DOI: https://doi.org/10.26682/ajuod.2020.23.2.15

Journal of University of Duhok., Vol. 23, No.2 (Agri. and Vet. Sciences), Pp 118-130, 2020

ZINC ADSORPTION IN DIFFERENT CALCAREOUS SOILS

PAYIZAN IHSAN RAMADHAN and LAZKEEN AHMED MERWEEN MEHMEDANY
Dept. Soil and Water Science, College of Engineering Agriculture Sciences,
University of Duhok, Kurdistan region – Iraq

(Received: July 13, 2020; Accepted for Publication: September 27, 2020)

ABSTRACT

Zinc adsorption was studied for ten selective representative soils according the difference amount of clay content, calcium carbonate and organic matter in Duhok governorate, Iraqi-Kurdistan region included (Kanimasi-1&2, Batofa, Zakho, Assih, Semeel, Khanke, Faydi, Zawita and Bamarny locations). Samples were air dried and sieved through a 2-mm sieve to study the physical and chemical characteristics of the soils, forms of zinc and it's adsorption. Results showed the soluble, DTPA extractable zinc (available), $CaCl_2$ extractable zinc (exchangeable) and total zinc ranged between (0.29 – 0.94), (0.88 – 1.64), (1.71 – 2.05), and (12.25 – 56.15) mg kg^{-1} respectively. Negative significant correlation found between soluble zinc with pH, also negative significant correlation found between DTPA extractable zinc with exchangeable potassium, bicarbonate and available phosphorus but positive significant correlation found between $CaCl_2$ extractable zinc with pH, total–Zn negatively affected with pH and positively with HCO_3 and sand. Results demonstrated that by increasing added zinc concentration to studied soil zinc will be adsorbed zinc adsorbed greatly at temperature 25°C and 48°C. In general total zinc adsorbed at 25C° in six concentrations was less than zinc adsorbed at 48C°. At temperatures 25°C and 48°C the high total amount of zinc adsorbed found in the soil of Zawita and Zakho respectively, but the lower total zinc adsorbed observed in soil of Batofa and Kani masi-2. The quantity of adsorption affected positively by presence of clay, calcium carbonate, active calcium carbonate and cation exchange capacity and negatively affected by the ion concentration of bicarbonate, calcium, potassium, organic matter and sand content.

KEYWORDS: *Zinc adsorption, temperature effect and forms of Zinc*

1. INTRODUCTION

Zinc is one of the eight trace elements that is essential for the normal growth and reproduction of crop plants, and is required in relatively small amounts in plant tissues (5-100) mg kg^{-1}, however in high concentrations can be toxic (Alloway, 2008; Vodyanitskii, 2010). The plants that zinc amount in their tissues is lower than 20 ppm, are encountered with zinc deficit (Vitosh *et al*., 1994; Marschner, 1995). Zinc plays a vital role in plant including, participation in the structure of plant enzymes, activating them, sugar metabolism and synthesis of tryptophan and indole acetic acid (Malakouti *et al*., 2008). Deficiency of zinc is a widespread nutritional problem occurred in calcareous soils (Pilbeam and Barker, 2007). High concentration of calcium carbonate in soils affects the amount of zinc that can be extracted from soil (Orabi *et al*., 1981).

Widespread zinc fractions are distributed over five pools, which can be quantified using sequential or batch fractionation schemes (Alloway, 2004; Saffari *et al*., 2009). Generally these are: (1) Zn in the soil solution, (2) exchangeable Zn in electrostatic reaction with soil particles, (3) inorganic Zn associated with secondary minerals such as carbonates or insoluble metal oxides, (4) organic Zn complexed, chelated or adsorbed to organic ligands, and (5) residual Zn held in primary minerals. Great information obtained from these fractions on the biological, geological and chemical processes occurring in a soil (Ramzan *et al*., 2014). Adsorption of zinc includes that part sorbed by the soil, when Zn is mineralized from organic material, released from soil minerals, and during irrigation or fertilization added to the soil. Sorption of Zn by $CaCO_3$ and precipitation of Zn hydroxides or Zn hydroxyl carbonates are the mechanisms controlling Zn solubility in calcareous soils (Papadopoulos and Rowell, 1989). Adsorption of Zn increased with the increasing in clay and $CaCO_3$ contents (Ashraf *et al*., 2008). Kiekens, (1980) demonstrated that two different mechanisms included in the adsorption of zinc by organic

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

matter and clays, one mechanism is intently related to cation exchange, and act basically in acid conditions and the other mechanism mainly included complexation and chemisorption by organic ligands**,** and operates in alkaline condition**.**

Zinc hydroxide ($ZnOH^+$) was the solid precipitate and the dominant zinc ion in alkaline equilibrium solution (Chittamart *et al*., 2016). Low total concentration of essential trace elements in the soil parent material, low availability due to high soil pH and high concentration of calcium causes to deficient in crops. High pH increases chemisorption and complexation to organic ligands and forms Zn hydroxyl carbonate, which is very stable (Nordberg *et al*., 2011). Zinc concentration in soil solution is very low due to high pH, low organic matter, and high calcium carbonate content in calcareous soils while its total content in some calcareous soils of southern Iran is usually enough (50–300 mg kg^{-1}) but; therefore, the bioavailability of Zn is usually low in these soils (Padidar, 2015). The amount released of zinc in the soil solution is controlled by the mechanisms of adsorption, and therefore it could be directly available to plant roots. Uygur and Rimmer, (2000) reported that uptake of zinc by plant depends on the release of Zn from the adsorption surface sites of soil particles or through the dissolution of mineral Zn-containing. Sorption isotherms provide suitable information about the capacity of soil retention and the adsorbed amounts by which the sorbet is held on to the soil.

The aims of this study are to investigate the forms of Zn in the soil samples, the effect of temperature and addition of Zn on adsorption phenomena of Zn in soil, and describe relationship between physicochemical properties of soils and adsorption, selected adequate amount of addition zinc fertilizer according to plants requirements.

2. MATERIAL AND METHODS

2.1. Soil Sampling and study area

Ten surface representative soils were selected from 30 surface soil samples (0 – 30 cm depth) depending on the differences in clay content, calcium carbonate and organic matter in Duhok governorate, Iraqi-Kurdistan region and these area included Kanimasi-1(Km_1), Kanimasi-2 (Km_2), Batofa, Zakho, Assih, Semeel, Khanke, Faydi, and Bamarny locations (Figure, 1). Samples were air dried ground and sieved through a 2-mm sieve for further laboratory analysis and adsorption studies.

