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Status of Potassium in Some Calcareous Soils of Egypt and Factors Affecting Its Forms

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Abstract

The current study throw some light on potassium (K) status in some calcareous soils of Egypt as well as its relations to soil indigenous properties. To achieve the targets of this study, eight selected profiles were dug in soils of the Western Desert of Egypt, North Sinai and El-Fayum governorate. Physical, chemical and mineralogical analyses of these soils were carried out. The total and different forms of potassium in soils (*i.e.* water soluble, exchangeable and NH_4OAc extractable) were evaluated.

Results of different analyses showed that the investigated soils varied in their indigenous physical and chemical properties. They also varied in their mineralogical compositions. Soil of Western Desert and North Sinai were dominated with kaolinite followed by smectite whereas soils of the other investigated areas were dominated by smectite followed by kaolinite. The studied soils varied, to some extent, in their contents of the total and different K-forms. To evaluate the effects of the indigenous soil properties on these forms of K correlation of each of these forms with the different soil properties were calculated. The most important correlations indicated that the clay content and the cation exchange capacity were of the most pronounced effect on the different K forms. However, the other soil properties although did not show significant correlations with the different K-forms, yet their influences on the K-forms cannot by neglected.

Key words: K-forms, mineralogical composition, calcareous soil, Egypt.

Introduction

Potassium is one of the major elemental constituents of the earth crust with an average of 2.3% (**Jalali, 2006**). Potassium is an essential element for plant growth and is a dynamic ion in the soil system; its importance in agriculture is well recognized (**Alfaro *et al.*, 2004**). Potassium dynamics in soils is related to the magnitude of equilibrium among various K forms and mainly governed by the composition of soils and their chemical and physical properties (**Bhattacharyya *et al.*, 2007; Usman and Gameh, 2008; Abdeen, 2014; Lalitha and Dhakshinamoorthy, 2014** and **Tantawy *et al.*, 2017**). Soil K exists in four forms in soils: soluble, exchangeable, fixed or non-exchangeable, and structural or mineral. The bulk of total soil K is in the mineral fraction (**Sparks and Huang, 1985**). Any change in the status of one form tends to be balanced by an appropriate shift in the other forms (**Lalitha and Dhakshinamoorthy, 2014**). The concentration of K in soil solution depends upon the rate of removal by the plants and the rapidity at which K can be desorbed from the adsorbed phase (**Abdeen, 2014**).The equilibrium between K forms determines the K status of the soil and its supply potential to plants (**Tantawy, 2017**). Plants can use only the potassium dissolved in the soil water and the exchangeable potassium on the surface of soil particles. This often amounts less than 100 mg kg^{-1} (**Bertol *et al.*, 2007**).

According to availability of potassium in soil, soil potassium is classified into three forms: unavailable, slowly available and readily available or exchangeable (**Sharpley, 1989** and **Bhonsle *et al.*, 1992**). The highest amount of the total soil K is in the mineral fraction, mainly as K-bearing primary minerals such as feldspars, muscovite, biotite, microcline and orthoclase and various other clays (**Sparks and Huang, 1985**). Mineral K comprised about 90-98% of the total K in the soils as structural K (**Pasricha, 2002, Sharma *et al.*, 2006** and **Anil *et al.*, 2009**).The exchangeable K is the form of K, which is existent on the soil matrix and can be replaced by other cations of neutral salts of the soil solution. The exchangeable K constitutes less than 2 % of the total K forms approximately 90 % of the available K (**Sparks, 2000**). It is the portion of the soil K that is electrostatically bound as an outer-sphere complex to the surfaces of clay minerals and humic substances (**Sparks, 1987, Havlin *et al.* 1999** and **Sparks, 2000**).

