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EFFECT OF THORIUM 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 thorium on maize dry matter yield, contents and uptake of N,P ,K, Na and Fe and thorium accumulation in maize plant.The pots were contaminated by thorium as Thorium Nitrate(Th $(NO_3)_4$,H_2O)at concentrations 0,5,10,11,12,13,14,15 and 50 ppm. Pots irrigated by 1/10 Hogland solution for15 days, increased to1/4 Hogland solution after that.The results show that the dry matter (shoot , root and whole plant)decreased with increasing thorium concentration in soil up to 12 ppm and slightly increased with increasing Th to 13 ppm . The Nitrogen content and its uptake decreased with increasing thorium concentration in media growth up to 11 ppm .They were slightly increased at Th concentration between 11-14 ppm in maize shoot and root. The shoots always contained N-content and uptake more than that found in roots . P- uptake decreased in both shoots and roots with increasing in thorium concentration in media growth.

INTRODUCTION

The behavior of radionuclide of thorium and decay series in soil is of great interest because the environmental effects of mining and disposal activities related to nuclear power plant .The soil- plant relationships of thorium and some other daughter radionuclide, are not well understood . Most studies have been concerned with relative uptake of these radionuclide by various plant species

Arribas and Henra (1999) , Dilaba and Rencz (2002), showed that there was correlation between uranium and thorium levels in soil and plant,while Brooks et al (2004) showed that there was no correlation between uranium and thorium levels in soil and plant, also Kovalevsky (1999) found that the uranium and thorium content in plants decreased from10 to 100 times than in soils , but , Dunn (2001and2002) found that uranium and thorium levels in Spruce were varying from 5 to 886 ppm but in soil were 2 ppm

The present study aims to investigate the effect of applied thorium concentration in soil on maize dry matter, N,P,K,Na, Fe and thorium contents in maize plant grown in sandy culture.

MATERIALS AND METHODS

A green house pot experiment (randomize design in three replicates)was conducted to study the effect of thorium on maize dry matter (shoot , roots and whole plant) N,P,K Na, Fe and thorium contents , during summer season of 2005.

The experiment was carried out by packing 27 plastic pots; 15 cm diameter and 12cm height with one kg. portions of washed dried sand treated by thorium as thorium nitrate [$Th(NO_3)_4$,H_2O] at rates of 0,5,10,11,12,13,14,15and 50 ppm. Each pot was then planted with five seeds of maize (Giza 10 variety), which had been soaked in water for 12 hours before their seedling. Three

replicates were conducted for each treatment. Moisture content was maintained at 60% of the soil water holding capacity with 1/10 Hoagland solution.

After 15 days from planting the maize plants were thinned to three plants per pot .Then, these were irrigated by using a 1/4 Hoagland solution up to 42 days to end of the experiment.

Both shoots and roots were washed with distilled water and dried at 70° C temperature.Portions from them were digested using $HClO_4$ and H_2SO_4 mixture . The extracts were analyzed for N,P,K,Na ,Fe (Jackson, 1973) and thorium content was determined according to the method of (Chalmers, 1976).

RESULTS AND DISCUSSIONS

Data presented in Table (1) revealed that maize dry matter (shoots, roots and whole plant)were significantly decreased with increasing thorium doses in growth media . The highest values of shoots , roots and whole plant were found with the treatment of control. While the lowest values were found with 50 ppm treatment ,whereas shoots dry matter yield sharply decreased up to 12ppm treatment , and slightly increased with 13, 14and 15ppm treatments ,where roots dry matter yield increased with 15 ppm treatment only .

Table 1 : Effect of thorium concentration in the soil on maize dry matter (shoots, roots and whole plant mg/pot)

Plant parts	Thorium concentration in soil (ppm)								
	control	5	10	11	12	13	14	15	50
Shoot	6.65	5.83	5.73	5.44	5.15	5.83	5.33	5.30	4.21
Root	4.23	3.79	3.73	3.42	3.14	3.40	2.91	3.33	2.25
Whole plant	10.88	9.62	9.46	8.86	8.29	9.23	8.24	8.63	6.46
Shoot/root	1.57	1.53	1.53	1.59	1.64	1.71	1.83	1.59	1.87

L. S. D at 5% Effect of thorium on roots dry matter:0.314 Effect of thorium on shoots dry matter:0.209 Effect of thorium on roots dry matter:0.088 Effect of thorium on whole plant : 1.61

The whole plant (shoots plus roots) dry matter yield decreased up to 12ppm treatment and increased with 13 and 15 ppm treatments. The whole plant dry matter decreased with individual plant parts was reflected in the shoots / roots ration which increased with increasing thorium levels until 14 ppm treatment and decreased with 15 ppm treatment thorium in growth media .

