THE DYNAMIC BEHAVIOR OF POTASSIUM IN SOME DIFFERENT AGRICULTURAL SOILS IN NINEVEH GOVERNORATE

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ABSTRACT

Quantity intensity parameters were used to evaluate the dynamics of potassium in soils under the management of different agricultural use. Sixteen soil samples were collected from Nineveh Governorate to study the forms of potassium relationship of different forms of in these soils, i.e., available, water-soluble, exchangeable, were ranged from (0.005-0.272),(0.486 to 1.252) and (0.749 to 2.355), respectively. In general, the quantity/intensity (Q/I) of K may serve as an index for the intensity and quantity of effective K supply to plants in soils. the quantity-Intensity relationship of Potassium was studied to quantify potassium release for the studied soils. results showed, potassium activity ratio (AR_e^K) is related to changes with labile potassium (±ΔK) at equilibrium and increased together with increasing potassium concentrations, and it is ranged between (3.91 and 24.21)×10^{-3} $(mol.L^{-1})^{1/2}$. The range of labile $K^+(K_L)$ values is equal to (0.18- 0.61) cmol.kg^{-1}, respectively, while the K^+ (PBC^K) was from 21.78 to 45.93 cmol.kg^{-1} $(mol.L^{-1})^{-1/2}$, The Free energy in the (−ΔG) ranged from -0.79 to -0.53 kJ.mol^{-1}.and Gapon Selectivity Coefficient (k_G) ranged from 0.93 to 1.65 $(mol.L^{-1})^{1/2}$. Therefore, this information may be used as references for potassium soil fertilization. The study provided more accurate information about the potassium dynamics of the soils and play a significant role in the behavior of potassium. The results of the statistical analysis showed a positive and significant correlation between potassium forms and some thermodynamic parameters of potassium and some soil properties, while the correlation was negative between these forms and $CaCO_3$.

***Keywords*:** (Q/I) characteristics, agricultural soils in Nineveh, buffering capacity, Potassium dynamics.

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INTRODUCTION

Potassium (K) is considered a dynamic nutrient in the soil system. Its forms in the soil are in equilibrium with each other**.** It has been reported that K could be distributed among different soil fractions including soil solution, exchangeable, non-exchangeable، fixed, and mineral forms. However, dynamic and equilibrium K in the soil different and appear to depend on soil characteristics, soils differ in tendencies to fix applied K in forms unavailable to plants and each soil has it is fixing the capacity for K which must be satisfied before any change in soil solution occurs (Al-Hamandi et al. 2019).

The ability of the soil to regulate the concentration of the food ion in the soil solution is an important factor in the soil readiness for potassium and can be determined by the intensity and quantity factors (Q / I).

The quantity and intensity of element (Q) and (I) are related in a relationship expressed by the regulatory ability of potassium, namely that the ability of the soil to compensate for the solid part lost against potassium depletion processes from the soil or the ability of the soil to absorb the added fertilizer to the liquid phase has been calculated divide the rate of change in quantity by the rate of change in intensity(Al-Obaidi et al. 2011).

In the Q/I curve the equilibrium activity ratio of K^+ (ARK_e) is a parameter for the intensity of labile K^+ in the soil. different soils exhibiting the same values of ARK_e with different values of capacity to maintain ARe^K when soil K^+ is depleted by the plant (Samadi, 2006). Higher values of labile K^+ indicated a greater K^+ release into soil solution resulting from a larger pool of soil K^+. A high value of the potential buffering capacity for K^+ (PBC_K) in the soil is indicative of a good K^+ availability while a low PBC_K value would propose a need for K^+ fertilization (Wang et al., 2004). In recent years, many papers have been published to assess the availability of K^+ in soils using Q/I concept or soil K^+ buffering characteristics (Lalitha and Dhakshinamoorthy, 2015; Bilias and Barbayiannis, 2018). The study aims to know the thermodynamic variation of potassium for some agricultural soils in Nineveh Governorate.

