J. Agric. Sci. Mansoura Univ., 34 (5): 5671 - 5681, 2009

EFFECT OF SOIL PROPERTIES ON THE SPESIFIC ADSORPTION OF ZINC BY SOME SOILS OF EGYPT.

Hussien, M. A. ; H. A. Ahmed and M. N. Ahmed
Soil and water Department of Agriculture Faculty Al-Azhar Uni

ABSTRACT

The present work aims to study the effect of some soil properties on specifically adsorbed zinc in some soils of Egypt. Therefore , surface and subsurface soil samples with different physico – chemical characteristics were selected from different location. The result showed that the adsorption zinc correlated positively with all of clay +silt content, pH, calcium carbonate and cation exchange capacity. The data indicated that the adsorption Zn increased with increasing (pH) and increased with increasing the concentration of Zn added in solution. Zinc desorption decreased as the pH values increased.
Keywords: specific adsorption, zinc, soil properties.

INTRODUCTION

Soil pollution may occur as a consequence of different types of unwanted substances.

- Intensive fertilization , as well with mineral as with organic manures.
- The contaminating products are integrated in the complex soil system and distributed amongst the different forms present, namely the solid forms, soluble and insoluble organo-mineral complexes adsorbed and exchangeable forms and free ions in soil solution.

It is very important to know that the physical and chemical properties of the soil play a great roll in governing the relation between reactivity and total content of the contaminating substance, however, its action is specifically linked to the nature of the pollutant , which may be more or less toxic.

The aim of this study is to obtain some information regarding the importance of the specific adsorption of Zink, in different soils of Egypt as a contribution dealing with the problem of soil contamination with heavy metals. The specifically adsorbed heavy metals cations could be defined as the amount of adsorbed heavy metals cations in presence of different amounts of some cations large enough to prevent adsorption on normal cation exchange sites as mentioned by Mc Laren and Crawford,1973.

MATERIALS AND METHODS

Three location were selected surface and subsurface. Soil samples were taken and analyzed. Soil samples were air dried and ground to pass through 2- MM sieve. Particle size analysis was carried out using pipet method, electrical Conductivity in soil paste extract. by Page et. al (1982); soil reaction (PH) in the soil past. PH – Meter; total calcium carbonate by the collin's calcimeter, Cottenie et al. (1982); organic Matter by rapid titration method; cation exchange capacity (CEC) by sodium acetate by Klute et al (1986) Available zinc was extracted by DTPA according to Lindsay et al (1978) total zinc by Hesse (1971).

The specific adsorption of zinc was measured by shaking 5g soil for 2h with 50ml NH4-acetate (N) at different pH values (6- 7- 8.5) the solutions were containing different amounts of (0- 100- 200- 400) ppm Zn as (Zncl2) , then Zn was measured by Atomic absorption spectrophometer.

RESULTS AND DISCUSSION

Table (1) shows that clay content of the studied soil samples between (5.5 – 31 %). Soil reaction ranged between (7.04 – 9.3). total calcium carbonate between (23 -46.9 %). Soil organic matter was in the range of (0.17 to 1.8%). the cation exchange capacity values were in the range of (2.06 – 20.01)meq /100g soil. The EC varied between 0.33 -10.9)ds/m.

Table(1): Some soil physical and chemicals properties of the representative soil samples

Location	Sample	Depth/ cm	Particle size distribution%			$CaCO_3$	O.M	PH	Ec ds/m	CEC me/100g
			sand	silt	clay					
I.	1	0-20	44.32	26.0	29.68	27.5	1.8	8.5	6.0	19.09
		20-50	46.32	22.0	31.68	33.1	0.70	8.6	9.0	20.01
	2	0-20	53.12	19.6	27.28	33.9	0.40	9.2	1.0	17.12
		20-50	50.32	23.6	26.08	30.5	0.20	8.7	1.1	16.95
	3	0-20	47.52	24.4	28.08	27.6	0.61	9.2	2.0	18.07
		20-50	50.72	24.0	25.28	43.1	032	9.3	2.3	16.12
II.	4	0-25	61.52	18.4	20.08	35.1	0.73	8.4	1.5	13.83
		25-75	57.92	20.0	22.08	37.5	0.27	8.6	3.8	14.32
	5	0-15	56.52	14.4	20.08	23.9	0.31	8.2	8.7	13.51
		15-40	44.4	26.0	29.68	26.4	0.28	8.6	7.2	19.02
	6	0-30	93.06	6.94		23	0.25	8.1	1.1	2.61
		30-60	85.37	14.63		24	0.27	8.1	1.4	4.43
III.	7	0-15	84.4	10.1	5.5	41	0.34	7.48	2.75	2.06
		15-24	79.55	11.9	8.5	38.8	0.28	7.82	4.52	4.31
	8	0-25	92.5	7.5		31.1	0.24	7.68	0.36	3.40
		25-70	94.0	6.0		27	0.17	7.98	0.33	3.31
	9	0-15	94.0	6.0		46.9	0.44	7.04	9.72	2.08
		15-40	30	30.5	30.5	37.8	0.41	7.31	10.91	14.41

