.93	24.40	15.25	10.42	8.85	5.65

It's clear that the whole plant mean values were affected by the zirconium concentrations, the least value was at the same treatment (500 mg Zr/L), and the highest value was also at control treatment. The inhibitory effect of zirconium on plant growth could be explained on the basis of its effect on the biological processes zirconium is considered to be toxic element to plant. In this respect, (Fodor, *et al.,* 2005 and Frrand *et al.,* 2006) found that zirconium inhibits the plant germination.

With regard to the effect of zirconium addition in the nutrient solution on phosphorus, content and uptake by maize plants are found in Tables 2 It is evident that the P- contents of maize plant shoot and root were increased with increasing zirconium concentration in the nutrient solution at the rates of 10 and 20 mg /L in maize shoot, and at 10 mg/L in maize shoot, after that, P-content by maize shoot and root decreased with increasing zirconium concentration as compared with the control (Fodor *et al.,* 2005) .

Table 2: Effect of increasing zirconium in nutrient solution on P, K, Fe, Zn, and Cu – content in maize dry matter (shoot and root) .

Zirconium in nutrient solution(mg/L)							
Plant parts	**Control**	**10**	**20**	**50**	**100**	**200**	**500**
Phosphorus %							
Shoot	3.29	4.01	3.8	2.0	2.3	1.9	1.01
Root	2.3	2.5	2.0	1.8	1.9	1.3	1.0
Potassium %							
Shoot	11.98	12.3	11.5	10.1	9.3	7.2	7.3
Root	7.01	8.5	7.3	6.8	4.2	2.9	3.2
Iron (ppm)							
Shoot	122	123	120	86	79	63	60
Root	199	196	189	102	98	99	97
Zn - (ppm)							
Shoot	18.3	17.9	15.8	13.2	12.0	10.9	9.8
Root	25.2	24.8	20.3	18.9	20.0	18.3	13.5
Cu – (ppm)							
Shoot	5.2	6.3	4.2	4.0	5.3	3.3	--
Root	11.3	10.0	8.9	8.2	10.0	6.7	--

Also, the P- uptake by maize shoot and root has the same trend, where the highest P- content values of maize shoot and root were obtained at 10 mg/L rates at shoot and root, respectively. While, the least P- uptake values at shoot and root were found at 500 mg Zr / L rates at shoot and root, respectively. the lower concentration of zirconium absorbed were beneficial for wheat plant (Triticum Aestivum) development. (Fodor *et al.,* 2005; and Ryser and Sauder 2006) .

Regarding the content of potassium in maize plant is data of Table 3, show a gradual increase in K- content due to increasing zirconium concentration up to 20 mg Zr/L rate, it decreased with increasing zirconium in maize shoot and root. The K- content of maize shoots was more than its

content in roots at most zirconium rates. The highest and least. K- Contents of maize shoot and root were obtained at 10 mg Zr/L and 200 mg Zr/L, for shoot and root, respectively.

Regarding K- uptake, data of Table 3 show that the uptake of potassium by maize shoot, was more than that found by maize root, at all zirconium rates. The K- uptake increased only with 10 mg Zr/L rate at maize shoot, and with 10 and 20 mg Zr/L rates with maize root, and sharply decreased with after that maize plant shoot and root.

Table 3: Effect of increasing zirconium in nutrient solution on P, K, Fe, Zn, and Cu ¯ uptake in maize dry matter (shoot and root).

Plant parts	Zirconium in nutrient solution(mg/L)						
	Control	10	20	50	100	200	500
Phosphorus(mg/pot)							
Shoot	49.51	60.00	55.1	18.7	17.13	12.06	3.33
root	22.90	24.82	19.8	10.62	5.64	3.25	2.35
Potassium(mg/pot)							
Shoot	180.29	184.5	166.75	94.43	69.28	45.72	24.09
root	69.81	84.40	72.27	40.12	12.47	7.25	7.52
Iron (mg/pot)							
Shoot	1.83	1.84	1.74	0.80	0.58	0.40	0.19
root	1.89	1.94	1.87	0.60	0.29	0.24	0.27
Zinc(mg/pot)							
Shoot	0.27	0.26	0.22	0.12	0.08	0.06	0.03
root	0.25	0.24	0.20	0.11	0.05	0.04	0.03
Copper(mg/pot)							
Shoot	0.07	0.09	0.06	0.03	0.03	0.02	--
root	0.11	0.09	0.08	0.04	0.02	0.01	--

