BEHAVIOUR OF POTASSIUM DESORPTION INDICATOR IN SOME SEMICTITIC RICH SOILS AT NORTHERN OF IRAQ

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ABSTRACT

A laboratory study was conducted to determine potassium adsorption and desorption indicators for 12 semictitic rich soils in Dohuk governorate northern of Iraq. Potassium adsorption isotherms was constructed by using miscible displacement technique with 0.01M KCl in 2.5 gm Ca^{2+} saturated soil for 60 minute with 10 minutes interval at a rate flow 1 ml per minute. After that soil samples were redisplaced with Ca^{2+} by using 0.01M $CaCl_2$ in the same method. The results showed an average amount of K^+ adsorbed ranged from 13.59 - 32.1 c.mole.kg^{-1}, while average amount of K^+ desorbed ranged from (0.53 - 4.45) c.mole.kg^{-1} and hence soil samples had a high hysteresis ranged from 70.3% to 96% and low desorption index ranged between 0.01 - 0.27.

Key words: semictite, adsorption, hysteresis, desorption index.

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INTRODUCTION

Potassium is an essential nutritive element for all plants (Mengel et al., 2001, White, 2003) and its availability in soils is limited by texture, clay minerals, rate of Fertilization, moisture content (Samadi, 2006, Simonsson, et al., 2007) and fertilizer management (Krauss, 2003). Rate of K^+ adsorption after fertilizer addition differs among soils because the response of crops to applied potassium are earlier and thus its unpredictability is due to different adsorption characteristics of potassium by various soils . Depending upon amount and type of clay minerals, up to 57% of the applied potassium can be adsorbed by soil colloids (Shanwall and Dahiya, 2006), Amount of K^+ adsorbed on clay particles depends on kinetic and thermodynamic factors (Du, 2004). Soils with high potassium specificity like illite and vermiculite rich soils (Karabachsch and Ultrich, 2007). Similarly, the rate of K^+ adsorption on illite and vermiculite was reported to be much slower than montmorillonite and kaolinite (Jalali, 2007, Al-Azawi, 2010). Clay minerals like semictite and kaolinite easily release all of their K^+ adsorbed than illite and vermiculite (Ghosh and Sing, 2001), upon removal rate by plants and rapidity at which potassium can be desorbed from the adsorbed phase whereas initial adsorption equilibrium solution levels serves as an index of potassium release (Rao et al., 2004, Jalali, 2006) . This equilibrium of potassium concentration appears to provide a better index of soil fertility. Desorption index refers to soil ability to release potassium after its addition to soil. A knowledge about the variation in K^+ adsorption among soils and equilibrium between solid-liquid phases of K^+ are necessary to predict desorption index of added K^+ fertilizers in soils to make precise K^+ fertilizers recommendations (Shanwall, 2006, Poonia, 2007, Rao and Taker, 2007). So a little is known available to K^+ adsorption-desorption in Iraqi soils. Study aimed to determine the effect of elapsed time on K^+ adsorption-desorption characteristics and desorption index of studied soils.

MATEIALS AND METHODS

Twelve soils were sampled within Vertisols order in Dohuk Governorate at northern Iraq. Soil samples were air-dried and grounded to pass through 2 mm sieve. Some chemical and physical properties are determined according the methods described by Carter and Gregorich, (2008) table.1,2. Soils were classified according to (Anonymous, 2006). Potassium adsorption was carried out by using miscible displacement technique as mentioned by Cracksi and Sparks, (1985), Shanwall. (2006) can be summarized as follows:

Calcium saturation: 2.5 gm of soil samples were placed into 47 mm Nucleopore filtered-column. The samples were saturated with 0.1M $CaCl_2$ solution at rate of 1 $ml.min^{-1}$ until equilibrium was reached later on (to remove K_{ex} from the soil sample).

K^+ adsorption: Ca^{2+} saturated soil was leached by using 0.01M KCl solution supplied at steady rate to renew the soil solution and to assess K^+ adsorption at constant K^+ concentration in soil solution. Solution was leached at the rate of $1ml.min^{-1}$ for each 10 minutes. Difference between initial and final K^+ represented the adsorbed by the soil.