The inhibitory effect of thorium on plant could be explained on the basis of its effect on the biological processes as thorium is considered as toxic element to plant. In this respect Aery and Jain (2002) , found that toxic effects with various doses of thorium on young plant even at lowest doses and Alive et al. (2002), found that increasing thorium concentration reduced the yield wheat and barleyby 1.1 – 2.0 times .

As regards to the effect of thorium addition in growth media on N- content of maize plant, Table (2) shows that the relative N-content of maize shoots and roots were decreased with increasing thorium doses as compared with the control. The N-content of maize shoots were higher than that found with maize roots. The N-content of maize shoots sharply decreased up to 10 ppm treatment and slightly increased with 11 ppm treatment. Also, N-content of maize roots were almost least more two times than that obtained with maize shoots up to treatment 11 ppm . The N-content of maize roots was higher than that found by maize shoots at the rats of 12 and13 ppm thorium treatments, and the same N-content were found by shoots and roots with 14 ppm treatment.

Table 2 : Effect of thorium concentration in the soil on N,P,k,Na and Fe-contents in maize dry matte (shoots and roots)

Plant parts	Thorium concentration in soil (ppm)								
	control	5	10	11	12	13	14	15	50
	Nitrogen %								
Shoot	0.21	0.17	0.15	0.19	0.15	0.15	0.23	0.08	0.06
Root	0.11	0.06	0.06	0.06	0.13	0.12	0.23	0.12	0.16
	Phosphorus%								
Shoot	0.15	0.12	0.12	0.08	0.08	0.09	0.09	0.08	0.07
Root	0.09	0.08	0.08	0.07	0.08	0.06	0.07	0.05	0.05
	Potassium%								
Shoot	0.42	0.34	0.33	0.33	0.28	0.30	0.33	0.54	0.30
Root	0.14	0.14	0.14	0.14	0.13	0.14	0.12	0.09	0.07
	Sodium %								
Shoot	0.02	0.03	0.03	0.01	0.008	0.01	0.01	0.08	0.004
Root	0.02	0.03	0.04	0.03	0.02	0.02	0.02	0.01	0.03
	Iron (ppm)								
Shoot	35.18	27.59	23.81	25.08	27.59	26.33	13.87	17.59	16.33
Root	56.53	80.40	123.11	136.65	62.82	62.30	62.82	62.90	47.74

Data in Table (3) indicates that N-uptake by maize shoots was higher than that obtained with maize roots , the same trend was found by N-uptake in maize shoot, its decreased with increasing thorium in growth media and slightly increased at the rate of 13ppm treatment. Also, N- uptake by maize roots decreased with increasing thorium in growth media up to 12 ppm treatment .It began to gradually increased till 50 ppm . Hassanien (1995) found that N-content and uptake by maize leaves and stems were higher than that found by maize roots .

Table 3 : Effect of thorium concentration in the soil on N,P,k,Na and Fe-uptake in maize dry matter (shoots and roots)

Plant parts	Thorium concentration in soil(ppm)								
	control	5	10	11	12	13	14	15	50
Nitrogen uptake (mg/ pot)									
Shoot	1.39	0.99	0,85	1.03	0.77	0.87	0.69	0.42	0.25
Root	0.46	0.22	0.22	0.20	0.40	0.37	0.37	0.39	0.36
Phosphorus uptake(mg/ pot)									
Shoot	0.99	0.69	0.68	0.43	0.41	0.52	0.47	0.42	0.29
Root	0.38	0.30	0.29	0.23	0.18	0.18	0.20	0.16	0.11
Potassium uptake (mg/ pot)									
Shoot	2.79	1.98	1.89	1.79	1.44	1.74	1.75	2.86	1.26
Root	0.59	0.53	0.52	0.47	0.40	0.43	0.34	0.39	0.16
Sodium uptake (mg / pot)									
Shoot	0.13	0.17	0.17	0.05	0.04	0.05	0.05	0.04	0.01
Root	0.08	0.11	0.14	0.10	0.06	0.6	0.05	0.03	0.06
Iron uptake (mg/ pot)									
Shoot	0.02	0.01	0.01	0.01	0.01	0.01	0.007	0.009	0.006
Root	0.02	0.03	0.04	0.04	0.01	0.01	0.010	0.020	0.010