2.2. Laboratory analysis

Soil pH and EC were measured in soil suspension (1:2, soil: water) with using pH-meter, and EC-meter according to (Rowell, 1996). Soil texture determined by hydrometer method as described by (Ryan *et al*., 2001). Soil extract 1: 2 was used for the purpose of estimating cations and anions as follows: soluble sodium and potassium (Na^+ and K^+) were determined by Flame photometer based on (Toth *et al*., 1948). Titration method was used for estimating soluble calcium and magnesium (Ca^{2+} and Mg^{2+}) with (0.02N) EDTA-Na_2 (Rowell, 1996). Sulphates SO_4^{-2} was determined by using spectrophotometer (JENWAY 6705 UV) along the wavelength (470 nm) (Verma *et al*, 1977). The chloride was determined by titration with $AgNO_3$ and K_2CrO_4 as an indicator (Estefan *et al*., 2013). Carbonate (CO_3^{-2}) and bicarbonate (HCO_3^-) were determined by titration with sulfuric acid (0.01N) using phenolphthalein and methyl orange as indicators (Estefan, *et al*., 2013).

The soil organic matter content was implemented by Walkly and Black method using $K_2CR_2O_7$ (1N) according to (Allison, 1965). Total carbonate minerals was done as per the method of Loeppert and Saurez, (1996), which treated by a known weight of soil with hydrochloric acid (1N) using Calcimeter equipment. Active carbonate was measured by the method of Loeppert and Suarez (1996). Using ammonium oxalate (0.2 M) and then titrated with potassium permanganate (0.2M). Cation exchange capacity (CEC) through replacing exchangeable cations with sodium acetate (NaOAC) and determining Na concentration by use of flame photometry (Summer and Miller, 1996). Soil Available phosphorus was determined by Olsen´s method using spectrometer at 880 nm as mentioned by (Rowell, 1996).

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

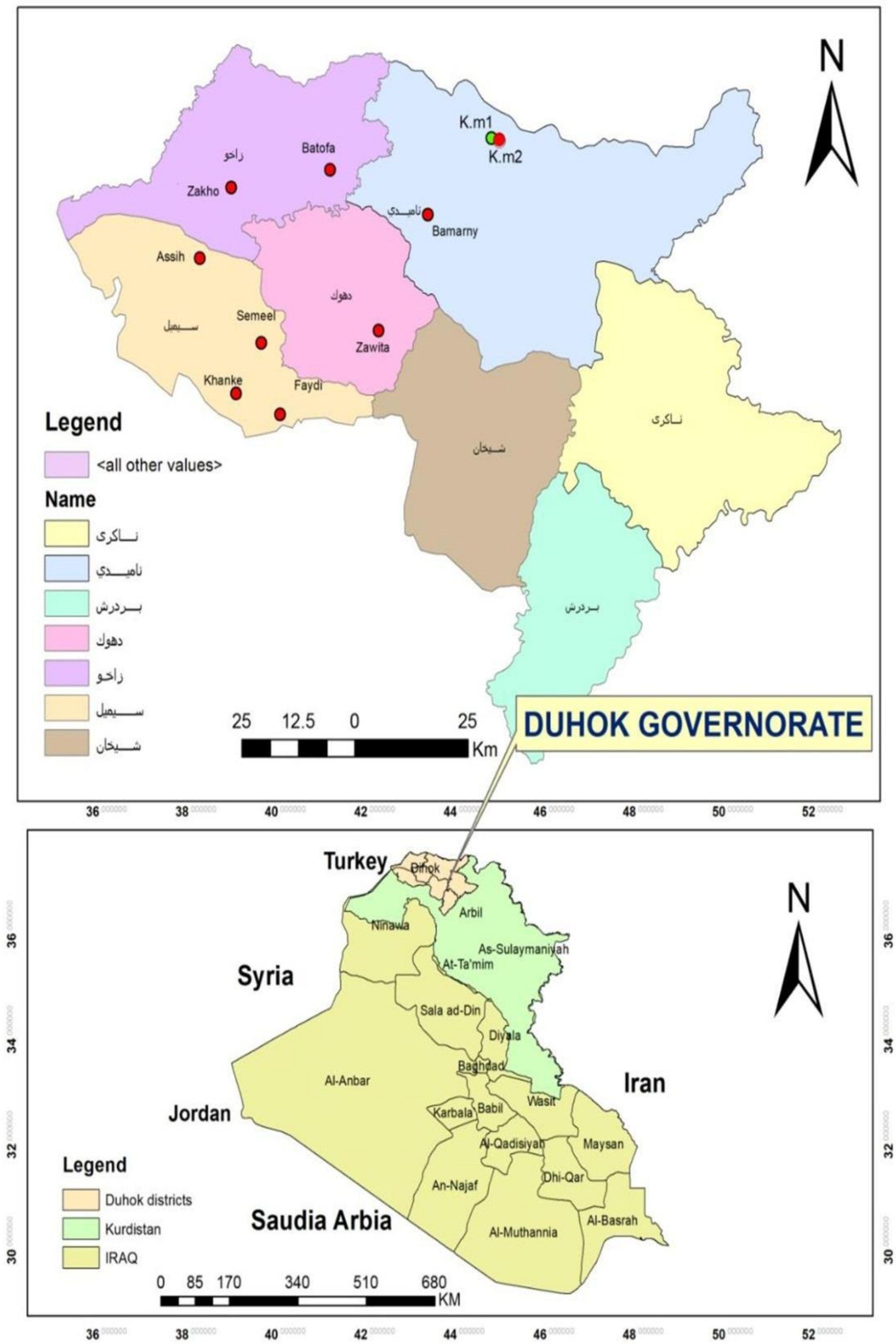

Figure (1) Locations of soil studied

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

2.3. Zinc forms and extracted

Total zinc was estimated after soil digestion using a mixture of Nitric/ Per chloric acid depending on (Gavlak *et al.*, 2003). Soluble zinc determined from the soil saturation extract (1:2) soil: water and $CaCl_2$ extractable zinc, air dry soil samples were subjected to extraction with 0.01M $CaCl_2$ (soil: $CaCl_2$ extraction solution) and determined them by atomic absorption Spectrophotometer (Rowell, 1996). AB-DTPA Extractable zinc (Available zinc) was determined depends on (Soltanpour and Workman, 1979; Soltanpour, 1991) in soil extract (1:2) (10 g soil: 20 ml DTPA extract solution 0.005M), and estimated zinc in solution by atomic absorption spectrophotometer.