MATERIAL & METHODS

Study area and sample collection and procedure

Sixteen representative surface soil samples were collected from different locations surrounding Nineveh province in Iraq depending on agricultural exploitation. Samples were dried, crushed, and passed through a 2mm sieve, then the chemical and physical analyses were conducted (Page, 1982). Soils were classified belong to, Vertic Haplocalcids (Soil Science Division Staff, 2017), chemical and physical characteristics were determined. Organic matter was determined by dichromate oxidation and the cation exchange capacity by dissolving soil with a neutral 1N NH_4OAc method. Electrical Conductivity (EC) and soil (pH) were measured using 1:2.5 soil to water suspension. Water-soluble, exchangeable, and total K extracts were estimated by flame photometer. Water soluble-K was estimated by shaking 1g of soil with 1:1, soil, water ratio, after shaking for 30 minutes on the mechanical shaker and later filtered to obtain clear extract according to Pratt, (1982). Exchangeable-K was determined by shaking 10g of the soil sample in 1 M of NH4OAC (buffered at pH 7) followed by filtration as described by (Pratt, 1982).

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Table (1) The coordinates of the soil model locations in the study areas using GPS

No.	Soils locations in nineveh	E (longitude)	N (latitude)
1	Shekhan	43.067871°	36.400189°
2	Fayida	42.944462°	36.765937°
3	Rabiea	42.165640°	36.827413°
4	Taleifur	42.434801°	36.398463°
5	Zamar	42.603095°	36.637181°
6	Talkif	43.123407°	36.507668°
7	Tallsquf	43.109155°	36.615920°
8	Alkuayr	43.395281°	36.071661°
9	Hamam Alealil	43.160517°	36.083506°
10	Alqiara	43.329590°	35.846058°
11	Makhmur	43.301382°	35.413790°
12	Al-Hamdaniya	43.417131°	36.321793°
13	Bieshiqa	43.353353°	36.697091°
14	Qibraleabd	43.231129°	36.186799°
15	Alkiba	43.028250°	36.421105°
16	Alkasar	43.239083°	36.218500°