Soluble potassium (soil solution K form) is the form of K that is directly taken up by plants and microbes. It constitutes 0.12 % of the total K. Potassium in soil solution is absorbed more readily by plants and leached out, although the most available K is an exchangeable form (**Brady and Weil, 2002**). Generally, levels of soil solution K are low, unless recent applications of K amendments have been made to the soil. Levels of soil solution K are affected by the equilibrium and kinetic reactions that occur between the forms of soil K (**Sparks and Huang, 1985, Kirkman *et al.*, 1994 Sparks, 2000** and **Abdeen, 2014**). The water soluble K is dependent upon the equilibrium between the different forms of K in the soil and the application or removal of K from the soil (**Zhang *et al.*, 2010**).

The aim of this work is to study the various potassium forms of the soils under study and their relations to the indigenous soil properties.

Materials and Methods

Eight soil profiles were selected to represent some calcareous soils of Egypt [*i.e*., soils of Western Desert (El-Salom and El-Dabaa); soils of North Sinai (El-Arish, Ber El Abd, Baloza and Romana) and soils of El-Fayum (Tamia and Kom Oshim)]. Soil profiles were dug and described according to **Soil Survey Staff** (**1993**) and **Soil Survey Staff** (**2010**). Soils were sampled from the different layers (0-30; 30-60 and 60-90 cm), air-dried, and crushed to pass through a 2 mm sieve and kept for laboratory analysis.

Particle size distribution and chemical properties were carried out according to the method outlined by **Klute** (**1986**) and **Page *et al.*** (**1982**).

Total potassium determined in soil samples after being digested by a mixture of HCl and HNO_3 (*aqua regia*) was carried out using flame-photometer. Water soluble potassium was determined in both the soil paste extract and in a dilute 1: 5 "soil: water" extract and potassium was measured using the flame-photometer **(Page *et al.*, 1982**).

Statistical analysis was conducted using Pearson correlation and regression (Curve estimation) analysis were used to determine the relations between potassium extracts (soluble, NH_4 acetate and total K) and some soil properties of the investigated soils, using Statistical Package for Social Sciences program (**SPSS, 2001**) version 18.0 according to (**Snedecore and Cochran, 1981**).

Results and Discussion

Mineralogical, physical and chemical characteristics of the investigated soils

The mineralogical composition of the clay fraction separated from representative soil samples was carried out by X- ray diffraction analysis according to **Johns *et al*. (1954)**. A semi-quantitative estimation of the clay minerals is given in **Table 1**.

Physical and chemical characteristics of the western Desert soils (El-Saloum and El-Dabaa) are presented in Tables 2 and 3. The dominant textural class of these soils was sandy loam. These soils were of relatively alkaline pH ranging from 7.32 to7.77 probably due to their calcareous nature **(Abdeen, 2014)**. Hydrolysis of $CaCO_3$ in calcareous soils results in release of both hydroxyl and bicarbonate ions. Since the hydroxyl ions are strong alkali radical whereas the bicarbonate ions are weak acidic radicals, therefore the soils pH values tended to be alkaline (**Balba, 1995**).

$$CaCO_3 + HOH \longrightarrow Ca^{2+} + HCO_3^- + OH^-$$

Table 1. Semi- quantitative mineralogical composition of the clay fraction (<0.002) separated from representative samples of the studied soils.

location	Interstate filed mineral	Clay minerals						Accessory minerals				
		Smectite	Kaolinite	Illite	Chlorite	Vermiculite	Palygorstite	Quartz	Feldspass	Calcete	Dolomite	Gypsum
Western Desert	Tra	Few	Dom	Few	--	--	Tra	Com	Tra	Com	Mod	Mod
North Sinai	Tra	Dom	Mod	Few	--	-	-	Com	Mod	Few	Few	--
El- Fayoum	Tra	Dom	Mod	Few	--	-	-	Mod	Few	Few	--	--

Dom.(>40%)Dominant
Com.(25-40%)Common
Mod.(15-25%)Moderate
Few.(5-15%)Few
Tra.(<5%)Trace
-- Absent

Electrical conductivity (EC) of El-Saloum soil ranged from 10.33 to 11.93 dSm^{-1}*i.e.* these soils are saline (EC > 4 dSm^{-1}), the corresponding EC values of El-Dabaa soils ranged from 2.51 to 7.73 dSm^{-1}. The lower values characterized the surface (0-30 cm) and subsurface (30-60 cm) layers of these soils (3.44 and 2.51 dSm^{-1}, respectively) *i.e.* soils of surface and subsurface layers were non-saline whereas EC value of the deepest layer (60-90 cm) of this soil was saline.