2.4. Soil sorption of zinc

To study the sorption of Zn by soils, 1 g soil subsample from each soil was placed in a 100 ml plastic bottle and equilibrated with 50 ml (soil/solution ratio of 1:50) of 0.01M $CaCl_2$ solution (to keep the ionic strength constant) containing varies concentration of Zn, such as 0, 6, 12, 24, 48, 96 and 192 mg kg^{-1} Zn as $ZnSO_4$ solution. Each sorption set, for Zn, was replicated two times. The soil suspensions were shaken for 24 hour at a slow (20 rpm min^{-1}) rate, and equilibrated for 24 h at 25±1 and 48±1C° in an incubator. After equilibration time, the suspension was filtered, and concentration of Zn in the clear extract solution was determined using Varian atomic absorption Spectrophotometry model (GBC 932 AA). Amount of Zn adsorbed by soils was calculated from the difference between the initial and final concentration of Zn in the equilibrium solution.

3. RESULTS AND DISCUSSION

3.1. Physical and chemical characteristics of soil:

Physical and chemical properties of the studied soils are shown in (table, 1). The dominant texture was clay in most of the studied soils. Clay content of soils was from 29.16 to 57.57%. Electrical conductivity of the soils showed non-saline nature and ranged between 0.21to 0.41 dS m^{-1}, and it may be due to in highest amount of precipitation in studied locations (Barwari, 2013). Soil pH varied from 7.45 (very slightly alkaline) to 8.05 (slightly alkaline). The most dominant soluble cations can be arranged as follow Ca^{2+}> Mg^{2+}> Na^{+}> K^{+}, however for soluble anions ranked as HCO_3^{-}> SO_4^{2-}> Cl^{-} , which except in soil of Zakho that arranged as follow HCO_3^{-} > Cl^{-} > SO_4^{2-}

Table (1):- Physio-chemical properties of studied soils

Locations	Sand %	Silt %	Clay %	Texture	pH	EC dS m^{-1}	Anions(meq.l^{-1})				Cations(meq.l^{-1})			
							CO_3	HCO_3	Cl	SO_4	Ca	Mg	K	Na
K.m_1	17.81	28.04	54.15	Clay	7.76	0.29	T	3.00	0.20	0.43	1.43	1.02	0.25	0.20
K.m_2	39.05	31.79	29.16	Clay Loam	8.05	0.21	T	2.00	0.18	0.22	0.92	0.82	0.16	0.31
Batifa	29.90	36.35	33.75	Clay Loam	7.58	0.41	T	3.00	0.15	0.46	3.67	0.20	0.48	0.24
Assih	13.78	44.74	41.49	Silty Clay	7.45	0.38	_	2.80	0.03	0.95	3.06	2.04	0.21	0.35
Zakho	12.49	42.03	45.48	Silty Clay	7.73	0.22	T	1.80	0.28	0.24	1.43	0.82	0.21	0.27
Semeel	10.41	52.54	37.05	Silty Clay Loam	7.83	0.32	T	2.60	0.15	1.71	2.55	0.71	0.39	0.47
Khank	15.27	37.62	47.11	Clay	7.87	0.24	T	2.40	0.03	0.60	1.33	1.12	0.25	0.43
Faydi	36.35	22.24	41.41	Clay	7.60	0.28	_	1.80	0.38	1.16	1.22	0.82	0.09	0.82
Zawita	21.14	28.22	50.63	Clay	7.78	0.29	T	1.60	0.10	0.46	1.63	0.71	0.21	0.35
Bamarny	18.11	24.32	57.57	Clay	7.86	0.30	T	2.20	0.33	0.38	1.84	0.31	0.11	0.24

T= trace

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

Results in (table, 2) shows some chemical properties of studied soil in Duhok governorate. Total calcium carbonate percentages were 51.36 – 305.30 g kg^{-1}. This indicates that studied soils considered as calcareous (Table, 2). This high total concentration of carbonate minerals was presumably owing to calcareous parent material. CEC exhibited a variant in studied soils and ranged from (15.65 to 34.78) Cmol kg^{-1}. The high value of CEC found in Km_1 in comparison with low value in $K.m_2$ might be associated to the higher rate of organic content and soil texture (clay) in these soils. A study conducted on Vertisols soils revealed that CEC was high due to clay content (Aydinalp and Cresser, 2003). Organic matter content of the studied soils are low or very low ranged between 7.83–37.10 g kg^{-1}, the highest value reported for k.m1 and the possible reasons may be related to the increasing of plant residues on the soil surface and low mineralization rates in these soils. Available phosphorus values ranged from 5.19 to 30.10 mg kg^{-1}. These values indicated that the level of phosphorus available were low to extremely high p content in studied soils.

Table (2):- Some chemical properties of studied soils

Locations	$CaCO_3$ g kg^{-1} soil	Active $CaCO_3$ g kg^{-1} $CaCO_3$	Q.M g kg^{-1} soil	CEC Cmol kg^{-1}	Available phosphorus mg kg^{-1} soil
$K.m_1$	51.36	2.31	37.10	34.78	30.10
$K.m_2$	79.02	3.95	22.16	15.65	5.19
Batofa	253.10	35.43	21.38	31.74	16.96
Assih	184.41	52.56	21.72	30.43	22.84
Zakho	192.23	24.03	8.62	34.35	16.61
Semeel	118.29	18.34	16.55	32.17	20.42
Khank	257.70	39.04	18.36	28.70	13.15
Faydi	194.26	28.17	13.21	16.52	7.61
Zawita	242.82	42.49	30.10	34.35	18.69
Bamarny	305.30	47.63	7.83	30.43	19.38

3.2. Form of zinc:

The results given in the (Table, 3) revealed that the water soluble content was found to be least and ranged from (0.29 to 0.94) mg kg^{-1}. The lowest value was observed in soil of $K.m_2$, whereas the highest amount was found in $K.m_1$ soil. This lower concentration of soluble zinc are in agreement with the findings of other authors (Kumar and Babel, 2011; Ramzan *et al*., 2014), who reported similar small amount, indicating that the soluble form contains less available contents in soils. Result shown negative significant correlation between soluble zinc with pH (-0.697*) while positive correlation but non-significant (Table, 4) shown with EC and available phosphorus, similar result found by Kandali *et al*., (2016) and Saxena et al., (2017). Singh and Umashankar, (2018) found inverse relationship of pH with water soluble zinc, and positive and significant relationships of exchangeable zinc with organic carbon and clay indicated that the available zinc increased with increase in organic matter and clay content.

