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Studies on some Physical and Chemical Properties of Sirt Area Cultivated Soils.

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ABSTRACT

This investigation has been conducted on the cultivated soil of Sirt area, Libya, that located 450 kilometers from East of Libyan capital Tripoli and between the coordinates 16°35´ E and 31°12´ N to study the potassium status in some soils of Libya. Forty-two soil samples were taken at the two different depth (0-20 and 20-40 cm) from 21sites to evaluate some physical and chemical parameters for soils such as mechanical analysis , total carbonate, organic matter , EC , pH, soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}), anions ($CO_3^{=}$, HCO_3^{-}, Cl^{-} and $SO_4^{=}$) , total K , available K , soluble water K, exchangeable K and non exchangeable K. Coordinates of cultivated soil samples were recorded using the Global Positioning System (GPS). Studied parameters were analyzed graphically by contour maps to show the spatial distribution of chemical constituents of the different soil samples. The results indicate that the majority of soil textures in the investigated area were Sandy Loam. The all soil samples at the studied area are poor in organic matter. The soil samples electric conductivity (EC) was suitable for agricultural purposes. (The highest value of total K in both depths was found in 0-20 depth and the lowest value was found in 20-40 depth) .Positive correlation was found between the total potassium and the clay content. (The highest values of available K in soil samples were found in 20-40 cm depth. In contrast the lowest values were found in 20-40 cm depth). The highest values of water soluble K (meq100g^{-1}soil) in studied soil samples of both depths were found in 20-40 cm depth, also the lowest values were found in 0-20 and 20-40 cm depth, respectively. (The highest values of non exchangeable K (meq100g^{-1}soil) content in studied soil samples of both depths were found in 0-20cm depth ,also the lowest values were found in 0-20 cm depth) . The soil samples at the studied area are poor in total K, available K, soluble water K, exchangeable K and non exchangeable K.

Keywords: Potassium status, Sandy loam, Global Positioning System (GPS), Sirt area.

INTRODUCTION

The soils of Libya are very shallow, coarse and low in organic matter content and water holding capacity (Laytimi, 2005). Soil studies have been conducted by the American and Russian governments over the last four decades, using various classification systems and methods of soil analysis (Newr, 2006). The (FAO) generated a Libyan soils map using their own classification system based on both previously mentioned surveys. Soil orders include Yermosols, Fluvisols, Regosols, Lithosols, Xerosols, and Solonchaks covering 62.745%, 1.38%, 0.63%, 6.78%, 5.02%, 0.52%, respectively of the country's area. The majority of these soils are silty loam in texture (63.0 %), followed by loamy very fine sand (7.0 %), coarse loamy (5.0 %), loamy (1.0 %), sand (0.6 %) and sandy clay (0.5 %) (Abagandura *et al.,* 2012). Potassium (K) is a major element of soils (Hue and Silva, 2000) and (Marschner, 1997), the normal content of total K in soils ranges from 0.40 to 30.0 g K kg^{-1} soil. About 98% of total K is bound in mineral form, whereas 2% occurred in soil solution and exchangeable fractions (Sparks, 2003and Khan *et al*., 2009). The importance of K in plant growth and yield has been known since Von Liebig published his results in 1840 (Sparks, 2000; Huang *et al*., 2005). Potassium (K) in soil generally exists in one of four equilibrated forms variable in their availability to plants: - Unavailable-K↔ slowly available-K↔ exchangeable – K(readily available) ↔ water soluble-K(readily available) .Many scientists have studied the soil K from different points of view, some of them studied the sources of K in earth crust and its forms in the soil focused on secondary clay minerals and investigated soil K status (Zhang *et al*., 2009 and Abdlgader, 2012). The others studied the chemical extractions for soil K and derived some values to express the soil supplying power, which correlated with the biological experiments (Pettigrew, 2008). Wetting and drying can significantly affect K fixation (Xu *et al*., 1995; Sharma *et al*., 2010). The drying soil under certain condition often cause a transformation of K from the exchangeable to the fixed or non-exchangeable form. Fixation of K (becomes non-exchangeable) can occur from drying soils with high exchangeable K or recent K fertilizer applications while, K release (becomes exchangeable) can occur when soils low in exchangeable K are dried because the clay sheets roll back and release K (Mc Lean and Watson, 1985). No or little studies have been done on the status of K in the main cultivated soil of Libya. Thus, the aim of this investigation is to evaluate the potassium status in different cultivated soils of Sirt area, Libya.