As regard to the P-content and uptake Tables (2 & 3), it is quite evident that the same trend were obtained by P-content and uptake. It decreased with increasing thorium doses till 12 ppm treatment, and slightly increased with 13 and 14 ppm by maize shoots. But it happened by maize roots with 14 ppm only .

P-content and uptake by maize roots are lower than that obtained by maize shoots . The highest P-content and uptake values were obtained with control treatment and, the lowest were found with the highest thorium 50 ppm treatment. This is due to the inhibitory effects of thorium levels, that reduced P-content and uptake. These results are in agreement with Sheppard et al. (1984).

Regarding to K-content and uptake ,Tables (2&3) revealed that K-content and uptake decreased in shoots due to increased thorium concentration in soil till 12 ppm it began increased gradually at the rats of 13 , 14 and 15 ppm . Also , K-content in maize roots were stable till 13 ppm thorium after that decreased with increasing thorium concentration but, K-uptake by maize roots were decreased with increasing thorium in growth media , unless roots uptake slightly increased with 13 ppm .Generally , rates of thorium significantly and progressively decreased K-content and uptake Alive et al. (2002), found that uranium and thorium increased mineral (mainly P and K) fertilizer rates reduced soybean, chickpeas yields.

As regard to Na-content and uptake the data of Tables (2 & 3) showed that Na-content and uptake by maize shoot increased with increasing thorium concentration in rates 5 and 10 ppm by shoots and 5 , 10 and 11 ppm by maize roots the lowest content and uptake by shoots and roots found with highest thorium concentration in the growth media 50 ppm.

The effect of thorium on Fe-content and uptake of maize plant Tables (2 & 3) showed that the Fe-content of roots was more than that found with shoots ,the highest Fe-content values of maize shoots and roots (35.18 and 136.65ppm) were obtained at control and 11 ppm .thorium concentration, respectively . The least Fe-content values of shoots and roots (13.87 and 47.74 ppm) obtained at 14 ppm and 50 ppm thorium concentration , respectively. The least Fe-uptake of shoot and roots was found at 14 thorium concentration. While the highest Fe-uptake were found at 10 and 11 thorium concentration. These results may be attributed to the decrease of root and shoot dry matter contents.

International Atomic Energy Agency (IAEA) Vienna technical reports series No.334 (1999);Moilton and Tohnson (1999) found that the plants show positive and significant correlation coefficient with their roots soil for the elements Fe-Cr-Ni and K, Which indicated the high selectivity on the plant for accumulation of those elements.

Also , data of Table (4 & 5) show that the thorium accumulation index of maize roots were more than two times higher that found by shoot at all concentrations . The highest value was found at 14 ppm in both shoot and root Jain and Aery (2002) ,found that roots accumulated most uranium and thorium followed by shoots and seeds.

Table 4 : Effect of thorium concentration in soil on thorium content in maize dry matter (shoots and roots)

Plant part		Thorium concentration in soil (ppm)								
		0	5	10	11	12	13	14	15	50
Shoot	*	-	1.23	1.57	2.20	5.88	5.21	6.22	5.84	9.23
	**	-	7.2	9.0	12.00	30.3	30.4	33.20	30.99	38.90
Root	*	-	4.61	5.79	7.71	15.98	18.21	24.15	16.8	60.84
	**	-	17.5	21.6	26.4	50.2	57.2	70.3	56.00	136.9

Table 5 :Accumulation index of thorium in maize plant as effected by thorium concentration in soil