Calcium carbonate of the studied Western Desert soils were relatively high ranging from 114.0 to 251.0 gkg^{-1} soil, however soils of El-Saloum were of generally lower $CaCO_3$ contents than the corresponding ones of El- Dabaa. Depth wise distribution of $CaCO_3$ within the studied soils did not follow a constant pattern.

Organic matter contents of the Western Desert soils were very poor and did not exceed 5.1 g kg^{-1}. Such a poor content of organic matter is mainly due to the very low vegetative cover in these soils, on one hand, and the high temperature on the other hand, which accelerates the decomposition of the formed organic matter in these soils.

Values of cation exchange capacity (CEC) of the studied soils seemed to be low (ranging from 10.32 to 15.67 $cmol_c\ kg^{-1}$) as a result of soil poverty in both the clay content and the organic matter which are responsible for the cation exchange capacity of soil.

Sodium cation (Na^+) dominated the soluble cations, therefore, resulted in somewhat high SAR values ranging from 6.41 to 19.74, whereas potassium cation (K^+) was of the least abundance. The anionic composition revealed that Cl^- anions were the dominant whereas HCO^-_3 ones were the least CO^{--}_3 anions were not detected.

Table 2. Physical and chemical characteristics of El-Saloum soils.

Soil depth (cm)	**Particle Size Distribution (%)**				**Texture**	**pH*****	**EC*** dSm^{-1}**	**$CaCO_3$ gkg^{-1}**	**O.M gkg^{-1}**	**CEC $cmol_c\ kg^{1}$**
	C.S*	**F.S***	**Silt**	**Clay**						
0-30	9.35	40.82	31.78	17.99	SL**	7.70	10.33	189.4	3.5	15.67
30-60	9.99	38.25	32.24	19.42	SL**	7.56	11.25	114.0	1.9	14.89
60-90	10.75	38.07	33.96	18.27	SL**	7.47	11.93	176.5	0.8	13.28

Soil depth (cm)	**Soluble Cations $mmol_c\ L^{-1}$					**Soluble Anions $mmol_c\ L^{-1}$			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	13.34	9.54	79.50	0.16	19.74	0.00	2.54	74.99	26.05
30-60	21.98	10.42	79.31	0.13	15.28	0.00	2.24	79.02	30.26
60-90	23.39	12.68	82.65	0.11	18.21	0.00	2.07	82.06	34.8

*C.S Corse Sand – F.C Fine Sand, **SL: Sandy loam, *** pH, EC and soluble ions were determined in soil paste extract.

Table 3. Physical and chemical characteristics of El-Dabaa soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture*	pH*	EC* $dS\ m^{-1}$	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c\ kg^{-1}$
	C.S*	F.S*	Silt	Clay						
0-30	7.2	31.4	44.16	17.25	SL	7.77	3.44	251	2.0	11.63
30-60	6.66	32.61	43.42	17.34	SL	7.32	2.51	250	2.5	10.32
60-90	5.88	32.97	43.05	18.12	SL	7.66	7.73	235	5.1	13.42

Soil depth (cm)	***Soluble Cations $mmol_c\ L^{-1}$**					***Soluble Anions $mmol_c\ L^{-1}$**			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	3.48	9.34	21.35	0.15	6.41	0.00	0.33	23.11	10.68
30-60	4.03	2.12	18.82	0.10	9.25	0.00	0.22	18.2	6.66
60-90	11.62	16.76	48.84	0.03	10.28	0.00	1.18	53.65	22.45