K^+ desorption: K^+ desorption was initiated by using 0.01M $CaCl_2$ solution which passed through soil at rate 1 $ml.min^{-1}$ for a period ranged from 10 to 60 minutes. Quantity of K^+ in solution for both adsorption and desorption was measured by flame photometer.

Table (1): Some physical and chemical properties for studied soils.

Location	No.	Sand	Silt	Clay	Organic. matter	$CaCO_3$ total	$CaCO_3$ active	CEC c.mole. kg^{-1}	pH	EC $dS.m^{-1}$
		$gm.kg^{-1}$								
Someel	1	140	380	480	13	115	45	41.2	7.9	0.5
	2	130	415	455	20	165	45	37	7.8	0.5
	3	025	480	495	12	173	65	25	7.7	0.4
	4	120	490	390	14	182	91	20	7.8	o.5
Bateel	5	075	510	415	16	221	52	26	7.9	0.3
	6	125	515	360	15	291	65	30.2	7.7	0.6
	7	120	500	380	12	282	45	29.1	7.8	0.6
	8	110	550	310	12	261	55	30.8	7.6	0.8
Zakho	9	200	440	360	21	225	60	28	8.0	0.3
	10	180	470	350	13	196	65	24.4	7.6	0.3
	11	140	450	410	14	231	54	28.5	8.1	0.4
	12	220	400	380	15	230	51	28.9	7.9	0.4

$$\% K^+ \text{ desorbed} = \frac{K^+ \text{ desorbed}}{K^+ \text{ adsorbed}} \times 100$$

$$\% K^+ \text{ hysteresis} = \frac{K^+ \text{ adsorbed} - K^+ \text{ desorbed}}{K^+ \text{ adsorbed}} \times 100$$

Desorption indicator: According to (Marzadori, 1991), the desorption index was calculated by the following formula :

DI = md / ma × 100

Where DI: desorption Indicator.

md: desorption isotherm slope.

ma: adsorption isotherm slope.

Table (2): Clay mineralogy and various K^+ forms for studied soils.

No	% Clay minerals				K^+		
					Soluble	Exch.	Non-exch.
	Illite	Semictite	Vermiculite	Kaolinite	c.mole.kg^{-1}		
1	20	19	13	20	0.011	0.75	1.29
2	30	31	5	21	0.005	0.73	1.16
3	33	27	12	26	0.003	0.49	0.91
4	29	20	17	32	0.010	0.93	3.46
5	22	30	10	22	0.003	0.53	2.06
6	22	21	14	29	0.004	0.51	0.96
7	27	18	21	21	0.011	0.73	1.47
8	38	17	13	19	0.007	0.57	1.34
9	30	31	15	22	0.003	0.48	0.74
10	14	22	19	21	0.011	0.54	0.91
11	19	25	14	19	0.016	0.4	0.61
12	21	20	11	22	0.005	0.31	0.28

RESULTS AND DISCUSSIONS

Adsorption capacity: Table.3 indicates the adsorption capacity (AC) of the studied soils, values of AC were ranged from 13.9 c.mole.kg^{-1} (sample No.3) to 32.1 c.mole.kg^{-1} (sample No.7). This variation in K^+ adsorption among studied soils reflects the differences in chemical mineralogical properties of the studied soils, as a result of X-ray diffraction. The smectite is dominant mineral in soil samples, it could increase K^+ fixation. In general smectite is considered to have the highest adsorption capacity, but chlorite have low capacity. The adsorption curve Fig.1 is initially showed that K^+ adsorption was rapid and then it leveled off with time. The initial fast adsorption may be related to the K^+ adsorption on the surface sites. Similar result was found by Mam Rasul and Al-Obaidi (2010) .

Desorption capacity: The data in table.3 indicated that the soil desorption capacity ranged from 0.53 c.mole.kg^{-1} (sample No.3) to 4.45 c.mole.kg^{-1} (sample No.10). The maximum quantity of K^+ desorption was related to silt fraction in soil. Positive correlation between K^+ desorption and silt fraction was recorded (r = 0.68*). Similar results was observed by Simard et al.,(1992) found that K^+ released rate from clay and silt was larger than sand to soil mineral structure Badraoui et al., (1992), they found that the soil content mica, illite and vermiculate minerals have a high release rate of K^+ compared with kaolinite minerals.