MATERIALS AND METHODS

Twenty one soil sites were selected to represent the cultivated soils at different locations of Sirt city, Libya by Global Positioning System (GPS) technique as shown in Table 1and Fig 1. The studied soil samples were taken in August, 2014. The experimental sites were represented by 42 soil samples .The first twenty one surface soil samples were taken at the depth of (0-20 cm) and the other twenty one soil samples were taken at the depth of (0-40cm). The obtained soil, samples were air dried, crushed and passed through a 2 mm sieve, thoroughly mixed then preserved in plastic bags for determination some soil physical and chemical properties according to the standard methods as well as potassium status in that soils.

Mechanical analysis was determined following the international pipette method without hydrochloric acid using 20 g air-dry soil and using NaOH as a depressing agent as described by Dewis and Fertais, (1970). Saturation percentage (SP) of the studied soils were determined using method described by Richards, (1954). Soil reaction (pH) was measured using a pH meter as mentioned by Richards (1954). The electrical conductivity of studied soils were measured in the soil paste extract by an EC meter according to the method of Jackson, (1967). Organic matter (OM) was determined by Walkley and Black's method as described by Hesse (1971). The amounts of soluble cations and anions meq L^{-1} in the studied soil samples were determined according to Hesse (1971). Total carbonate was determined using Collin's calcimeter according to (Jackson, 1967). .The potassium forms (total K, available K, soluble water K, exchangeable K and non exchangeable K) was determined according to Hesse (1971).

Table 1. The coordinates of soil locations in study area.

Site	N			E		
No.	DD	MM	SS	DD	MM	SS
1	31	12	59.3	16	35	84.2
2	31	10	53.2	16	38	43.9
3	31	10	72.1	16	39	56.3
4	31	9	25.0	16	57	31.9
5	31	9	00.6	16	58	47.5
6	31	8	39.2	17	2	20.4
7	31	8	1.10	17	3	64.0
8	31	7	17.1	17	7	50.5
9	31	7	51.4	17	4	89.9
10	31	7	77.7	17	4	3.80
11	31	2	58.8	16	42	58.8
12	31	10	53.5	16	38	4.20
13	31	4	6.4	16	41	44.1
14	31	9	34.6	16	55	51.3
15	31	3	97.8	16	41	55.9
16	31	9	37.4	16	55	51.9
17	31	11	72.0	16	21	86.2
18	31	11	54.3	16	21	65.8
19	31	11	61.9	16	21	90.9
20	31	11	67.7	16	24	83.0
21	31	11	77.1	16	24	79.9

DD :degrees MM :minutes SS :seconds

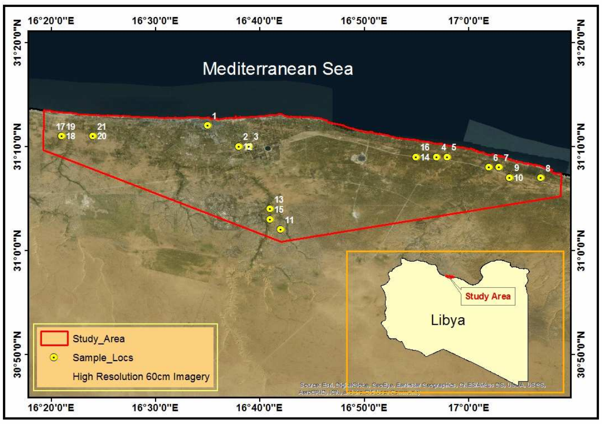

Fig 1. The location of studied area and soil samples chosen for study.

RESULTS AND DISCUSSION

Soil physical properties of studied soil samples

Data presented in Table (2) and Fig (2, 3, 4 and 5) show some soil physical properties such as particle size distribution (coarse sand, fine sand, silt and clay), organic matter, calcium carbonate content and texture of the investigated soil samples at two different depths (0-20 and 20-40cm).

Table 2. Some soil physical properties of the study area.