Table (3):- Form of zinc in soils

Sample locations	Total Zn $mgkg^{-1}$	$CaCl_2$ extract $mgkg^{-1}$	Soluble Zn $mgkg^{-1}$	DTPA extract $mgkg^{-1}$
$K.m_1$	18.90	1.71	0.94	0.88
$K.m_2$	21.30	2.07	0.29	1.64
Batofa	48.05	1.79	0.66	0.97
Assih	56.15	1.79	0.77	1.11
Zakho	39.05	1.82	0.43	1.26
Semeel	12.25	2.07	0.53	1.33
Khank	26.90	1.82	0.31	1.45
Faydi	18.35	1.81	0.82	1.54
Zawita	33.55	1.95	0.45	1.52
Bamarny	28.35	1.98	0.49	1.71

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

Two single extractants (AB-DTPA, pH 7.6 and 0.01 N $CaCl_2$) of soil Zn extractable, the quantity of Zn extracted by different extractants is shown in (Table, 3). There were noticed differences between the values extracted by two extractants, amounts of Zn extracted by chelating agent (DTPA) were lower than amounts of soil extracted by $CaCl_2$-Zn extractable value ranged between (0.88 - 1.64) and (1.71 – 2.07) mg kg^{-1} from DTPA extractable Zn (Available) and $CaCl_2$ extractable Zn (Exchangeable) respectively, the heights value in two extractable found in Km_2 and low value in Km_1. The quantity of Zn extractable by $CaCl_2$ (Exchangeable) is more than Zn extractable by DTPA (Available) this due to DTPA is coating matter occur complexes with micro nutrient but $CaCl_2$ is chemical component extracted the mineral and organic forms of Zn this means adsorbed Zn on clay surface and Zn bond with organic active group (Chahal *et al*., 2005). The result in Table (4) showed inverse significant relationship of available-Zn with HCO_3 (-0.759**), K (-0.631*), available-P (-0.654*) and positive significant relationships with exchangeable zinc (0.686*). While exchangeable zinc has positive significant relationships with pH (0.666*) and negative significant correlation with soluble zinc organic (-0.637*).

The available Zn (DTPA) of some soil in Tanzania ranged from 0.4 – 3.1 mg kg^{-1} and found no negative and positive significant correlation of zinc with physicochemical properties of soil (Makoi, 2016). Studies by Kitundu and Mrema, (2006) showed that available or extractable quantities of Zn as low in almost all soil samples tested ranging from 0.08 to 0.93 mg Zn kg^{-1} soil. Kumar *et al*., (2016) shown positive significant correlation between Zn-DTPA with O.M and negative non-significant correlation with pH. Studies on different forms of zinc in Homs, Syria, demonstrate the exchangeable zinc ranged between (0.12 - 2.84 mg kg^{-1}) and the average value was (0.58 mg kg^{-1}) (Shamsham and Nassra, 2015).

Table (4):- Correlation coefficient between total adsorption at two temperatures (25 and 48 C°), zinc forms, with physicochemical properties of studied soils and with it.

Soil properties	Soluble-Zn $mgkg^{-1}$-	Available-Zn DTPA $mgkg^{-1}$	Exch Zn $CaCl_2$ $mgkg^{-1}$g	Total Zn $mgkg^{-1}$	Total Adsorption Zn at 25C° $mgkg^{-1}$	Total Adsorption Zn at 48C° $mgkg^{-1}$
pH	-0.697*	0.566	0.666*	-0.644*	0.294	-0.226
EC	0.561	-0.539	-0.347	0.602	-0.547	-0.053
CEC	0.124	-0.53	-0.275	-0.153	0.162	0.444
O.M	0.357	-0.494	-0.259	0.222	-0.257	-0.432
$CaCO_3$	-0.277	0.331	-0.059	-0.066	0.398	0.392
A-$CaCO_3$	-0.069	0.175	-0.121	0.212	0.325	0.361
Clay	0.181	0.054	-0.291	-0.379	0.562	0.583
Silt	-0.183	-0.352	0.153	-0.301	0.009	-0.201
Sand	0.014	0.288	0.113	0.614*	-0.526	-0.308
Ca^{2+}	0.31	-0.545	-0.159	0.313	-0.038	-0.553
Mg^{2+}	0.244	-0.249	-0.325	-0.37	-0.156	0.001
K^{+}	0.058	-0.631*	-0.078	0.201	-0.208	-0.564
Na^{+}	0.162	0.359	0.032	0.436	0.095	0.219
HCO_3^-	0.493	-0.759**	-0.385	0.634*	-0.788**	-0.397
Cl^-	0.207	0.31	0.041	-0.035	0.102	0.413
SO_4^{2-}	0.300	-0.035	0.183	0.331	-0.199	0.275
Available-p	0.520	-0.654*	-0.378	0.184	-0.104	0.280
Soluble –Zn	1.000	-0.628*	-0.637*	0.08	-0.486	0.095
Available-Zn DTPA	-0.628*	1.000	0.686*	-0.376	0.605**	0.171
Exch-Zn $CaCl_2$	-0.637*	0.686*	1.000	-0.412	0.23	-0.005
Total-Zn	0.080	-0.376	-0.412	1.000	-0.100	-0.063

** Significant at the 0.01 level, * Significant at the 0.05 level

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

Total –Zn ranged between (12.25 – 56.15) mg kg^{-1} the highest value found in Assih soil but the lower in Semeel soil this due to type and quantity of zinc minerals in the parent material of this soils. Singh and Umashankar, 2018; Hussain *et al*., 2010 stated that concentration of Zn in soil parent material as the main factor affecting Zn concentration in soil. Negative significant relationship found between total -Zn with pH (-0.644*) but negative non-significant correlation with exchangeable-Zn, clay, available-Zn and positive significant relationships found with HCO_3 (0.634*), sand (0.614*), and positive non-significant relationships with EC and Na. Athokpam *et al*., (2018) found all the zinc fractions showed positive correlation with EC, OC, CEC, available nitrogen, available potassium, clay and negative correlation with pH, available phosphorus and silt.

3.3. Adsorption of zinc

Figure (2 and 3) demonstrate that with increasing added zinc concentration to studied soil cause increasing zinc adsorbed at temperature 25 and 48°C, Similar results was determined by (Akay and Doulati, 2012). In general total zinc adsorbed at 48C° in six concentrations more than zinc adsorbed at 25C°, or at increase the temperature from 25 to 48°C the quantity of adsorption increase in all soil studied. The adsorption of Zn increases with an increase in temperature from 30 to 40C° (Sampranpiboon *et al*., 2014).

At temperature 25°C the high mount of zinc adsorbed found in the soil of Zawita (9353) mg kg^{-1} at 196 ppm Zn add) with adsorption rate coefficient 48.68 L kg^{-1} (Figure, 2) and the lower total zinc adsorbed at same temperature was observed in soil of Batofa (8973 mg kg^{-1} at 196 ppm Zn add) with adsorption rate coefficient 46.84 L kg^{-1} these differences demonstrate in significant positive correlation with available-Zn (0.605**) and non-significant positive correlation clay, $CaCO_3$ and significant negative relationships with HCO_3 (-0.788**), and non-significant negative relationships with K, Ca and EC. The significant positive correlation between total adsorbed zinc at 48 C° and available means as adsorbed zinc increases the capacity to extract Zn by DTPA would be more, the results obtained by Hosseinpur and Motaghian, (2015) stated the ability of this chelating agent for the prediction of Zn bioavailability.