I- Al- Amiriyah
II- Cairo –Alexandria rood
III- Al-Hmmam

Total zinc

Data in table (2) show that total Zn in the soils ranged from 34.7 to 149.3 ppm The highest content was recorded in Al- Hmmam region in the soil sample No (7-8-9) The soils were derived from various parent materials not originally rich in Zn bearing minerals.

Available Zinc

Data in Table (2) showed that available zinc content in the studied soils ranged from (0.236 to 1.418)ppm

Table (2): Total and available Zn 0f the studied soil sample.

Location	Sample	Depth/ cm	Total Zn	Available
I.	1	0-20	93.9	1.29
		20-50	100.7	1.36
	2	0-20	102.4	1.26
		20-50	96.3	1.14
	3	0-20	73.4	1.13
		20-50	91.1	1.41
II.	4	0-25	59.5	1.35
		25-75	34.7	0.74
	5	0-15	67.9	1.34
		15-40	60.1	1.16
	6	0-30	36.9	1.22
		30-60	57.9	1.18
III.	7	0-15	142.3	0.45
		15-24	68.2	1.21
	8	0-25	112	1.36
		25-70	81.3	1.34
	9	0-15	109.1	0.47
		15-40	149.3	0.23

The specifically adsorbed Zn :-

- **Effect of different PH values on Zn-desorption**

The data are presented in Table(3) and Figure(1). It is evident that Zn-desorption decreased as the PH values increased. The same trend was found in the surface soil samples as well as in the subsurface soil samples. This emphasizes that the soil organic matter did not play any role towards Zn-desorption. Lindsay (1973) pointed out that predominant Zinc species in soil below PH 7.7 is Zn+2 and at higher PH values the neural Zinc hydroxide, Zn(OH)2 .The same conclusion was found by El bordiny et al (2008).

- **Effect of different PH values on the specific adsorption of Zn at a constant concentration of applied Zn:**

At 100 added Zn, table (4) and figure (2), the data showed obviously an increase in the specifically adsorbed Zn as the PH values increased from 6 to 8.5.

The same trend was found at 200 ppm added Zn, Table (5) and figure (3).

Chaney (1973) pointed to the fact that toxicity level of Zn strongly depend on several factors which control the Zn availability in soils. One of the major factors is the PH. However, Zn behavior in soil is complicated by the occurrence of adsorption great number of complexes which have adsorption cationic character like Zn(OH)+ or an anionic character like Zincate anions $Zn(OH)^{-}_{3}$, $HZnO2^{-}$ and ZnO_2^{-2}. The some results were emphasized by Metwally *et al* (1992) and Halen (1991), Jain *et al* (1997) and Abou- Hussien (2002).