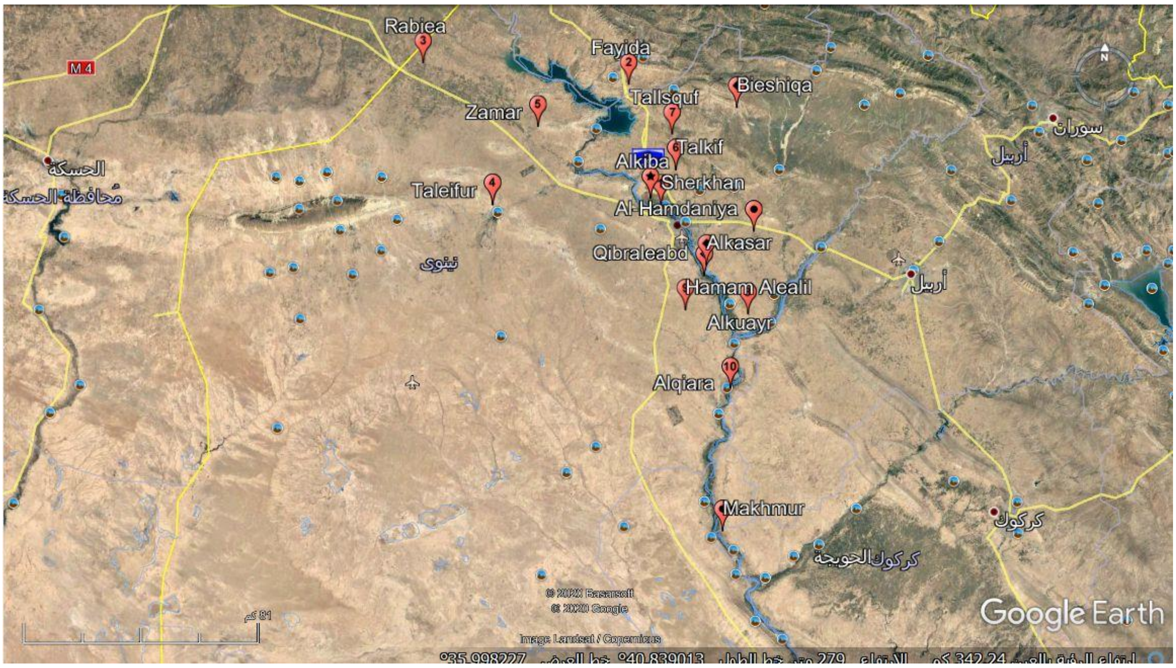

Figure (1) A map showing the soil sampling locations in nineveh

Experimental method and procedure

The quantity-intensity of K^+ was determined according to (Beckett 1964) by adding 50 ml of 0.01M $CaCl_2$ solutions containing (0, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 2, 5, 7, 10 $mmol.L^{-1}$) KCl concentrations to 2.5 g of the soil sample. The soil suspensions were shaken vigorously for 2 h and left for overnight (24 h) for equilibration and then centrifuged. The suspensions of soil samples were filtered and the supernatants were analyzed for K^+ by a flame photometer and Ca^{++} and Mg^{++} titrated with verminate (Carter and Gregorich, 2008). The K^+ intensity (I) or the activity ratio of K^+ (AR^K) relative to Ca^{++} Mg^{++} species of each equilibrium solution was calculated. The change in the amount of K in solution gained or losses by the soil (±ΔK) were calculated according to the following equation.

$$(\pm\Delta K) = (Ci\text{-}Cf) \times V/W \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where: V=Volume of solution (d m^3) and W=Weight of dry soil (Kg)

The K intensity factor in the liquid phase for soil expressed as activity ratio AR^K was computed from the measured concentration of Ca, Mg, and K in the supernatant solution after equilibrium. The activity ratio of potassium (AR^K) was calculated according to Ratio law (Beckett, 1964) as:

$$AR^K = \frac{a_K}{\sqrt{a_{Ca} + a_{Mg}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where: a_i = ionic activity species (Ca, Mg, and K). The ionic activity was calculated according to the Lewis equation (Sposito 2008)

$$a_i = C_i \times \gamma i \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where: a_i = ionic activity, C_i =the species concentration of ions in ($mol.L^{-1}$).

The ionic activity coefficients were calculated by the empirical Davies equation y (Sposito, 2008):

$$\log\gamma i = -0.512 Z_i^2 \left[\frac{\sqrt{I}}{1+\sqrt{I}} - 0.3I\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where: γi= the mean activity coefficient of the electrolyte. Z_i= the species valence of the ion. I = ionic strength in mol L^{-1}.

From a plot of (±ΔK) versus the activity ratio, the Q/I parameters were obtained. The intercept of the Q/I curve on the AR^K_{equ} axis, where K=0, gave the soil K activity ratio at equilibrium (AR^K_0), which denotes the soil solution K activity relative to the Ca + Mg at equilibrium. The potential buffering capacity of potassium at equilibrium (PBC^K_0) was calculated as the slope of the linear relationship of the Q/I. The labile potassium (ΔK_0) was obtained from the intercept of the extrapolated linear part of the Q/I isotherm on the quantity axis. The free energy of the K replacement ($-\Delta G^K_{equ}$) was computed from the following equation as reported by (Beckett, 1964).

$$-\Delta G^K_{equ} = 2.303RTlog\, AR^K_0 \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where R and T are gas constant and absolute temperature, respectively.

Gapon constant was calculated according to (Evangelou and Karanthansis ,1986):

$$k_G = PBC^K / CEC \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where:

k_G = Gapon constant ,

PBC^K= Potassium Potential buffering capacity

CEC= Cation exchange Capacity.

Table (2): Some quantity-intensity linear equation of Potassium for the soils.