At temperature 48°C the mount of zinc adsorbed by soil of Zakho (9393.10 mg kg^{-1} at 196 ppm Zn add) with adsorption rate coefficient 49.01 L kg^{-1} was higher than other soils (Figure, 3), and the lower total zinc adsorbed in same temperature was observed in soil of k.m_2 (9120.95 mg kg^{-1} at 196 ppm Zn add) with adsorption rate coefficient 47.49 L kg^{-1} these varieties could be depended on some soil properties particularly clay content, $CaCO_3$, pH, and available phosphorus. Similar influences of properties indicated by many studies (Ashraf *et al*., 2008; Hararah *et al*., 2012). The results illustrate non-significant positive correlation with clay, CEC and $CaCO_3$ and non-significant negative relationships with sand and O.M.

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

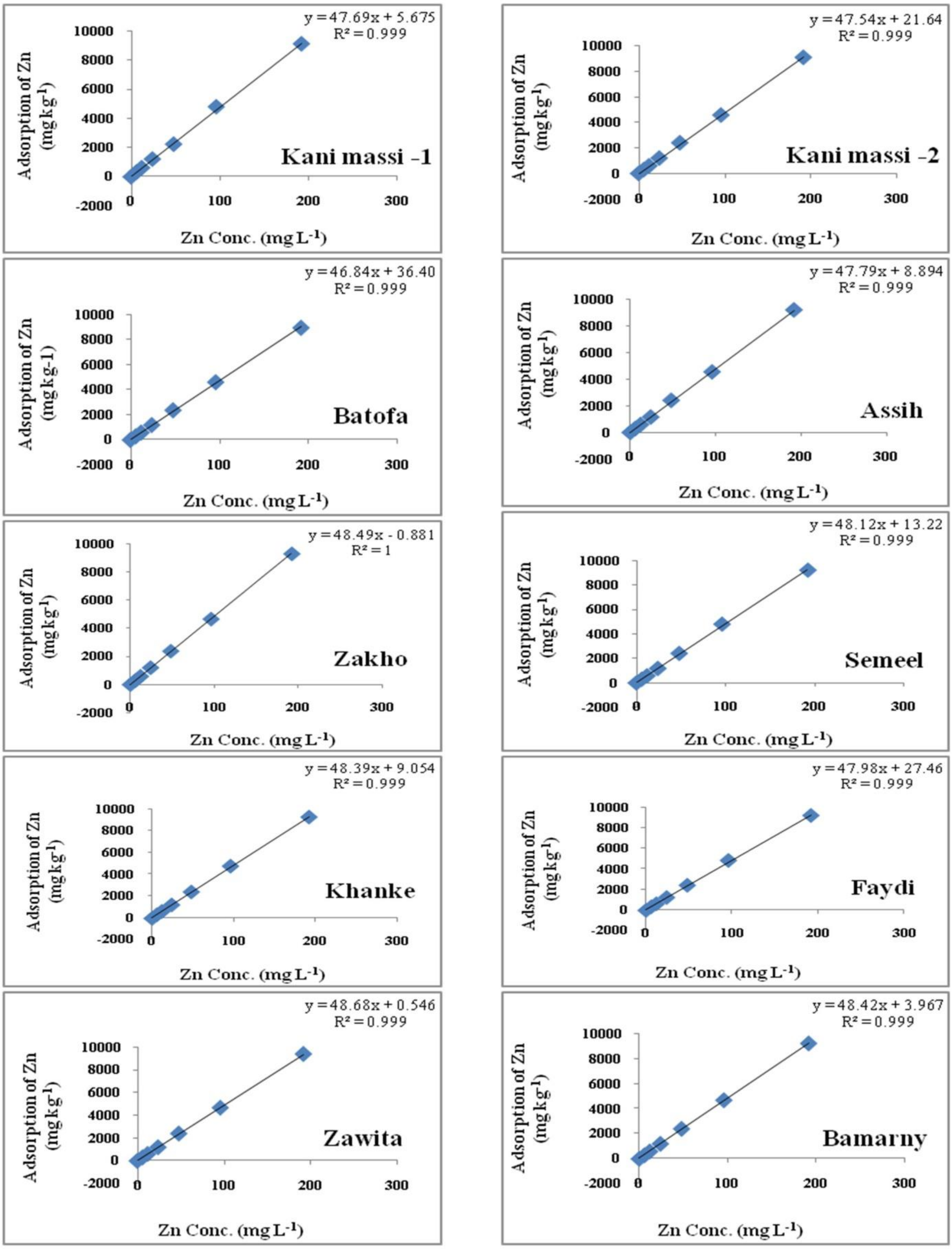

Figure (2): Isotherm adsorption of Zn in different locations for Duhok governorate at 25 °C