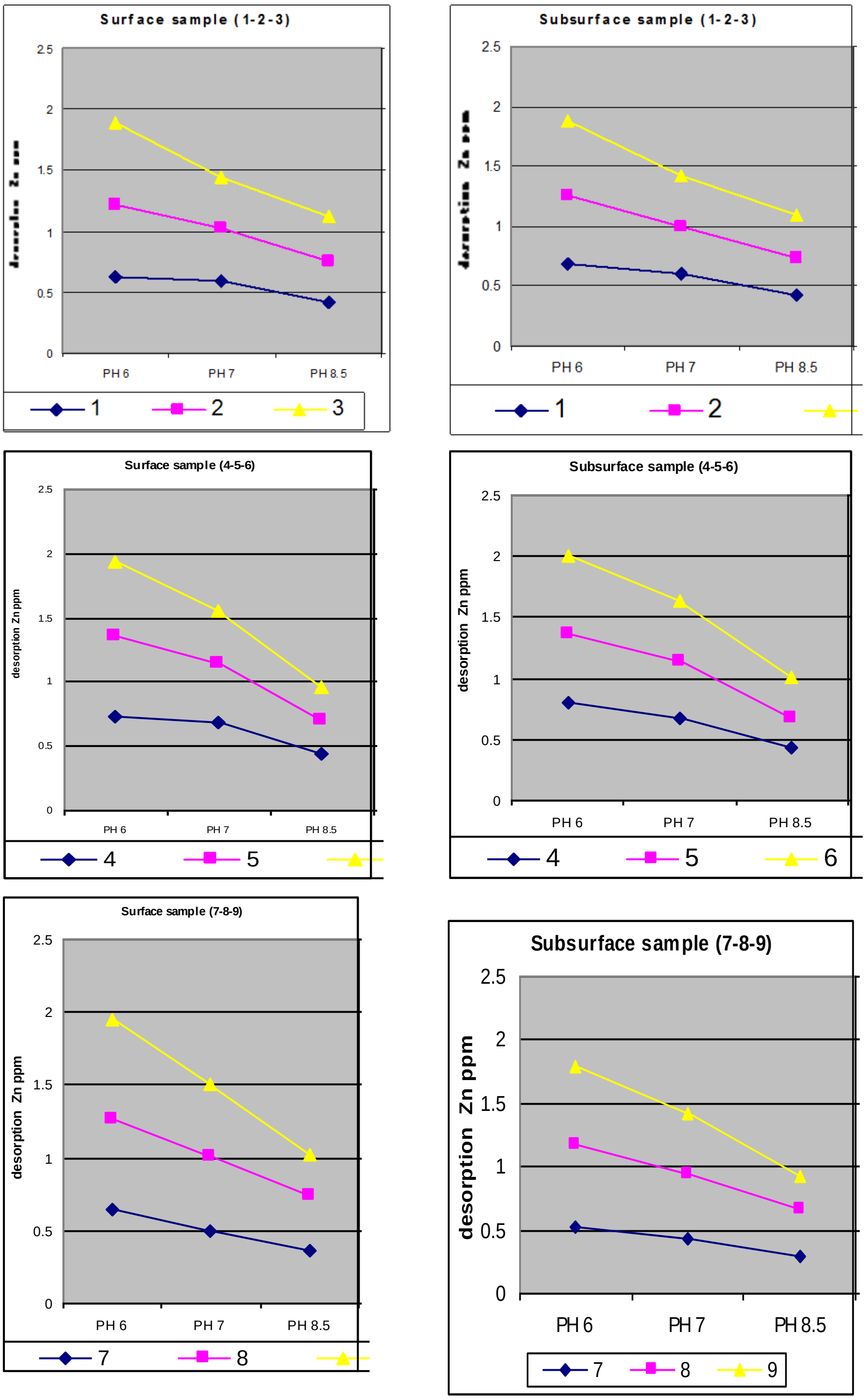

Figure (1): Effect of different pH values on Zn -desorption

Table (3): effect of the different pH values on Zn- desorption

Location	Sample	Depth/ cm	Desorption		
			pH 6	pH 7	pH 8.5
I-	1	0-20	0.62	0.59	0.42
		20-50	0.68	0.59	0.41
	2	0-20	0.58	0.43	0.32
		20-50	0.57	0.39	0.31
	3	0-20	0.68	0.42	0.38
		20-50	0.61	0.42	0.35
II-	4	0-25	0.73	0.68	0.44
		25-75	0.79	0.67	0.43
	5	0-15	0.61	0.45	0.25
		15-40	0.56	0.45	0.24
	6	0-30	0.58	0.41	0.27
		30-60	0.64	0.50	0.34
III-	7	0-15	0.65	0.49	0.36
		15-24	0.53	0.43	0.29
	8	0-25	0.61	0.51	0.37
		25-70	0.63	0.51	0.36
	9	0-15	0.68	0.49	0.28
		15-40	0.62	0.48	0.26

Table (4): effect of the different pH values on specific adsorption of 100ppm added Zn.