* See footnotes of Table 2

The main physical and chemical characteristics of the north Sinai soils (El-Arish, Beer-El-Abd, Baloza and Romana) are presented in Tables 4 to 7. Soils of El-Arish, Baloza and Romana showed a sandy loam texture due to their relative higher clay contents, while those of Beer El-Abd only showed a sandy texture.

pH values of the studied soils were generally alkaline and seemed highest in layers of Beer-El-Abd, lowest in soils of both El-Arish and Baloza and came in-between in soils of Romana.

Soils of both El-Arish and Beer- El-Abd were non-saline because their EC value were, generally, less than $4dSm^{-1}$ whereas soils of both Baloza and Romana were saline since their EC values, generally, exceeded 4 d Sm^{-1}.

The highest $CaCO_3$ contents characterized layers of Baloza soils especially the 30-60 cm layers. On the other hand, El-Arish, Beer El-Abd and Romana soils contained relatively lower $CaCO_3$ contents.

Table 4. Physical and chemical characteristics of El-Arish soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^{-1}
	C.S*	**F.S***	**Silt**	**Clay**						
0-30	17.07	43.04	25.31	19.58	SL**	7.79	2.18	150.6	2.10	9.01
30-60	11.9	42.20	26.71	19.19	SL**	7.65	2.66	208	3.10	7.35
60-90	12.92	42.36	25.55	19.17	SL**	7.72	3.40	309	1.80	8.99

Soil depth (cm)	***Soluble Cations $mmol_c$ L^{-1}**					***Soluble Anions $mmol_c$ L^{-1}**			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	6.89	2.79	10.86	0.11	4.34	0.00	2.05	9.6	9.01
30-60	8.24	4.47	12.89	0.07	4.39	0.00	1.11	12.75	11.7
60-90	8.73	6.86	17.9	0.045	5.34	0.00	1.60	16.65	15.27

* See foot notes of Table 2 and ** SL Sandy loam

Table 5. Physical and chemical characteristics of Baloza soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^{-1}
	C.S*	F.S*	Silt	Clay						
0-30	7.76	33.57	40.22	18.45	SL**	7.44	17.45	307	20.5	26.30
30-60	7.47	32.41	41.59	18.54	SL**	7.28	21.88	555	20.3	25.81
60-90	6.96	33.16	41.56	18.33	SL**	7.30	24.17	164	19.9	24.88

Soil depth (cm)	***Soluble Cations $mmol_c$ L^{-1}**					***Soluble Anions $mmol_c$ L^{-1}**			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	24.15	32.40	116.72	0.07	17.50	0.00	2.02	123.30	59.20
30-60	33.81	43.09	141.02	0.06	18.20	0.00	2.94	135.59	79.46
60-90	43.46	52.47	144.73	0.05	16.80	0.00	3.40	151.47	85.87

* See foot notes of Table 2 and ** SL Sandy loam

Table 6. Physical and chemical characteristics of Romana soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^1
	C.S*	F.S*	Silt	Clay						
0-30	6.71	31.60	44.62	17.08	SL**	7.89	12.88	265	2.1	25.99
30-60	7.07	32.76	43.40	16.78	SL**	7.66	13.65	212	4.2	25.23
60-90	8.27	32.24	43.49	10.00	SL**	7.51	18.01	151	2.2	24.31

Soil depth (cm)	***Soluble Cations $mmol_c$ L^{-1}**					***Soluble Anions $mmol_c$ L^{-1}**			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	12.98	17.72	96.93	0.08	19.69	0.00	1.01	92.77	34.02
30-60	18.13	25.88	91.62	0.06	15.49	0.00	2.11	89.99	43.50
60-90	25.88	46.60	106.97	0.05	13.86	0.00	3.64	120.11	56.05