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

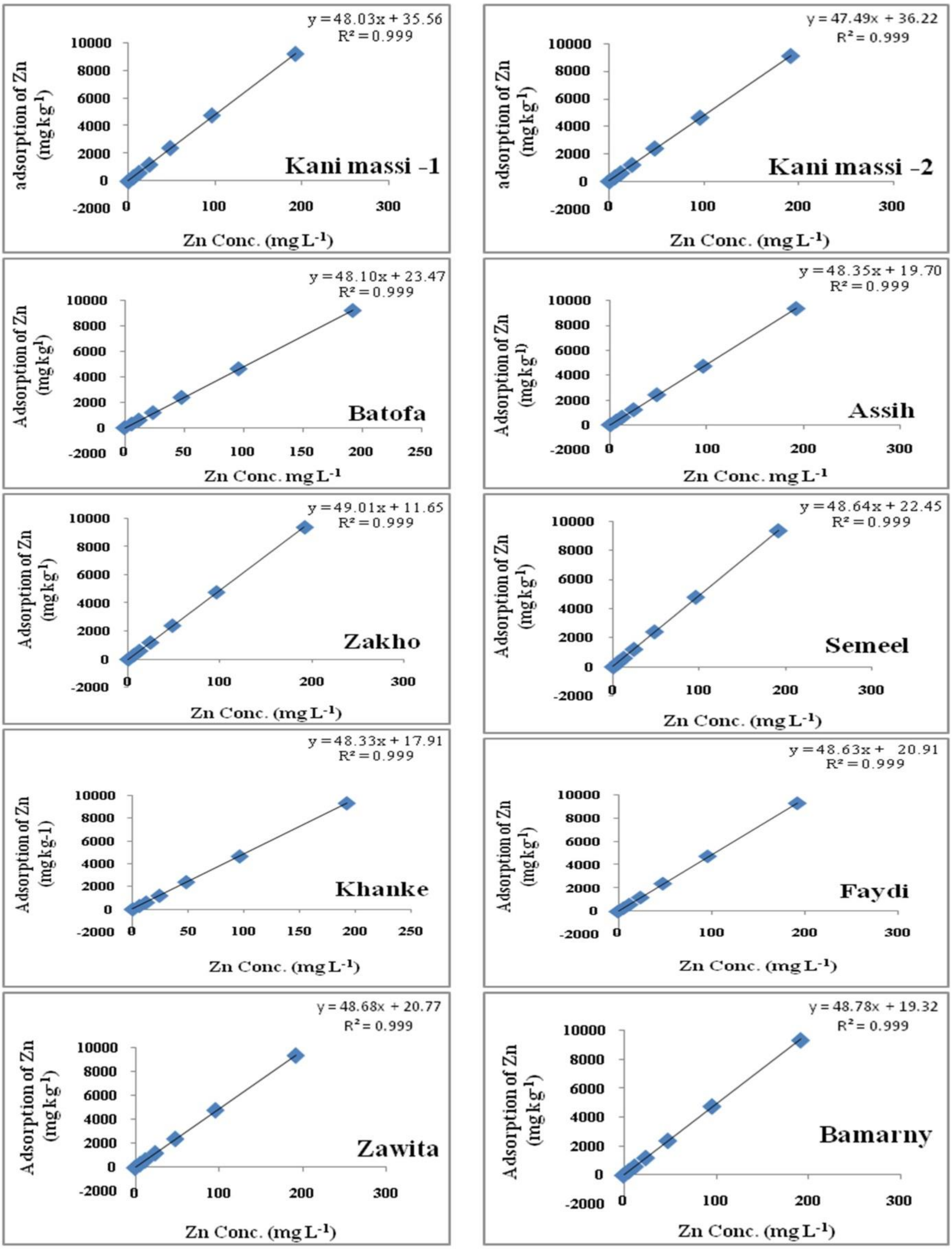

Figure (3): Isotherm adsorption of Zn in different locations for Duhok governorate at 48 °C

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

4- CONCLUSION

The results in the ten calcareous Duhok governorate soils were non-saline with slightly alkaline and in different texture with clay ranged from (29.15 to 57.57 %), $CaCO_3$ (51.36 to 305.6) g kg^{-1}, active $CaCO_3$ (2.31 to 52.56) $g.kg^{-1}$, CEC (15.65to 34.78) Cmol. kg^{-1}, organic matter (7.83-37.10) $g.kg^{-1}$, available phosphorus (5.19 to 30.10) $g.kg^{-1}$. The forms of soluble ranged from (0.29 to 0.94), DTPA extractable (Available) zinc (0.88 to 1.64),$CaCl_2$ extractable zinc(Exchangeable) (1.71 to 2.05), and total zinc (12.25 – 56.15) $mg.kg^{-1}$. Negative significant correlation found between soluble zinc with pH, available and exchangeable zinc but positive non-significant correlation found EC, available-p, HCO_3 and O.M**.** While negative correlation found between DTPA extractable zinc with potassium, HCO_3, soluble-Zn, Ca and CEC, O.M but positive significant correlation with pH, but positive significant correlation found between $CaCl_2$ extractable zinc with pH and DTPA extractable zinc. Total-Zn shown negative significant correlation with pH but negative non-significant correlation with exchangeable-Zn, available-Zn and positive significant relationships found with HCO_3, sand, and positive non-significant relationships with EC and Na.

Increasing added zinc concentration to studied soil cause increasing zinc adsorbed at temperature 25 and 48°C, as well as with increasing temperature from 25 to 48°C an increasing trend of the adsorption amount of studied soil was observed. The high mount of zinc adsorbed at 25°C found in the soil of Zawita (9353mg kg^{-1} at 196 ppm Zn add) and the lower total zinc adsorbed at same temperature was observed in soil of Batofa (8973 mg kg^{-1} at 196 ppm Zn add). At temperature 48°C the mount of zinc adsorbed by soil of Zakho (9393.10 mg kg^{-1} at 196 ppm Zn add) and the lower total zinc adsorbed in same temperature was observed in soil of $k.m_2$ (9120.95 mg kg^{-1} at 196 ppm Zn add). The quantity of adsorption affected positively by presence of clay, calcium carbonate, active calcium carbonate and cation exchange capacity and negatively affected by the ion concentration of bicarbonate, calcium, potassium, organic matter and sand content.

ACKNOWLEDGMENTS

I would like to express our sincere appreciation to the College of Engineering Agriculture Sciences, University of Duhok for access to the laboratory equipment's. I am also grateful to the College of Engineering Agriculture Sciences, University of Duhok, for providing me this chance and technical support to carry out this research.

REFERENCES

Akay, A. and Doulati, B., 2012. The effect of soil properties on Zn adsorption. Journal of International Environmental Application and Science, 7(1), p.151.

Allison, L.E., 1965. Total carbon. In: C.A. Black (ed.) Method of soil analysis, part2. Agronomy Amer. Soc. of Argon, adison, Wis.9, pp.1367-1389.

Alloway, B. J., 2008. Zinc in Soils and crop nutrition. Second edition, published by IZA and IFA. Brussels, Belgium and Paris, France.

Alloway, B.J. 2004. Zinc in soils and crop nutrition. First edition. International Zinc association (IZA). Brussels, Belgium.

Ashraf, M.S., Ranjha, A.M., Yaseen, M., Ahmad, N. and Hannan, A., 2008. Zinc adsorption behavior of different textured calcareous soils using Freundlich and Langmuir models. Pak. J. Agri. Sci, 45(1), pp.6-10.

Athokpam, H.S., Ralte, L., Chongtham, N., Singh, N.B., Devi, K.N., Singh, N.G. and Sharma, P.T., 2018. Status and Forms of Zinc in Acidic Soils of Imphal West District, Manipur (India). Int. J. Curr. Microbiol. App. Sci, 7(4), pp.2349-2358

Aydinalp, C. and Cresser, M., 2003. The Background Levels of Heavy Metals in Vertisols Under Mediterran Tupe of Climate in the Region of Turkey. Journal of Central European Agriculture , 4 (4), pp. 279-29.

Barwari, V.I.H., 2013. Soil Physic-Chemical Properties as Influenced by Slope Position Under Different Vegetation Covers In Duhok Governorate (Doctoral dissertation, M. Sc. Thesis Submitted to the Council of the Faculty of Agriculture and Forestry, University of Duhok).