Location	Sample	Depth/ cm	Added Zn 100ppm		
			pH 6	**pH 7**	**pH 8.5**
I.	1	0-20	62.21	70.54	77.25
		20-50	46.24	58.45	63.41
	2	0-20	42.34	52.17	57
		20-50	43.15	54.27	69.81
	3	0-20	41.25	51.28	57.12
		20-50	34.47	43.2	50.47
II.	4	0-25	36.72	47.11	53.07
		25-75	42.66	50.19	56.17
	5	0-15	44.21	52.91	58.46
		15-40	45.38	59.19	65.14
	6	0-30	40.31	51.09	56.74
		30-60	48.81	57.37	61.18
III.	7	0-15	35.89	44.51	49.15
		15-24	35.67	43.21	47.31
	8	0-25	39.21	46.61	50.14
		25-70	30.22	36.87	41.21
	9	0-15	31.41	40.51	44.71
		15-40	37.91	45.81	51.01

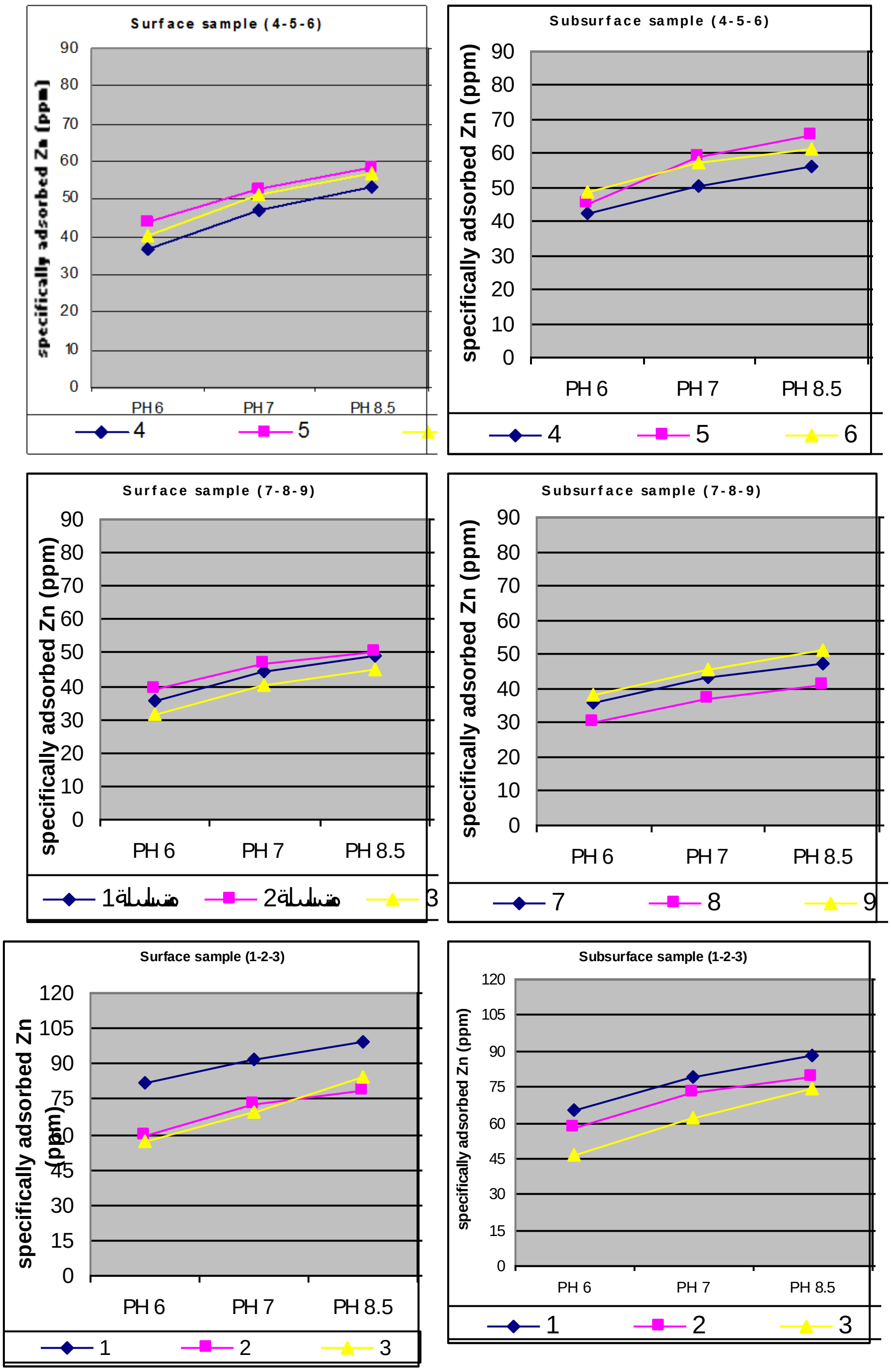

Figure (2): Effect of different pH values on specific adsorption of 100ppm added Zn

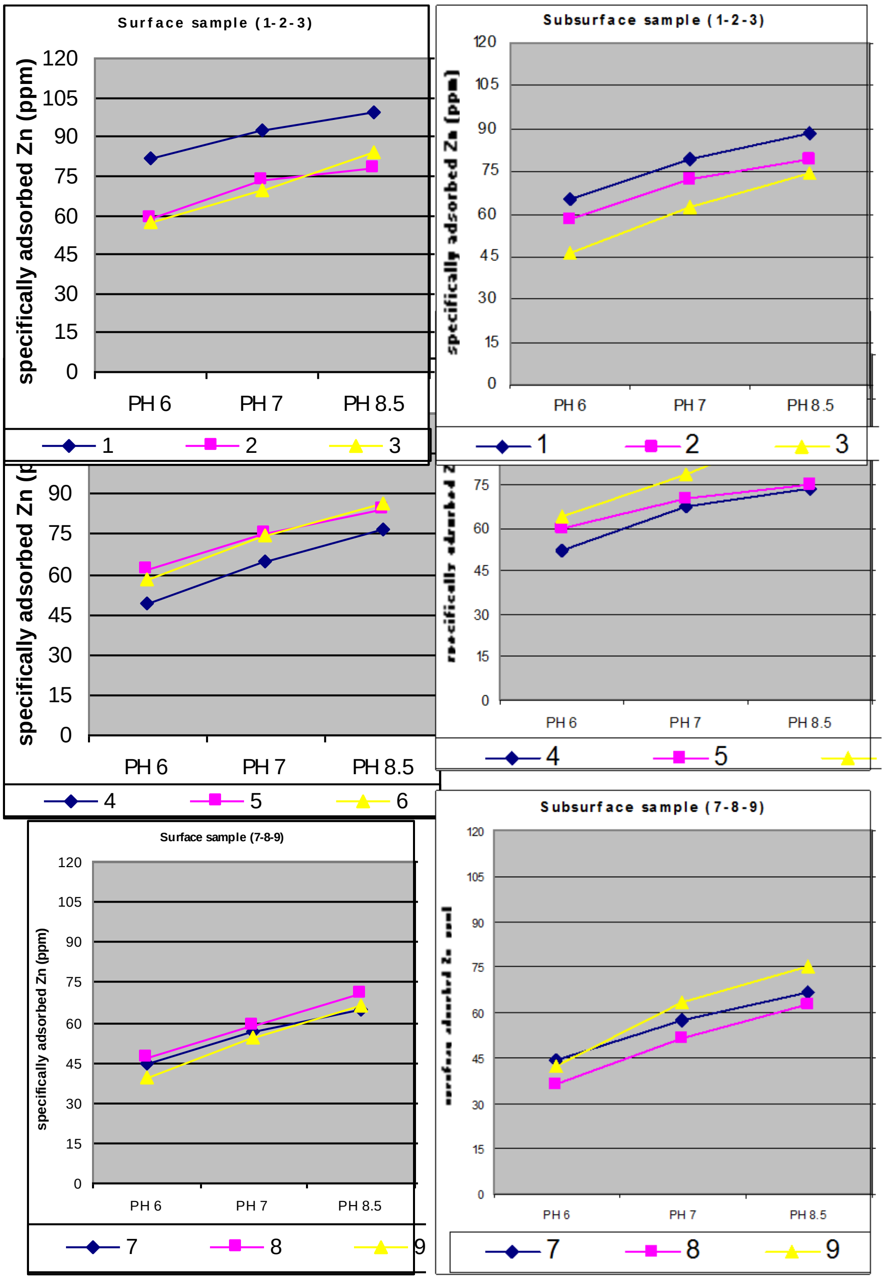

Figure (3): Effect of different pH values on specific adsorption of 200ppm added Zn