No.	Soils locations in nineveh	linear equation	(R^2)
1	Shekhan	y = 45.938x - 0.1827	0.9730
2	Fayida	y = 45.445x - 0.2415	0.9625
3	Rabiea	y = 41.271x - 0.2903	0.9684
4	Taleifur	y = 35.150x - 0.2543	0.9723
5	Zamar	y = 29.726x - 0.2110	0.9746
6	Talkif	y = 31.730x - 0.3391	0.9843
7	Tallsquf	y = 28.773x - 0.3381	0.9858
8	Alkuayr	y = 30.177x - 0.3649	0.9763
9	Hamam Alealil	y = 31.375x - 0.4016	0.9764
10	Alqiara	y = 32.150x - 0.4221	0.9534
11	Makhmur	y = 32.987x - 0.4565	0.9727
12	Al-Hamdaniya	y = 34.538x - 0.4904	0.9652
13	Bieshiqa	y = 25.992x - 0.4361	0.9865
14	Qibraleabd	y = 27.018x - 0.5400	0.9784
15	Alkiba	y = 21.784x - 0.5191	0.9710
16	Alkasar	y = 25.301x - 0.6125	0.9573

RESULTS AND DISCUSSION

Soil properties

The soil under study characterized by the highest value of lime (321gm.kg^{-1}) in soil 5 and the lowest value (185 gm.kg^{-1}) in soil 15. EC ranged from(0.14 - 0.34 dS.m-1), the pH was neutral (7.1-7.7).

Soluble Potassium

This potassium represents the dissolved ion in soil solution at any time and under conditions of field moisture and is not adsorbed on the surface of colloids and its percentage increases in the soil solution due to the conditions of hydrolysis or substitution by other cations, as the results Showed (0.005 to 0.272) Cmol.Kg-1.soil, In (table 4). It may be due to the increase in its organic matter content and the repeated succession of hydration and drying processes during cultivation, which affects the release of potassium From K-bearing minerals soluble potassium these results were in with (Shakeri and Abtahi, 2019) and Odyuo et al. (2015) which showed that the values of potassium dissolved in the soil ranged between (0.023-0.0317) Cmol.Kg-1.soil for the surface and subsurface horizons of the soil. Siddiqua et al. (2018) indicated in their study of (20) selected soil samples from different locations of nalgonda district of Telangana state chosen based on their difference in soil type and depth, practices management soil, and the nature of their use (0.173-0.031) Cmol.Kg-1.soilSeveral studies on Iraqi soil indicated that there is a large variation in the content of these soils of soluble potassium, this may be due to the difference in the studied soil and the nature of the prevailing minerals in it and the nature of its use, and from the results of studies for some of the soils of Iraq, Al-Obaidi (1996) found in a study of some Iraqi soil that The concentration of

Soluble potassium in the surface layers of the soil ranged between (0.001-0.090) Cmol.Kg-1.soil, he showed that these values decreased their rates by increasing depth, due to the activity of biologists, the increase in organic matter and ionic strength, and the repeated succession of hydration and drying processes, which

Table (3) Physical and chemical characteristics of calcareous soils.

NO.	Locations	PSD gm kg^{-1}				pH	EC_e dSm^{-1} at 25°C	CEC $cmol_c kg^{-1}$	gm kg^{-1}	
		Sand	Silt	Clay	Texture				O.M.	$CaCO_3$
1	Shekhan	250	300	450	C	7.7	0.34	29	19	311
2	Fayida	280	330	390	CL	7.4	0.27	28	16	282
3	Rabiea	310	385	305	CL	7.3	0.18	25	14	263
4	Taleifur	330	420	250	L	7.2	0.18	22	11	243
5	Zamar	278	243	470	C	7.6	0.32	29	15	321
6	Talkif	290	350	360	CL	7.3	0.25	28	11	292
7	Tallsquf	315	390	295	CL	7.2	0.18	24	9	282
8	Alkuayr	330	430	240	L	7.2	0.17	21	7	263
9	Hamam Alealil	275	260	465	C	7.5	0.30	28	13	282
10	Alqiara	300	370	330	CL	7.3	0.23	27	9	253
11	Makhmur	320	405	275	CL	7.1	0.16	23	6	243
12	Al-Hamdaniya	340	425	235	L	7.1	0.15	21	5	224
13	Bieshiqa	251	339	410	C	7.5	0.29	28	10	272
14	Qibraleabd	310	375	315	CL	7.2	0.21	26	7	234
15	Alkiba	350	420	230	L	7.1	0.14	20	3	185
16	Alkasar	325	415	260	CL	7.1	0.15	23	5	204