* See foot notes of Table 2 and ** SL Sandy loam

Table 7. Physical and chemical characteristics of Beer El Abd soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^1
	C.S*	F.S*	Silt	Clay						
0-30	82.04	13.04	0.11	3.93	S**	8.85	3.21	399	10.1	3.51
30-60	88.77	8.02	0.14	3.07	S**	7.88	2.22	257	0.9	2.35
60-90	90.16	6.48	0.58	2.78	S**	7.98	2.24	289	0.5	2.44

Soil depth (cm)	***Soluble Cations $mmol_c$ L^{-1}**					***Soluble Anions $mmol_c$ L^{-1}**			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	2.08	6.21	23.38	0.11	8.68	0.00	5.1	23.15	2.37
30-60	2.51	7.48	12.12	0.09	4.10	0.00	3.4	6.46	12.33
60-90	3.66	6.97	10.94	0.12	3.68	0.00	1.52	9.23	10.88

* See foot notes of Table 2 and **S: Sandy

Organic matter contents of all North Sinai soils were generally low except for Baloza soils whose organic matter contents were about 20 g kg^{-1} soil. Both the relatively lower contents of the clay fraction and organic matter content were responsible for the low values of cation exchange capacity of North Sinai soils, which were highest in El-Arish soils and lowest in Beer-El-Abd ones.

The cationic composition of North Sinai soils was dominated by Na^+ while the anionic composition was characterized by dominance of Cl^- anions. Ca^{2+} ions came next to Na^+ ones in the cationic composition of North Sinai soils while SO_4^{2-} anions came next to Cl^- anions in the anionic composition of these soils. Sodium adsorption ratio (SAR) was low in soils of El-Arish and Beer El-Abd. On the other hand, Baloza and Romana soils have higher sodium adsorption ratio (SAR) ranged from 13.86 to 19.69.

Physical and chemical characteristics of El-Fayum soils (Tamia and Kom Oshim) are presented in Tables 8 and 9, respectively. Tamia soils were characterized by a clay texture, slightly alkaline pH, very high EC values (> 4dSm^{-1}), high $CaCO_3$ contents (≥ 200.4 gkg^{-1}), low organic matter contents and relatively high cation exchange capacities. Na^+ dominated the soluble cations followed by Ca^{2+} then Mg^{2+}, while K^+ was the least one. The SAR values were higher than 15 indicating sodicity of these soils. Carbonate anions were detected in the lowest concentrations, whereas the Cl^- anions dominated the soluble ones. SO_4^{2-} anions were detected in concentration exceeding the corresponding ones of HCO_3^-.

Kom Oshim soils are characterized by a sandy clay loam texture (SCL), a slightly alkaline pH, high EC values (> 4.0 dS m^{-1}), low organic matter content, relatively high $CaCO_3$ content and cation exchange capacity (CEC) ranging from 23.70-25.39 $cmol_c$ kg^{-1}. Sodium cation dominated the cationic composition while Cl^- ions dominated the anionic one. The SAR values exceeded 15 and ranged from 24.75 to 25.05.

Table 8. Physical and chemical characteristics of Tamia soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^{-1}
	C.S	F.S	Silt	Clay						
0-30	8.38	24.88	34.4	32.35	CL*	7.99	27.27	200.8	10.9	23.82
30-60	7.56	26.49	36.36	29.60	CL*	7.64	30.64	252.1	8.50	23.47
60-90	6.31	26.69	37.62	29.37	CL*	7.36	31.87	200.4	6.70	24.82

Soil depth (cm)	*Soluble Cations $mmol_c$ L^{-1}					*Soluble Anions $mmol_c$ L^{-1}			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	15.97	34.57	220.717	0.43	33.85	0.00	2.51	217.05	51.98
30-60	17.58	47.79	240.00	0.36	31.90	0.00	2.71	248.66	54.30
60-90	17.25	47.99	251.63	0.30	33.44	0.00	2.73	255.99	59.03

* See foot notes of Table 2 and **CL: Clay Loam

Table 9. Physical and chemical characteristics of Kom Oshim soils.