Maize plant parts	Thorium concentration in soil(ppm)								
	control	5	10	11	12	13	14	15	50
Shoot	-	1.44	0.9	1.09	2.52	2.33	2.37	2.06	0.77
Root	-	3.50	2.16	2.40	3.83	4.40	5.02	3.73	2.73

$$\text{Accumulation index} = \frac{\text{Metal conc. in plant tissue}}{\text{Metal conc. In grown media}}$$

Bjerr and Schifrup (1985)

Concerning the relative distribution of thorium content in maize shoot and roots ,data of Table (6)showed that the shoots contained 49.75% to 34.71% and the roots from 65.29% to 50.26% .It is ,also showed that the amount of thorium in maize roots was higher than in shoot, at all levels .The highest shoots thorium content as the percent of the total thorium uptake was found at 12 ppm rate, and the least value was found at 50 ppm rate .While, in roots the highest found at 50 ppm rate and the least was found with 12 ppm rate. The relative distribution of the shoot thorium content increased with increasing thorium rates til 12 ppm and decreased until 50 ppm ,in the opposite the relative distribution of roots thorium decreased with increasing thorium rates till 12 ppm. These results are in agreement with Al-Shobaki (1997) who found that the distribution of uranium in plant parts in shoot was less than in roots .

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

Maize plant prets	Thorium concentration in soil (ppm)								
	control	5	10	11	12	13	14	15	50
Shoot	-	38.75	39.02	40.82	49.75	49.66	46.38	46.38	34.71
Root	-	61.25	60.98	59.18	50.34	50.34	53.62	53.18	65.29

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تاثير الثوريوم على نمو وامتصاص بعض العناصر بواسطة نبات الذرة الشامية

محمد عيسى عليوة الشوبكى

اجريت تجربة اصص (مزارع رملية) لمعرفة تأثير اضافة الثوريوم للتربة بتركيزات مختلفة (صفر،٥ ،١٠ ،١١، ١٢، ١٣، ١٤، ١٥، ٥٠ جزء فى المليون) على نباتات الذرة الشامية (جيزة ١٠) وتأثيرة على محتوى وامتصاص عناصر النيتروجين ,الفوسفور ,البوتاسيوم ,الصوديوم ,الحديد. وكذلك تراكم العناصر بالمجموع الخضرى والجذرى فى المزارع الرملية. من البحث امكن التوصل الى النتائج التالية:أدت زيادة الثوريوم فى وسط النمو الى نقص معنوى فى المحصول الجاف للذرة الشامية (مجموع خضرى –وجذور –ومحصول كلى)وكانت اعلى قيم للمحصول الجاف وجدت مع الكنترول واقلها وجدت عند اضافة ٥٠(جزء فى المليون) فى وسط النمو وانخفضت قيم الجزء الخضرى حتى المعاملة ١٢ (جزء فى المليون) ثم بدأت الزيادة الطفيفة مع المعاملات ١٣،١٤،١٥ وبالنسبة للجذور زادت فقط مع المعاملة ١٥(جزء فى المليون) اما بالنسبة للمجموع الكلى للنبات فاخفض مع المعاملة ١٢ (جزء فى المليون) وزادت بعد ذلك مع ١٣،١٥ (جزء فى المليون) العلاقة بين المجموع الخضرى والجذور (خضرى/ جذور) زادت مع زيادة معدلات الاضافة من الثوريوم فى وسط النمو حتى المعاملة ١٤ (جزء فى المليون)وانخفضت مع المعاملات ١٣،١٥ (جزء فى المليون) وبالنسبة لتأثير الثوريوم على محتوى النيتروجين فى نباتات الذرة الشامية اظهرت النتائج انخفاض محتوى النيتروجين فى الذرة (مجموع خضرى وجذور)مع زيادة الثوريوم مقارنة بالكنترول وكذلك الحاللعنصرى البوتاسيوم والفوسفور اما محتوى وامتصاص الصوديوم فقد زادت مع المعاملتين١٠،٥ (جزء فى المليون) للمجموعالخضرى, والمعاملات١٠،١١،٥ (جزء فى المليون)للجذور ز وعلى العكس من ذلك فان محتوى وامتصاص الحديد فى الجذور كان اعلى من المجموع الخضرى لنفس النبات. واظهرت النتائج ان تراكم الثوريوم بالجذوركان اعلى منمحتواة فى المجموع الخضرى لنفس النبات .