makes potassium-bearing minerals more susceptible to weathering. Hussein, (2007) found in his study on some soil in Nineveh governorate that the dissolved potassium ranged between (0.59-0.03) Cmol. Kg^{-1}.soil, he also observed a positive correlation relationship (r = 0.43) between soluble potassium and soil content of clay and a negative correlation with silt (r = -0.33). Also (Al-Jubouri,2010), when studying some forest soils in northern Iraq, found that the values of dissolved potassium ranged between (0.002-0.162) Cmol.Kg^{-1}.soil. (Al-Badrani and ALI; 2019) found the status of distribution of different potassium images in some limestone soils in northern Iraq, and the results showed that the values of dissolved potassium ranged between (0.006 - 0.146) $Cmol.Kg^{-1}$.soil.

Table (4) Potassium forms in studied soils samples

No.	K-forms (Cmolec Kg^{-1})		
	Soluble	Exch	Available
1	0.272	1.252	2.355
2	0.165	0.964	1.898
3	0.078	0.664	1.683
4	0.010	0.527	0.847
5	0.243	1.218	2.121
6	0.146	0.938	1.829
7	0.068	0.643	1.625
8	0.009	0.513	0.817
9	0.204	1.177	2.034
10	0.107	0.906	1.742
11	0.049	0.623	1.547
12	0.007	0.499	0.778
13	0.175	1.150	1.956
14	0.088	0.885	1.693
15	0.029	0.609	1.489
16	0.005	0.486	0.749

Exchangeable potassium

Is considered one of the most important images on which potassium is found in the soil with plant nutrition, through the state of equilibrium with dissolved potassium and held on the surfaces of the exchange complexes and can be released to the liquid phase through the cation exchange process that is known by the reaction reverse adsorption table 4 showed the amount of potassium exchangeable where ranged between(0.486-1.252) $Cmol_cKg^{-1}$.soil, It is noted that the soils differ in the values of exchangeable potassium, because it may be due to the variation in minerals composition of these soils. our results where lass then values optioned Kundu et al., (2014) for the surface layer ranged from(0.176 -0.207) $Cmol.Kg^{-1}$.soil, Surface layer While Panwar and Shila, (2018) referred that Exchangeable potassium in the Nignoti region in the Indore Province ranged between (0.266-1.012) $Cmol.Kg^{-1}$.soil.Several studies conducted on Iraqi soil indicated that there is a large variation in the content of these soils of Exchangeable potassium. Among the results of studies for some Iraqi soil, (Al-Badrani and Ali; 2019) indicated that the amount of potassium exchangeable ranged between (0.146-0.006) $Cmol.Kg^{-1}$.soil.

Available potassium

The available-K content in the studied soils was ranged from 0.749 – 2.355 cmol.kg^{-1} (Table 4). These values were higher in soils. Similar results were also reported by (Al-Obaidi, 2011); (Siddiqua *et al*., 2018) ; (Al-Badrani and Ali; 2019).

Q/I parameters equilibrium activity ratio of K (AR_e^K)

The ionic efficacy ratio is a basic thermodynamic value used in calculating all relevant thermodynamic criteria and as a guide or indicator for fast potassium readiness. It represents the percentage of cations in the solution in equilibrium with mutual cations and it indicates fast potassium readiness as shown in (table 5) that(AReK) where ranges between (3.91 and 24.21) x10^{-3} (mol.L-1)$^{1/2}$. these values where agreed with Augel et al., (2018) in southern ethiopia, activity ratio values ranged from (0.0008-0.0115) x10^{-3}(mol.L^{-1})$^{1/2}$ and also agreed with Bilias and Barbayiannis, (2019) in Northern Greece for twenty surface soil samples, (0.0001--0.049) x10^{-3} (mol.L^{-1})$^{1/2}$. Al-Obaidi et al., (2008), found in their study of some of nineveh governorate's soil, that the amount of(AreK) efficacy ranged between (3.74 and 93)x10^{-3} (mol.L^{-1})$^{1/2}$. Al-Hamandi et al. (2019) some soils of Baghdad Governorate that (0.44 and 11.39)x10^{-3} (mol.L^{-1})$^{1/2}$.