Table (5): effect of the different pH values on specific adsorption of 100ppm added Zn.

Location	Sample	Depth/ cm	Added Zn 200ppm		
			pH 6	pH 7	pH 8.5
I.	1	0-20	81.54	29.24	99.15
		20-50	65.52	79.29	88.19
	2	0-20	59.22	73.18	78.29
		20-50	58.14	72.49	79.41
	3	0-20	57.18	69.84	84.21
		20-50	46.29	62.12	74.27
II.	4	0-25	48.91	64.93	76.62
		25-75	51.84	67.24	73.84
	5	0-15	61.62	75.43	81.51
		15-40	59.89	69.83	74.63
	6	0-30	58.26	74.81	86.43
		30-60	63.51	78.44	96.41
III.	7	0-15	44.58	56.73	64.91
		15-24	43.91	57.69	66.54
	8	0-25	46.62	59.15	71.05
		25-70	36.27	51.71	62.64
	9	0-15	39.85	54.16	66.14
		15-40	42.19	63.43	75.12

- **Effect of increasing concentration of applied Zn on the specific adsorption of Zn at adsorption constant PH value:**

At PH 6, It is evident from the data shown in Table(6) that the increase in the concentration of added Zn form 100 to 200 to 400 ppm led to an increase in the specifically adsorbed Zn, as well as PH 8.5 Table (7), so that the specifically adsorbed Zn increased as the applied Zinc concentration increased. However, the increase in the specifically adsorbed Zn was always more obvious at the higher PH value(8.5). Abou – Hussien et al (2000) found the adsorbed amount of Zn increased with increasing the concentration in added and equilibrated solution. The adsorbed Zn was decreased by removal of organic matter. This result can be explained on the basis of the contribution of the non. Specific adsorption by different soil components as found by Ahmed (1979). . The result showed that the adsorption zinc correlated positively with all of clay +silt content, pH, calcium carbonate and cation exchange capacity. Elbording et al (2008) found negative correlation of available Zn and PH value due to the high amount of the specifically adsorbed Zn. Al – Tamimi (2006) concluded that Zinc sorption is highly correlated with clay, silt, calcium carbonate and organic matter content. These results are in a good agreement with our results.

Table (6): Effect of added Zn on the specific adsorption of Zn at pH 6

Location	Sample	Depth/ cm	CEC me/100	$CaCO_3$	Silt+ clay	At pH6 added Zn pmm			
						0	100	200	400
I.	1	0-20	19.09	27.5	55.68	0.62	62.21	81.54	177.25
		20-50	20.01	33.1	35.68	0.68	46.24	65.52	169.12
	2	0-20	17.12	33.9	46.88	0.58	42.34	59.22	158.2
		20-50	16.95	30.5	49.68	0.57	43.15	58.14	159.24
	3	0-20	18.07	27.6	52.48	0.68	41.25	57.18	149.1
		20-50	16.12	43.1	49.28	0.61	34.47	46.29	141.19
II.	4	0-25	13.83	35.1	38.48	0.73	36.72	48.91	158.81
		25-75	14.32	37.5	42.08	0.79	42.66	51.84	152.69
	5	0-15	13.51	23.9	34.48	0.61	44.21	61.62	172.24
		15-40	19.02	26.4	55.86	0.56	45.38	59.89	172.62
	6	0-30	2.61	23	6.94	0.58	40.31	58.26	168.12
		30-60	4.43	24	14.63	0.64	48.81	63.51	175.64
III.	7	0-15	2.06	41	15.60	0.65	35.89	44.58	148.26
		15-24	4.31	38.8	20.45	0.53	35.67	43.91	142.36
	8	0-25	3.40	31.1	7.5	0.61	39.21	46.62	148.85
		25-70	3.31	27	6	0.63	30.22	36.27	141.72
	9	0-15	2.08	46.9	6	0.68	31.41	39.85	148.21
		15-40	14.41	37.8	61	0.62	37.91	42.19	153.92
$rCaCO_3$						0.98	0.96	0.94	0.97
rCEC						0.83	0.90	0.92	0.85
rSilt+ clay						0.87	0.93	0.95	0.89