Hysteresis of potassium: Strong hysteresis behavior of K^+ adsorption-desorption was observed for studied soils as illustrated by discrepancy between adsorption and desorption isotherm Fig.1. Due to strong adsorption and low recovery, results indicated that potassium is not susceptible to leaching losses from the surface sites. Low values of DI increases in hysteresis. Table 3 showed the lower DI value which indicates an increase in difficulty of the K^+ adsorbed to K^+-desorbed from soil surfaces. Highest value of K^+ hysteresis 96% was recorded from (sample No.10), lower value 70.3% were obtained from (samples No.3) tab.3 and fig1. Little amount of K^+ adsorption was desorbed back into the liquid phase indicating to

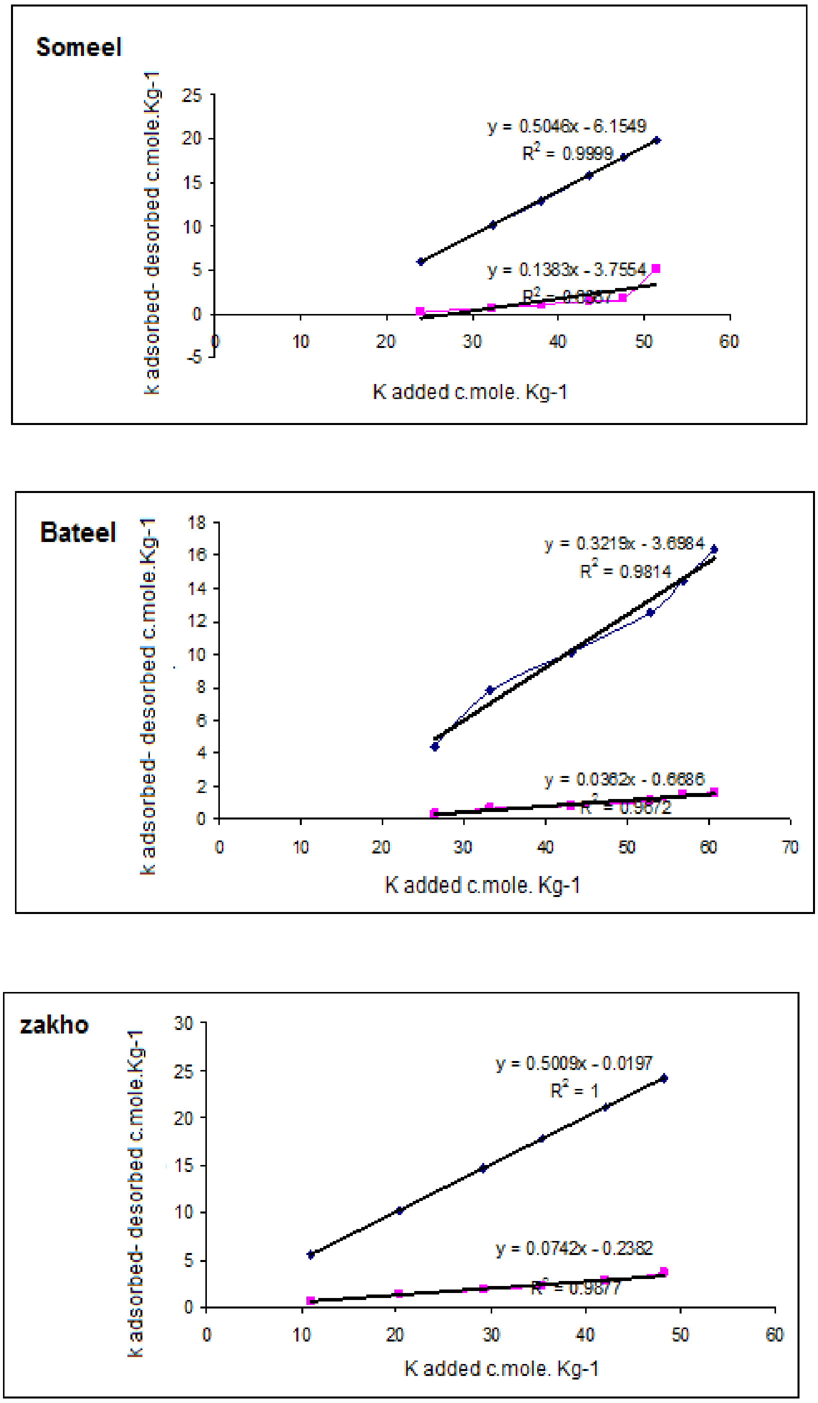

Fig. (1): Regression relationship between K^+ added and K^+ adsorbed-desorbed for studied soils.

Table (3) : K^+ adsorption-desorption, % K adsorbed, % K hysteresis and desorption index for studied soils.

No.	K^+ adsorbed	K^+ desorbed	K^+ hysteresis	%K^+ desorbed	%K^+ hysteresis	desorption Index (DI)
	c.mole.Kg^{-1}					
1	19.8	2.17	17.63	11.0	89.0%	0.27
2	14.8	0.94	13.86	6.4	93.6%	0.01
3	13.9	0.53	13.37	3.9	96.0%	0.50
4	15.1	1.68	13.42	11.1	88.8%	0.13
5	16.4	1.65	14.75	10.0	89.9%	0.11
6	17.3	2.09	15.21	11.8	87.9%	0.20
7	32.1	3.01	20.09	9.4	90.6%	0.10
8	29.7	4.07	25.63	13.7	86.3%	0.15
9	29.2	3.52	20.68	14.5	85.5%	0.15
10	16.0	4.45	11.55	15.3	70.3%	0.02
11	17.0	1.46	15.54	8.6	91.4%	0.11
12	23.7	3.89	19.81	16.4	83.6%	0.18