The labile pool of K(K_L)

The values of mobile potassium are the best criterion for explaining the potassium availability in the soil solution in the long term compared to the exchangeable potassium since high values of (K_L) indicate a significant release of potassium into the soil solution, as opposed to the negative value is a measure of the potassium (unstable) which It is on planer surface sites. the results range from(0.18- 0.61) cmol.kg^{-1}(table 5), the variation in values of (K_L) indicate a significant the clay minerals of the soil contribute to increasing the number of specific and non-specific sites responsible for potassium adsorption and holding, and this is reflected in the adsorbed amount in the soil. Soils rich in montmorillonite clay with large specific surfaces release more potassium than soils containing mica (illite) and vermiculite, which are among the minerals that stabilize the element because of these two large surface charges, the source of which is the same substitution in the silica layers that can be seen in their crystal nets, In addition to the mica mineral that only a small part of the shipments is ready for exchange (Sokolova et al., 2018). in iraqi soils, Al-Obaidi et al., (2011), showed in their study to assess the fertility condition in some soils of Kirkuk governorate using beckett method, that the values of mobile potassium ranged from (0.99-0.34) cmol.kg^{-1}, Al-Hamandi et al. (2019) indicated that the K_L values for some baghdad soils ranged from(0.37-15.57)cmol.kg^{-1}, the results of the statistical analysis indicated that values the labile pool of K.

Potential buffering capacity (PBC^K)

The capacity of the soil to preserve the potassium potential in the soil represents any depletion of potassium. Although the rate of release of this element from the non-reciprocal to the reciprocal phase cannot be measured from the relations of capacitance and intensity, it is possible to measure the ability of the soil to maintain the change that occurs to the potassium ion, which It gives it an indication of liberation, It is clear that the high values of the buffering capacity of the potassium voltage express a constant readiness of the elements for a long

Table (5): Thermodynamic parameters of potassium in studied soils samples.

NO.	Linear equation	(R^2)	ARKe*10-3 (mol L-1)1/2	K_L $cmol_c\ kg^{-1}$	PBC^K $cmol_c\ kg^{-1}$ $(mol\ L^{-1})^{-1/2}$	-ΔG k.J mol^{-1}	k_G $(L\ mol^{-1})^{1/2}$
1	y = 45.938x - 0.1827	0.9730	3.91	0.18	45.93	-0.79	1.58
2	y = 45.445x - 0.2415	0.9625	5.32	0.24	45.44	-0.74	1.62
3	y = 41.271x - 0.2903	0.9684	7.01	0.29	41.27	-0.70	1.65
4	y = 35.150x - 0.2543	0.9723	7.24	0.25	35.15	-0.70	1.60
5	y = 29.726x - 0.2110	0.9746	6.90	0.21	29.72	-0.71	1.02
6	y = 31.730x - 0.3391	0.9843	10.37	0.33	31.73	-0.65	1.13
7	y = 28.773x - 0.3381	0.9858	11.40	0.33	28.77	-0.63	1.20
8	y = 30.177x - 0.3649	0.9763	12.10	0.36	30.17	-0.63	1.44
9	y = 31.375x - 0.4016	0.9764	12.71	0.40	31.37	-0.62	1.12
10	y = 32.150x - 0.4221	0.9534	13.13	0.42	32.15	-0.61	1.19
11	y = 32.987x - 0.4565	0.9727	13.54	0.45	32.98	-0.61	1.43
12	y = 34.538x - 0.4904	0.9652	14.20	0.49	34.53	-0.60	1.64
13	y = 25.992x - 0.4361	0.9865	16.39	0.43	25.99	-0.58	0.93
14	y = 27.018x - 0.5400	0.9784	19.99	0.54	27.01	-0.55	1.04
15	y = 21.784x - 0.5191	0.9710	23.37	0.51	21.78	-0.53	1.09
16	y = 25.301x - 0.6125	0.9573	24.21	0.61	25.30	-0.53	1.10