Table (7): Effect of added Zn on the specific adsorption of Zn at pH 8.5

Location	Sample	Depth/ cm	CEC me/100g	$CaCO_3$	Silt+ clay	At pH 8.5 added Zn pmm			
						0	100	200	400
I.	1	0-20	19.09	27.5	55.68	0.42	77.25	99.15	206.65
		20-50	20.01	33.1	35.68	0.41	63.41	88.19	211.24
	2	0-20	17.12	33.9	46.88	0.32	57	78.29	201.54
		20-50	16.95	30.5	49.68	0.31	69.81	79.41	204.86
	3	0-20	18.07	27.6	52.48	0.38	57.12	84.21	194.28
		20-50	16.12	43.1	49.28	0.35	50.47	74.27	192.53
II.	4	0-25	13.83	35.1	38.48	0.44	53.07	76.62	198.37
		25-75	14.32	37.5	42.08	0.43	56.17	73.84	195.21
	5	0-15	13.51	23.9	34.48	0.25	58.46	81.51	206.21
		15-40	19.02	26.4	55.86	0.24	65.14	74.63	198.14
	6	0-30	2.61	23	6.94	0.27	56.74	86.43	194.21
		30-60	4.43	24	14.63	0.34	61.18	96.41	198.39
III.	7	0-15	2.06	41	15.60	0.36	49.15	64.91	186.27
		15-24	4.31	38.8	20.45	0.29	47.31	66.54	183.85
	8	0-25	3.40	31.1	7.5	0.37	50.14	71.05	189.24
		25-70	3.31	27	6	0.36	41.21	62.64	186.67
	9	0-15	2.08	46.9	6	0.28	44.71	66.14	191.38
		15-40	14.41	37.8	61	0.26	51.01	75.12	198.76
$rCaCO_3$						0.98	0.78	0.96	0.98
rCEC						0.87	0.97	0.89	0.85
rSilt+ clay						0.91	0.97	0.92	0.89

REFERENCES

Ahmed, H. A. (1979): Belastung und Belastbarkeit von Boeden und Pflanzen in Stadtlandschaften mit Schwer metallen. Diss. Hohenheim Uni: Stuttgart, W.germany.

A. L. M etwally, A. S. Mashhady, A. M. Falatah, M. Reda(1992) Effect of pH on Zinc adsorption and solubility in suspensions of Sifferent clay and soils. Soil Sci Dept. College. Agric, King saud Univ,. Saudi Arabia.

Chaney, R. L., 1973: Crop and food chain effects of toxic elements in sludges and effluents. Recycling municipal sludges and effluents on land, Champaign, PP. 129-141.

Cottoenie, A., M.Verloo, G. Velghe and L.Kiekens (1982) Biological and analytical aspects of soil pollution. Laboratory of analytical and agrochenistry state Univ. Ghent – Belgium Belgium, 424P.

E . A .Abou Hussien , R. A. Khalil and A.A. Khalil (2002). Adsorption of Fe and Zn by Clay- humic Complexes. Soil Sci 42, No.1 ,pp 127 – 138.

E . A.Abou Hussien , R. A. Khalil, S.A. Radwan and M.M. Hammad. (2000). Synthetic Compounds of Iron and Zinc Adsorption on Treated Soil Clay Fraction. J. Soil. Sci. 40. No.3. pp. 399-411.

El-bording, M.M and Camilia, Y. El- Dewiny (2008) Effect of some salt Affected soil properties on Micronutrients Availability. J. Appl.Sci. Res. 4(11)1569-1573

Halen.H., Van-Bladel.R. and Cloos,P. (1991). Relationship between pH andsorption of copper, zinc and cadmium some soils and clay minerals. Pedologie., 41:1. 47-68.