Soil depth (cm)	Particle Size Distribution (%)				Texture	pH*	EC* (dS m^{-1})	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	CEC $cmol_c$ kg^{-1}
	C.S	F.S	Silt	Clay						
0-30	8.45	22.99	36.13	32.44	SCL**	7.86	20.80	157.0	15.4	23.70
30-60	7.64	19.93	38.01	34.42	SCL**	7.65	21.40	112.5	9.8	24.02
60-90	7.03	18.84	35.73	38.40	SCL**	7.81	21.21	137.6	7.0	25.39

Soil depth (cm)	*Soluble Cations $mmol_c$ L^{-1}					*Soluble Anions $mmol_c$ L^{-1}			
	Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	34.32	20.77	152.49	0.36	24.75	0.00	1.70	144.98	61.04
30-60	35.27	21.53	156.8	0.33	25.05	0.00	1.90	152.66	59.32
60-90	36.23	20.67	154.39	0.32	24.79	0.00	1.99	150.08	59.43

*See foot notes of Table 2 and **SCL: Sandy clay loam.

Forms of K in the investigated soils

Data presented in Table 10 show that the calcareous soils of both EL-Saloum and El Dabba show similar trends for soluble K but with less magnitude in El Dabba. The relatively lower values of both water soluble and NH_4OAC-extractable K might be attributed to the calcareous nature of both soils beside of the poverty of these soils in their contents of total potassium. Soils of North Sinai (also of calcareous nature) show low values of all the K forms relatively higher values of all K forms were found in soils of El-Fayum (Tamia and Kom Oshim) probably due to the higher contents of the K between minerals.

Data presented in Table 11 reveal that water soluble potassium form correlated significantly and positively with the clay and organic matter contents besides of both the EC and CEC values, however, this soluble potassium form correlated significantly but negatively with $CaCO_3$ content. Values of NH_4-OA_C extractable potassium (exchangeable) correlated positively and significantly with each of silt and organic matter contents beside of both EC and CEC values. On the other hand, the aforementioned potassium form correlated significantly but negatively with the soil pH.

Table 10. Status of water soluble, K- NH_4-OAc and Total-K (mg kg^{-1}) in the studied calcareous soils

Regions	Soil depth (cm)	Water soluble	NH_4-OA_C	Total	Water soluble	NH_4-OA_C	Total
		El-Saloum			**El- Dabha**		
Western Desert area	**0-30**	6.50	152	547	6.11	154	642
	30-60	5.21	658	1250	3.92	138	560
	60-90	4.32	764	1330	1.39	287	998
		El- Arish			**Beer El-Abd**		
North Sinai area	**0-30**	4.39	72	341	4.59	77	598
	30-60	3.00	65	364	3.60	132	1134
	60-90	2.19	89	254	4.51	55	439
		Balouza			**Romana**		
	0-30	3.00	832	4538	3.21	659	4658
	30-60	2.71	987	5432	2.64	764	4132
	60-90	2.11	754	4327	2.02	654	3087
		KomOshim			**Tamia**		
El-Fayum area	**0-30**	14.2	350	1250	16.9	238	3210
	30-60	13.0	295	1410	14.1	284	1250
	60-90	12.7	415	3630	11.9	581	2420

Relationships between studied forms of potassium and the indigenous soil properties.

Total potassium correlated positively and significantly with organic matter content as well as EC and CEC values of the investigated soils. The negative effect of $CaCO_3$ on total potassium content appeared from the negative significant correlation between these two variables.

The most important correlations indicated that the Soil EC, organic matter content and the cation exchange capacity were the most pronounced effect. However, the other soil properties although did not show significant correlations with all different K-forms, yet their influences on the K-forms cannot be neglected.