time, that is, the high values of the buffering capacity of potassium means that the soil has a high organizational ability against changes taking place concerning the level of potassium in the soil solution, that is, it can supply the soil solution with potassium by balancing the rest of the potassium in the soil. the low value of the regulatory capacity of potassium indicates the nature and quality of the minerals prevalent in that soil, which have a low potassium content and are held in high energy, as well as low content of organic matter. the results show(21.78 to 45.93) $cmol.kg^{-1}$ $(mol.L^{-1})^{-1/2}$. They attributed the difference in the values of the organizational capacity to the difference in the number of specific sites of potassium in soils.

Free energies of exchange of Ca with K (-Δ*G*)

It is a guide to know the potassium available in the soil, and it expresses the relative ease with which the ion moves from the solid part (the soil) to the liquid phase and then to the surface of the plant root, which is a measure of the potassium's chemical effort relative to the chemical voltage of calcium in the soil. As the results appear ranged from -0.79 to -0.53 $kJ.mol^{-1}$, The reason for the changes in free energy is due to the type of minerals present in the soil and changes in the conditions of equilibrium of the soil solution with its solid phase, which will directly affect the values of free energy. (Augel et al.,2018; Bilias and Barbayiannis,2019) . our results agreed with Al-Hamandi et al. (2019) that they (-1.09 to -0.63 $kJ.mol^{-1}$).

Gapon selectivity coefficient (k_G)

The availability of potassium indicates the relationships and relative affinity of the soil in the presence of Ca or Mg in both the solid phase of the soil and the soil solution under equilibrium conditions (Samadi, 2012). As the exchangeable potassium, calcium and magnesium are considered in the solid phase of the soil to settle a dynamic equilibrium state with the concentration of cations themselves in the soil solution. this status was determined by(Samadi; 2006). As the results of this research showed between0.93 to 1.65 $(mol.L^{-1})^{1/2}$. changes in the values of the bone constant are attributable to the interchangeable Ca and Mg levels, as well as the soil selective behavior of K, compared to calcium, magnesium and dominant due to the preferential attraction of ions in some locations of soil colloids, these reasons are consistent with the findings of Hamandi et al. (2019) while studying the soil of baghdad 0.02 to 0.07 $(mol.L^{-1})^{1/2}$, capone constant is affected by organic matter and there is a positive relationship between them (r=0.581**). The results of the statistical analysis in Table (6) indicated that there is a positive and significant correlation relationship at the level of (1% and 5%) between dissolved and intermittent potassium and ready with potassium forms and relations of intensity and capacity as well as some characteristics of the studied soil and it is clear that there are positive and moral relationships and this is confirmed by some studies that Conducted on Iraqi soil before (Hamandi et al. 2019; Al-Badrani and ALI; 2019).

CONCLUSIONS

Adopting fertilizer recommendations for the Iraqi soil for potassium taking into consideration the ready quantities thereof, adopting Q / I curves in determining the potency levels of potassium in the soil and conducting field experiments to find out the response of crops to fertilizing with it, as well as adding potassium increases the adsorption process and this process is automatic and controls it The process of spreading and also the necessity of relying on (AR_e^K, KL, PBCK, -ΔG, k_G) to assess the soil fertility, as well as many studies and linking it with clay minerals to follow mineral changes as a result of fixing and depleting this element in soil.

Table (6): Correlation coefficients between potassium forms and some thermodynamic parameters of potassium and some soil properties.