Hesse, P.R. (1971). A Text Book of soil chemical analysis. William Clowe and sons limited, London, Great Britain.

Jain C K and Daya Ram(1997) Adsorption of Lead and Zinc on Bed Sediments of the River Kali. Water Research,Vol.31,No. 1, 154- 162, 1997.

Klute, A., and C.Dirksen (1986). Hydraulic conductivity and diffusivity: Laboratory method. PP: 687 – 734. in A. klute of. Methods of soil Analysis part 1.2nd ed. Agron. Monoger, g. A. S A and SSSA, Madison, Wisconsin, U.S.A..

Lindsay, W.L., and W.A. Norvelly (1978) Development of DTPA soils test for Zn, Fe, n and Cu. Soil Sci. Soc. Am. J., 42; 421 – 428.

Lindsay, W. L., 1973: Inorganic reaction of sewage wastes in soil. Recycling municipal sludges and effluents on land; Champaign, III., PP 91-96.

Mclaren, R.G. and Crawford, D.V.(1973). Studies on soil copper. II. The specific adsorption of copper by soild. J. Soil Sci. 24:443-452.

R. A. AL- Tammimi (2006)Zinc sorption by some Torrifluvents soil of Sub-Sharian region South of Libya. J. Agric. Sci, 18 (2):01-10

Page, A.L., R.B. Miller and D.R. keeney (1982) methods of soilAnalysis, part 2. chemical and Microbiological properties. Second Edition. ASA - SSSA, Madison, wis consin, U.S.A.

J. Agric. Sci. Mansoura Univ., 34 (5), May, 2009

تأثير خواص التربة على الادمصاص النوعي للزنك فى بعض الاراضى المصرية

محمد عبد السلام حسين ، حسن على أحمد و محمد نظير أحمد
قسم الاراضى والمياه - كلية الزراعة - جامعة الأزهر

تناولت هذه الدراسة تـأثير خـواص التربـة علـى الادمصـاص النـوعي للزنـك فـى بعض الاراضى المصرية.

وقد أجريت هذه الدراسة على عينات تربة سطحية وتحت سطحية من أماكن مختلفة

أولا:- أوضحت نتائج الخواص الطبيعية والكيميائية على زيادة نسبة كربونات الكالسيوم، والانخفاض الواضـح فـى المـادة العضـوية،تباين مـن حيـث نسـبة الطـين وتفـاوت فـى السـعة التبادليـة الكاتيونيـة والمرتبطة بنسبة الطين.

ثانيا:- تجربة الادمصاص

أ- تأثير pHعلى انطلاق الزنك

وتناولت هذه التجربـة تغير قيم pH (٦-٧-٨,٥) فـى محلـول NH4-acetat والمضـاف إلى عينات التربة وأتضح أنه بزيادة pH أدى إلى نقص انطلاق الزنك.

ب- تأثير pHعلى ادمصاص الزنك

وتناولت هذه التجربـة تغير قيم pH (٦-٧-٨,٥) فـى محلـول NH4-acetat والمضـاف إلى عينات التربة مع تثبيت اضافة الزنك لهذا المحلول مره عند تركيز ١٠٠ومره عند ٢٠٠ ppm واتضح أنه بزيادة pH أدى إلى زيادة نسبة ادمصاص الزنك.

ت- تأثير زيادة تركيز الزنك المضاف على الادمصاص.

وفى هذه التجربـة تـم تغير تركيـز الزنـك المضـاف إلـى عينـات التربـة عنـد (١٠٠-٢٠٠-٤٠٠) ppm مـع تثبيت pH عند٦ مره وأخرى عند ٨,٥ و؟أوضـحت النتـائج أنـه بزيـادة إضـافة التركيز زاد ادمصاص الزنك.كما أوضح التحليل الاحصائى إن درجة الارتباط كانت معنويـة بين الادمصاص وكلا من نسبة الطين +الغرين ونسبة كربونات الكالسيوم و السعة التبادلية الكاتيونية كما أظهرت النتـائج ان الادمصـاص فـى عينـات التربـة السطحية والتحت سطحية كانت منقاريـة وكـان الاختلاف قليل جدا ويمكن تفسير ذلك لقلة المادة العضوية والتى لم تلعب اى دور .