The obtained results show that the values of Fe- content in the plant tissues progressively decreased with increasing zirconium in the nutrient solution compared with the control, the results showed increased in Fe-content in the maize tissues (shoot and root) only with the 10 mg/L of Zirconium rate and started to decreased with the all rates. Also, data show that Fe- content by maize root was usually higher than that obtained by the plant shoot, one. The highest Fe- content of maize shoots and roots were found in 10 mg Zr/L treatment. While, the least Fe- content value of maize shoot and root were obtained at 500 mg Zr/L, treatment. The same trend was found by Fe- uptake by maize tissues, data of Table 3 show that the highest Fe- uptake of maize tissues (shoots and roots), were obtained with 10 mg Zr/L treatment, and the least were found with 500 mg Zr/L treatment. Also, the data of Fe-uptake was in maize root higher than that obtain by maize shoot.

It is evident that Zn and Cu content of maize tissues (shoot and root) were decreased with increasing zirconium concentration in the nutrient solution compared with control until 100 mg Zr/L and decreased at the other treatments the Zr and Cu-content by maize roots were higher than that obtained by maize shoot at all treatments. The highest Zn and Cu- content

values of maize shoot and root were obtained at control treatment, respectively. Also, the least values of Zn and Cu- content were obtained at 500 and 200 mg Zr /L, treatments, respectively.

Concerning to the Zn and Cu uptake by maize tissues (shoot and root) data of Table 3 show that the Zinc uptake by maize root were higher than that obtained by maize shoot, at all treatments, but in the Cu – uptake the data showed that Cu- uptake by maize root were higher than that found by maize shoot at control,10, 20 and 50mg Zr/L, treatments, respectively. The highest Zn and Cu- uptake values of maize shoot and root were found at control 10 mg Zr/L and respectively. The least Zn and Cu-uptake by maize shoot and root were found at 500 mg Zr/L, and 200 mg Zr /L, respectively. These results was confermed with Abdel - Sabour *et al.,*(1988) and Hooda *et al.,* (1997).

Zirconium can be taken into the body by eating food, drinking water or breathing air. Gastrointestinal absorption from food or water is the principal source of internally deposited zirconium in the general population zirconium is a health hazard only if it is taken in to the body. The risk coefficients for water are about 75% of that cietary ingestion(Ferrand *et al.,* 2006)

Table 4: Effect of increasing zirconium concentration in the nutrient Solution on zirconium status in maize plant part (ppm).

Plant parts	Zirconium In nutrient solution mg/L						
	Control	10	20	50	100	200	500
Shoot	--	2.25	3.93	9.32	14.7	25.3	86.3
Root	--	4.05	6.25	13.9	25.8	37.0	103.2

Regarding, the effect of zirconium concentration in the nutrient solution on its content in the maize (shoot and root), data of Table 5 show that zirconium content of shoot or root increased with increasing zirconium concentration in nutrient solution . But, the zirconium content and uptake of maize roots was higher than that found by maize shoots at all zirconium rates.

Table 5: Effect of increasing zirconium concentration in the nutrient solution on zirconium uptake by maize plant parts (mg/pot).

Plant parts	Zirconium In nutrient solution mg/L						
	Control	10	20	50	100	200	500
Shoot	--	33.75	56.98	87.14	109.51	160.65	248.79
Root	--	40.21	61.87	82.01	76.62	92.5	242.62

The least and highest zirconium values for shoot or roots were obtained at 10 and 500 zirconium treatments, respectively.

Concerning to the rate of zirconium uptake by maize plants (Shoot and Root) Table 6 show that the zirconium uptake increased with increasing zirconium amounts, in the growth media by maize Shoot or Root, and the zirconium uptake by maize Root were higher than that found by Shoot up to

50 mg Zr/L rate, and found by maize Shoot higher than that found by Root at the high Concentrations in 100, 200, and 500 mg Zr /L rates respectively.