strong tendency of K^+ to be sorbed by clay or organic matter Fig.1, thereby these soils have a large specific surface area to sorbed. These results agree with those of Huang (2005), Khodabaksh (2006), Karabachsh and Ultrich (2007), Al-Semmak (2008), Al-Obaidi and Hussain (2010) who referred that rich semictitic and illitic soils of northern Iraq (Nineveh, Duhok, Erbil, Sulaimania governorates), have a high fixing capacity for potassium.

سلوكية دليل تحرر البوتاسيوم الممتز في بعض الترب الغنية بمعدن السمكتايت في شمالي العراق

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الملخص

أجريت دراسة مختبريه لتحديد سلوكية و تحرر البوتاسيوم لأثني عشرة موقعا تمثل رتبة Vertisols من محافظة دهوك في شمالي العراق . تم أمتزاز البوتاسيوم باستخدام تقنيات الإزاحة الأمتزاجية الهادئة بإمرار محلول 0,01 مولا ري كلوريد البوتاسيوم لعينة تربة 2,5 غم مشبعة بالكالسيوم وبمعدل جريان 1سم^3 / دقيقة لفترات زمنية قدرها 10 دقائق ولمدة 60 دقيقة . بعدها تم استبدال البوتاسيوم الممتز بمحلول 0,01 مولا ري كلوريد الكالسيوم وبنفس الطريقة السابقة ولمدة 60 دقيقة أيضا. وقد أشارت النتائج إلى تباين الترب في أمتزازها للبوتاسيوم ومقدار البوتاسيوم المتحرر، إذ تراوحت الكمية الممتزة من 13,55 - 32,1 سنتي مول.كغم$^{-1}$، بينما بلغت الكمية المتحررة من البوتاسيوم الممتز من 0,53 - 4,45 سنتي مول.كغم$^{-1}$، وامتازت هذه الترب بظاهرة تخلف عالية للبوتاسيوم K^+ hysteresis تراوحت من 70,3% - 96% ودليل تحرر منخفض تراوح من 0,01 - 0,27 .

كلمات دالة: السمكتايت، أمتزاز، تخلف، دليل التحرر.

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