Table 11. The correlations coefficient between studied different K-forms and the indigenous soil properties.

Soil property	K-water		K- NH_4-.OAc		K-Total	
	Regression Equation	**r**	**Regression Equation**	**r**	**Regression equation**	**r**
Clay %	Y=1.2474*x+-801	0.422^{**}	Y=2.644*x+380.45	0.107	Y=26.41*x+2011.22	0.145
Silt %	Y=0.215*x+8.160	0.195	Y=5.382*x+273.76	0.276^{**}	Y=18.175*x+2005.81	0.192
Sand %	Y=-0.176*x+19.25	-0.107	Y=-1.864*x+987.70	0.081	Y=-4.439*x+2622.78	-0.180
O.M mg kg^{-1}	Y=11.888*x+2.119	0.385^{**}	Y=195.814*x+235.055	0.213^{**}	Y=1554.083*x+1433.961	0.355^{**}
$CaCO_3$ mg kg^{-1}	Y=-0.709*x+31.419	-0.474^{*}	Y=2.511*x+447.232	-0.111	Y=-33.437*x+3071.742	-0.143^{*}
pH	Y=-12.192*x+112.197	-0.215	Y=186.6786*x+1900.058	-0.278^{*}	Y=1556.176*x+6899.017	-0.150
EC dS m^{-1}	Y=0.818*x+5.299	0.189^{**}	Y=11.235*x+284.197	0.313^{**}	Y=73.088*x+1341.110	0.522^{**}
CEC $Cmole_c$ kg^{-1}	Y=0.542*x+2.726	0.467^{**}	Y=8.617*x+200.522	0.272^{**}	Y=50.264*x+1147.7642	0.503^{**}

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حاله البوتاسيوم في بعض الأراضي الجيريه بمصر و العوامل المؤثرة في صوره

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تهدف الدراسة الحالية إلى إلقاء بعض الضوء على حالة البوتاسيوم في بعض الأراضيَ الجيرية في مصر وكذلك علاقاتها مع خصائص هذه الأراضى. ولتحقيق أهداف هذه الدراسة تم اختيار ثمانية مواقع في أراضى الصحراء الغربية وشمال سيناء والفيوم. أجريت التحليلات المعدنية والطبيعية والكيميائية لهذه الأراضى. تم تقييم النتائج والصور المختلفة للبوتاسيوم في التربة (الميسرة والقابلة للذوبان ، القابلة للتبادل و المستخلصة بخلات الأمونيوم) . وأظهرت النتائج المختلفة و المتحصل عليها أن هذه الأراضى التي تم اجراء البحث عليها كانت مختلفة في خصائصها الطبيعية والكيميائية كما اختلفت في التركيبات المعدنية لها. وقد وجد من التحاليل المعدنية لمكونات هذه الأراضى ان أراضي الصحراء الغربية وشمال سيناء كان السائد بها معدن الكاؤلينيت يليه السميكتايت بينما كانت الأراضي في المناطق الأخرى تحت الدراسة يسود بها معدن السميكتايت يليه الكاؤلينيتز وجد أيضاَ تباين ملحوظ إلى حد ما في محتوى هذه الأراضى من صور البوتاسيوم المختلفة. ولتقييم مدي إرتباط خصائص التربة مع صورالبوتاسيوم المختلفة فقد أظهرت النتائج أن هناك إرتباط لهذه الصور تمامامع خصائص التربة المختلفة، وتشير النتائج ان هناك ارتباط قوي وواضحاَ مع كل من محتوى الطين والسعة التبادلية الكاتيونية والمادة العضوية ، ومع ذلك فإن خصائص التربة الآخرى على الرغم من عدم وجود ارتباطات لها ذات دلالة معنوية مع صور البوتاسيوم المختلفة إلا أنه لا يمكن إهمال تاثيرها على صور البوتاسيوم في التربة.