Concerning the relative distribution of zirconium in maize plant shoot and root, data of Table 6 show that the root contained from and shoot contained from. It is also quit evident that the zirconium in maize shoots were lower than that found by root at 10, 20, and 50 mg Zr/ L concentrations, respectively, and increased with the other treatments to 500 mg Zr /L these results are in agreement with those of Fodor *et al.,* 2005 .

Table 6: The amount of zirconium in maize plant parts (shoot and root) as a percent of total zirconium uptake

Plant parts	Zirconium In nutrient solution mg/L						
	Control	10	20	50	100	200	500
Shoot	--	45.63	47.94	51.51	58.88	63.57	54.00
Root	--	54.37	52.06	48.49	41.17	36.43	46.00

Conclusion

According to the previous discussion, it seems that there is an obvious need for more research work to be carried out on the risk assessment of heavy metals contaminated water. The results show that zirconium application decreased shoot, root and whole plant (shoot plus root); The highest and lest dry matter yield of shoot were 15.05 and 3.30 g /pot for treatment control and 500 mg Zr /L, respectively. The highest and least root dry matters were 9.96 and 2.35 g /pot, treatments, control and 500 mg Zr /L. zirconium content and uptake of maize (shoot and root) increased with increasing zirconium concentration in nutrient solution. and zirconium content and uptake by maize root were higher than that obtained by maize shoot.

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تأثير إضافة الزركونيوم فى المحلول المغذى على نمو وامتصاص بعض العناصر بواسطة نباتات الذره

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اجريت تجربه اصص فى مزرعه رمليه داخل الصوب خلال صيف 2006 ,لدراسةتأثير إضافة عنصر الزركونيوم بتركيزات مختلفه (صفر , 10, 20 , 50 , 100 , 200 , 500 مللى جرام / لتر) فى المحلول المغذى على محصول الماده الجافه لنبات الذره الشاميه (هجين جيزه 10) وتأثير محتوى وإمتصاص عناصر كل من الفوسفور والبوتاسيوم من المغذيات الكبرى, الحديد والزنك والنحاس من المغذيات الصغرى, وكذلك حالة الزركونيوم (إمتصاص ومحتوى ونسبه مئويه) فى المجموع الجذرى والخضرى لنباتات لذره.
وكانت النتائج المتحصل عليها كما يلى :-

أدت زيادة إضافة الزركونيوم فى المحلول المغذى الى تناقص محصول الماده الجافه (المجموع الجذرى والخضرى) تدرجيا مع زيادة إضافة الزركونيوم وتناقص محتوى وإمتصاص الفوسفور بواسطة نبات الذره (جزء جذرى وخضرى) مع زيادة الزركونيوم فى المحلول المغذى . وكذلك زاد محتوى البوتاسيوم تدريجيا مع زيادة معدلات الزركونيوم حتى المعامله 20 مللى جرام / لتر, وبدأ يتناقص مع زيادة إضافة الزركونيوم فى المحلول المغذى , وان الجزء الخضرى من البوتاسيوم كان أعلى دائما فى المحتوى والامتصاص من الجذور. وان الحديد كان دائما فى الجذور أعلى منها فى الجزء الخضرى لنباتات الذره الشاميه . أما بالنسبه للزنك والنحاس فإن محتوى وإمتصاص كلا من الزنك والنحاس فى الجزء الخضرى والجذور لنباتات الذره تأثرت بالتناقص مع زيادة معدلات الزركونيوم فى المحلول المغذى . وأن كمية الزنك والنحاس فى جذور النباتات كانت أعلى من مستوياتها فى الجزء الخضرى وأن محتوى الزركونيوم فى الجذور يزداد بزيادة معدلات إضافة العنصر فى المحلول المغذى وكذلك الحال بالنسبه للجزء الخضرى, وأن المحتوى والامتصاص بالنسبه لعنصر الزركونيوم أخذ نهج العناصر الثقيله بوجوده فى الجذور بمستوى أعلى من الجزء الخضرى .

قام بتحكيم البحث

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