Chahal, D. S., Sharma, B. D. and Singh, P. K., 2005. Distribution of forms of zinc and their association with soil properties and uptake in different soil orders in semi-arid soils of Punjab, India. Communications in Soil Science and Plant Analysis.36; 2857-2874.

Chittamart, N., Inkam, J., Ketrot, D. and Darunsontaya, T., 2016. Geochemical

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

fractionation and adsorption characteristics of zinc in Thai major calcareous soils. Communications in soil science and plant analysis, 47(20), pp.2348-2363.

Estefan, G., Sommer, R. and Ryan, J., 2013. Methods of soil, plant, and water analysis. A manual for the West Asia and North Africa region, pp.170-176.

Gavlak, R., Horneck, D., Miller, R.O. and Kotuby-Amacher, J., 2003. Soil, plant and water reference methods for the western region. WCC-103 Publication, Fort Collins.

Hararah, M.A., Al-Nasir, F., El-Hasan, T. and Ala'a, H., 2012. Zinc adsorption–desorption isotherms: possible effects on the calcareous vertisol soils from Jordan. Environmental Earth Sciences, 65(7), pp.2079-2085.

Hosseinpur, A.R. and Motaghian, H., 2015. Evaluating of many chemical extractants for assessment of Zn and Pb uptake by bean in polluted soils. Journal of soil science and plant nutrition, 15(1), pp.24-34.

Hussain, S., Maqsood, M.A. and Rahmatullah, M., 2010. Increasing grain zinc and yield of wheat for the developing world: A Review. Emirates Journal of Food and Agriculture, pp.326-339.

Kandali, G.G., Barua, N.G., Basumatary, A. Medhi, B.K. and Kurmi, K., 2016. Zinc fractions and their availability in wetland rice in acidic soil of Assam. Journal of the Indian Society of Soil Science 64(1): 58-65.

Kiekens, L., 1980. Adsorptieverschijnselen van zware metalen in gronden (Doctoral dissertation, Ghent University).

Kitundu, K.M.B. and Mrema, J.P., 2006. The Status of Zn, Cu, Mil, and Fe in the Soils and Tea Leaves of Kibena Tea Estates, Njombe, Tanzania. Tanzania Journal of Agricultural Sciences, 7(1).

Kumar, Pramod, Ashok Kumar, Pardeep Kumar, B. P. Dhayni, U. P. Shahi, Satendra Kumar2, Robin Kumar3 and Ashish Dwivedi., 2016. Nutrients Status of Cultivated Soils of Ganga Canal Area of Meerut District of Uttar Pradesh. International Journal of Bio-resource and Stress Management, 7(4) Special: 606 – 613.

Kumar, M. and Babel, A.L., 2011. Available micronutrient status and their relationship with soil properties of Jhunjhunu Tehsil, District Jhunjhunu, Rajasthan, India. Journal of Agricultural Science, 3(2), p.97.

Loeppert, R.H. and Suarez, D.L., 1996. Carbonate and gypsum. Methods of Soil Analysis: Part 3 Chemical Methods, 5, pp.437-474.

Makoi, J.H.J.R., 2016. Status of Fe, Cu, Zn and Mn and their relationship with some physical chemical properties in the soils of Sonjo and Lupiro alluvial/flood plains in Kilombero and Ulanga Districts, Morogoro, Tanzania. Academia Journal of Biotechnology, 4(3), pp.76-84.

Malakouti, M.J., Keshavarz, P. and Karimian, N., 2008. A comprehensive approach towards identification of nutrients deficiencies and optimal fertilization for sustainable agriculture. Tarbiatmodares University press, 132p.

Marschner, H. (1995). Mineral nutrition of higher plants. London: Academic Press.

Nordberg, G. F., Nordberg, M., Fowler, B. A., & Friberg, L., 2011. Handbook on the Toxicology of Metals. Burlington: Elsevier Science, P. 928.

Orabi, A.A., Mashadi, H., Abdallah, A. and Morsy, M., 1981. Effect of zinc and phosphorus on the grain yield of corn (Zea mays L.) grown on a calcareous soil. Plant and Soil, 63(2), pp.291-294.

Padidar, M., 2015. Effect of soil properties on kinetic zinc release. Res. J. Fish. Hydrobiol, 1010, pp.12-15.

Papadopoulos, P. and Rowell, D.L., 1989. The reactions of copper and zinc with calcium carbonate surfaces. Journal of Soil Science, 40(1), pp.39-48.

Pilbeam, D.J. and Barker, A.V., 2007. Handbook of plant nutrition (No. 631.81 H236h). Florida, US: CRC Press.

Ramzan, S., Bhat, M.A., Kirmani, N.A. and Rasool, R., 2014. Fractionation of zinc and their association with soil properties in soils of Kashmir Himalayas. Ind. J. Agric. Soil Sci, 2, pp.132-142.

Rowell, D. L., (1996). Soil science. Methods and application. Reading. University of United Kingdom.

Ryan, J. G. E.G. and A. A. Rashid., 2001. Soil and plant analysis Laboratory Manual. ICARDA, Aleppo, Syria, and NARC, Islamabad, Pakistan. (2nd Ed.), pp: 139-140.

Saffari M, Yasrebi J, Karimian N, Shan XQ (2009). Evaluation of three sequential extraction methods for fractionation of zinc in calcareous and acidic soils. Research Biological Science, 4: 848-857.

Sampranpiboon, P., Charnkeitkong, P. and Feng, X., 2014. Equilibrium isotherm models for adsorption of zinc (II) ion from aqueous solution

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

on pulp waste. WSEAS Transactions on Environment and Development, 10, pp.35-47.

Saxena, M., Das, A. and Choudhury, S., 2017. Chemical fractionation of zinc and its relationship with important properties of rice grown soils. IJCS, 5(4), pp.1205-1211.

Shamsham, S. and Nassra, R., 2015. Fractionation of zinc and their association with soil properties in soils of governorate homs. Environmental and Earth of Journal, 7(2), pp.118-126.

Singh, V.I.N.A.Y. and Umashankar, S.R., 2018. Zinc fractions in paddy soils and their relationship with soil properties. Annals of Plant and Soil Research, 20(2), pp.148-152.

Soltanpour, P.N. and Workman, S., 1979. Modification of the NH4 HCO3-DTPA soil test to omit carbon black. Communications in Soil Science and Plant Analysis, 10(11), pp.1411-1420.

Soltanpour, P.N., 1991. Determination of nutrient availability and elemental toxicity by AB-DTPA soil test and ICPS.In Advances in soil science (pp. 165-190). Springer, New York, NY.