	Soluble	Exch	Available	AR^K_e*10^{-3} $(mol\ L^{-1})^{1/2}$	K_L $cmol_c\ kg^{-1}$	PBC^K $cmol_c\ kg^{-1}$ $(mol\ L^{-1})^{-1/2}$	-ΔG k.J mol^{-1}	k_G $(L\ mol^{-1})^{1/2}$
Soluble	——							
Exch	0.975**	——						
Available	0.907**	0.899**	——					
AR^K_e*10^{-3} $(mol\ L^{-1})^{1/2}$	0.506**	0.377	0.399	——				
K_L $cmol_c\ kg^{-1}$	0.565**	0.437	0.464	0.948**	——			
PBC^K $cmol_c\ kg^{-1}$ $(mol\ L^{-1})^{-1/2}$	0.633**	0.233	0.286	0.821**	0.692**	——		
-ΔG k.J mol^{-1}	0.558**	0.412	0.426	0.961**	0.951**	0.861**	——	
k_G $(L\ mol^{-1})^{1/2}$	0.205	0.338	0.263	0.584**	0.431	0.804**	0.593**	——
CEC	0.920**	0.923**	0.852**	0. 462	0.468*	0.353	0.477*	0.259
O.M	0. 809**	0.711**	0.682**	0.843**	0.858**	0.744**	**0.894	0.281
Ec	0.974**	0.969**	0.820**	0.524**	0.577**	0.360	**0.565	0.198
PH	0.952**	0.919**	0.794**	0.588**	0.701**	0.424*	0.646**	0.101
$CaCO_3$	0.807**-	0.728**-	0.681**-	0.793**-	0.804**-	0.485*-	0.750**-	0.137-
Clay	0.976**	0.967**	0. 586**	0.466	0. 508*	0.304	0.495*	0.581**

(*)and (**)significant at 0.01 ,0.05 probability level, respectively.

السلوك الديناميكي لعنصر البوتاسيوم لبعض الترب الزراعية المختلفة في محافظة نينوى

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الخلاصة

استخدام منحنيات(السعة/الشدة) لتقييم ديناميكية البوتاسيوم في التربة تحت إدارة الاستعمال الزراعي المختلف, اذ جمعت ستة عشر عينة من التربة بمحافظة نينوى لدراسة توزيع صور البوتاسيوم المختلفة في هذه الترب ، الذائب، الجاهز، المتبادل اذ تراوحت الأشكال المتاحة من (0.005 إلى 0.272) و (0.486 إلى 1.252) و (0.749 إلى 2.355) ، على التوالي. بشكل عام ، قد يكون مخطط الكمية / الشدة (Q / اللبوتاسيوم) بمثابة مؤشر لقوة وكمية الإمداد الفعال للبوتاسيوم للنباتات في التربة. تمت دراسة معاملات

شدة الكمية للبوتاسيوم لقياس إطلاق البوتاسيوم للتربة المدروسة. أظهرت النتائج أن الفعالية الايونية للبوتاسيوم (ARKe) مرتبطة بالتغيرات مع البوتاسيوم القابل للتغاير (± ΔK) في حالة توازن وزيادة مع زيادة تركيزات البوتاسيوم ، وتتراوح بين (3.91-24.21) × 10^{-3} مول. لتر$^{-1}$. مدى البوتاسيوم المتحرك لعينات الترب المدروسة، فقد تراوحت بين (0.18-0.61) سنتيمولK. كغم$^{-1}$ على التوالي, بينما السعة التنظيمية لجهد البوتاسيوم تتأرجح بين (21.78-45.93) سنتيمول. كغم$^{-1}$/ (مول. لتر$^{-1}$)^{½}, تراوحت الطاقة الحرة في (–ΔG) من –0.79 إلى –0.53 كيلو جول . مول$^{-1}$ و تراوحت الانتقائية في معامل كابون (k_G) بين (0.93–1.65) (مول. لتر$^{-1}$)^{½}. لذلك ، قد تستند هذه المعلومات إلى مصادر تسميد البوتاسيوم للتربة. قدمت الدراسة معلومات أكثر دقة حول ديناميكية البوتاسيوم في التربة وتؤدي دورًا مهمًا في إدارة البوتاسيوم. اظهرت نتائج التحليل الاحصائي وجود ارتباط موجب ومعنوي بين أشكال البوتاسيوم وبعض المعلمات الديناميكية الحرارية للبوتاسيوم وبعض خواص التربة في حين ان كان الارتباط سالب بين هذه الصور و كاربونات الكالسيوم $CaCO_3$.

الكلمات المفتاحية: خصائص الكمية والشدة , الترب الزراعية في نينوى , السعة التنظيمية للتربة , ديناميكية البوتاسيوم .

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