Summer, M.E. and Miller, W.P., 1996. Methods of Soil Analysis, Part 3, Chemical Methods, SSSA Book Series, vol. 5. Soil Sci. Soc. Am., Madison, WI.

Toth, S.J., Prince, A.L., Wallace, A. and Mikkelsen, D.S., 1948. Rapid quantitative determination of eight mineral elements in plant tissue by a systematic procedure involving use of a flame photometer. Soil Science, 66(6), pp.459-466.

Uygur, V. and Rimmer, D.L., 2000. Reactions of zinc with iron-oxide coated calcite surfaces at alkaline H. European Journal of Soil Science, 51(3), pp.511-516.

Verma, B.C., Swaminathan, K. and Sud, K.C., 1977. An improved turbidimetric procedure for the determination of sulphate in plants and soils. Talanta, 24(1), pp.49-50.

Vitosh, M.L., Warncke, D.D. and Lucas, R.E., 1994. Zinc determine of crop and soil. Michigan State University Extension.

Vodyanitskii, Y. N., 2010. Zinc forms in soils (Review of publications). Eurasian Soil Science, 43 (3), pp.269-277.

نیسیانا زنکـــید ئاخێـــن کســـلێ یێت جیـاواز دا ل بارێزگـــــه ها دهـــــوك

پوختە

دیاردا نیسیانا زنکی هاته خواندن د 10 ئاخێن هه لبزارتی و جیاواز دریزا ته قنێ و کسلێ و مادێ ئه ندامی دا ل بارێزگه ها دهوك ل هه ریما کوردستانا عیراقێ و لڤان جهان (کانی ماسی-1- کانی ماسی-2-باتوفا- زاخو-ئاسیهی- سیمیل- خانکی-فه یدیئ- زاویته و بامرنێ) سامپلێت ئاخێ هاتیه هشکرن و ل موخلا 2 ملم کرن بو خواندنا ساخله تێن ئاخا و جورین زنکی و نیسیانێ. تێدا. ئه نجاما دیارکر کو جه ندایه تیا زنکێ شل و یێ به رهه ف ویێ گهور و یێ سه رجه م دنافبه را (0.29-0.94)-(0.88-1.64)-(1.71-2.05) و(12.25-56.15) ملگم کم-1 لدویف ئێك. په یوه ندیا کریدانی یه نیگه تیف و مه عنوی بو دنافبه را زنکێ شل دگه ل نمرا ترشاتی و تفتاتیا ئاخێ (pH),هه ر ئه وپه یوه ندی دیار بو دنافبه را زنکێ به ر هه ف دگه ل بیکاربونات و پوتاسیومی و فسفورێ به ر هه ف. به لێ په یوه ندیا گریدانێ یه پوزه تیف و مه عنه وی بو دنافبه را زنکێ گهور دکه ل pH. بلا pH کارتَکرنه کا نه رێنی هه بو لسه ر سه رجه مێ زنکی به لێئایونی HCO3و ره ملێکارتَکرنه کا ئه رێنی هه بو.

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac

ئه نجاما ديار كر زيده بونا دياردا نيسيانى دگه ل زيده بونا ريزا هافێتنا زنكى بو سه ر ئاخێن فه كولينى ل هه ردو پيلێن كه رمێ 25°و48°م. زنكێ نيسياى زێده بو بزێده بونا بلا كه رمێ ز 25°بو48°م. مه زنترين نيسيان جێبو ل ئاخا زاويته و زاخو لدويف بلاكه رمێ 25°و48°موكێمترين نيسيان جێبو ل ئاخا باتوفا و كانى ماسى-2 .وجه ندایاتیا زنكێ نيسياى كارتيكرنه كا ئه رينى لسه ر دهيته كرن ب هه بونا ته قنێ و كسلى و كسلا جالاك و قه بارا كهورينا كاتيونا و كارتيكرنه كا نێگه تيف لسه ر دهيته كرن ب هه بونا مادێ ئه ندامى, ره ملێ, ئايوناتێن بيكاربوناتى و كالسيومى و بوتاسيومى.

امـــتزاز الزنــك فـــي ترب كلســية مختلفــةفي محافظـة دهـــوك

الخلاصـــة

تم دراســـة امـــتـــزاز الزنك في عشـــــرة ترب مـختارة ومختلفـــــة في مـحتواها من الطين وكاربونات الكالسيوم والمادة العضويـــــة فى محافظـــــــة دهـــوك باقليـم كردســـــــــتان العــــراق وهـــذه المواقـــــع هي (كانــي ماســــي-1, كانــي ماســــي-2, باطوفـــــــة- زاخـــــــو- اســـــيهي- ســــــميل- خـــانك- فايــــــده- زاويتـــــــــــه- بامرني) تم تجفيف العينات ونخلها بمنخل 2 ملم لدراســــــة صفات الترب و صور الزنك والامــــــتزاز.النتائج بينت بان كميةالزنك الذائب والجاهز والمتبادل والكلي تراوحت بين (0.29-0.94)و(0.88-1.64)و(1.71-2.05) و (56.15 – 12.25) ملغم كم$^{-1}$على التوالي. لوحظ علاقة ارتباط معنوية سالبة بين Zn الذائب مع الـ pH بينما وجدت علاقة ارتباط معنوية سالبة بين Zn الجاهز مع البوتاسيـوم, البيكاربونات والفسـفور الجاهز بينما وجدت علاقــــة ارتباط معنويــــــة وموجبــــــة بين Zn المتبادل مع الـpH. واثرت الـــpH يصورة سلبية على الزنك الكلي بينما ايون HCO_3 والرمل اثرت بصورة ايجابية عليها.

اوضـحت النتائــج زيادة امــــــتزاز Zn مع زيادة تركـــــيز Zn المضاف الي ترب الدراســـــة في درجــــــــتي الحرارة 25 و 48°م. وازدادت تركــــــــــيز Znالممتزبزيادة درجـــــة الحـــــرارة من 25 الى 48°م. وان اعـــلى امتزاز ظهــــرت في تربتــــــــي زاويتـــــــه و زاخـــــو عنـد درجـــــتتي حرارة 25 و 48°م على التوالـــــي بينما اقل امتزاز كانت في تربتــــــي باطوفـــــــــة وكانــــــي ماسي-2.وان كميات Zn الممتز تاثــرت ايجابيـــــا بوجــــود الطـــــين و كاربونات الكالسـيوم الكليـــــة والنشـــطة والســـعة التبادليـــــة الكاتيونيــــــــة بينما تاثرت سـلبيا بوجـود المادة العضويـــــة والرمل وايونات البيكاربونات والكالسـيوم والبوتاسـيوم.

ppaeezy@yahoo.com ; Lazkeen.merween@uod.ac