Site No.	Depth (cm)	Sand (%) Coarse	Fine	Total	Silt (%)	Clay (%)	$CaCO_3$ (%)	OM (%)	Texture	SP (%)
1	0-20	43.44	42.39	85.84	2.36	11.81	53.41	0.54	Sandy loam	30.48
	20-40	67.87	27.03	94.89	2.57	2.57	42.39	0.47	Sand	31.05
2	0-20	42.32	40.27	82.59	2.48	14.92	58.43	1.00	Sandy loam	31.55
	20-40	40.59	49.24	89.82	2.54	7.63	53.98	0.64	Sand	33.76
3	0-20	63.81	27.32	91.13	2.24	6.68	71.85	0.63	Sand	35.56
	20-40	28.04	57.75	85.79	2.03	12.16	74.93	0.59	Loamy sand	37.88
4	0-20	30.13	54.91	85.04	1.84	13.05	88.58	0.78	Loamy sand	38.27
	20-40	9.62	83.97	93.59	2.15	4.21	87.42	0.80	Sand	39.19
5	0-20	9.33	79.23	88.56	1.91	9.54	85.85	0.76	Loamy sand	38.74
	20-40	41.64	45.62	87.26	2.12	10.56	81.63	0.63	Loamy sand	39.62
6	0-20	40.71	47.94	88.65	1.90	9.45	84.23	0.56	Loamy sand	38.4
	20-40	74.34	5.95	80.29	3.27	16.41	86.23	0.58	Sandy loam	39.12
7	0-20	29.52	58.88	88.40	1.95	9.71	82.59	0.71	Loamy sand	38.4
	20-40	23.37	59.41	82.78	3.82	13.38	74.36	0.66	Sandy loam	38.18
8	0-20	28.25	54.56	82.81	1.89	15.25	75.15	0.61	Sandy loam	37.83
	20-40	37.79	45.58	83.37	2.07	14.59	75.87	0.76	Sandy loam	39.5
9	0-20	28.09	55.27	83.36	3.71	12.97	80.03	0.68	Sandy loam	40.54
	20-40	71.20	12.36	83.55	4.12	12.30	80.58	0.70	Loamy sand	37.16
10	0-20	50.71	28.39	79.10	6.29	14.62	77.42	0.44	Sandy loam	35.97
	20-40	35.29	60.40	95.69	2.17	2.17	79.26	0.47	Sand	40.98
11	0-20	62.30	20.29	82.59	2.48	14.93	72.94	0.49	Sandy loam	40.97
	20-40	47.79	37.18	84.97	2.13	12.88	71.35	0.66	Loamy sand	31.7
12	0-20	32.02	52.68	84.70	2.19	13.11	46.60	0.71	Loamy sand	32.01
	20-40	30.24	51.24	81.48	2.30	16.19	56.15	0.27	Sandy loam	38.23
13	0-20	40.25	46.45	86.70	2.21	11.08	74.64	0.26	Loamy sand	37.16
	20-40	65.30	15.78	81.08	1.88	17.03	75.04	0.27	Sandy loam	41.69
14	0-20	41.04	45.45	86.49	4.52	8.99	82.31	0.83	Loamy sand	40.63
	20-40	57.56	23.24	80.80	2.42	16.79	80.16	0.49	Sandy loam	37.4
15	0-20	45.48	42.16	87.64	2.48	9.87	72.93	0.32	Loamy sand	37.55
	20-40	61.36	25.78	87.13	6.43	6.43	76.84	0.22	Loamy sand	39.32
16	0-20	46.66	35.08	81.74	5.49	12.81	76.34	0.39	Sandy loam	38.63
	20-40	39.24	40.75	79.99	3.66	17.70	79.49	0.20	Sandy loam	41.07
17	0-20	45.23	37.22	82.45	7.80	9.74	76.28	0.74	Loamy sand	40.31
	20-40	56.89	32.71	89.61	2.07	8.31	78.20	0.37	Sand	34.09
18	0-20	53.03	34.09	87.12	2.13	10.71	74.60	0.19	Loamy sand	32.73
	20-40	51.87	25.50	77.36	7.53	15.07	74.78	0.27	Sandy loam	34.72
19	0-20	49.08	28.52	77.60	3.43	18.94	76.40	0.19	Sandy loam	36.49
	20-40	44.43	40.13	84.56	1.91	13.48	77.00	0.19	Loamy sand	33.5
20	0-20	56.17	25.56	81.73	6.09	12.18	70.11	0.24	Sandy loam	33.24
	20-40	46.71	35.58	82.29	2.23	15.50	65.88	0.37	Sandy loam	33.08
21	0-20	46.53	33.34	79.87	10.05	10.05	69.76	0.36	Sandy loam	34.18
	20-40	51.41	37.04	88.45	2.30	9.22	71.25	0.36	Loamy sand	34.18

From data in Table (2), it was found at the two different depths that the coarse sand content in the studied soil samples vary widely from 9.33 (site No. 5) to 63.81% (site No. 3) and from 9.62 (site No. 4) to 74.34% (site No. 6) in 0-20 and 20-40 cm depth, respectively.

The presented data indicate that the coarse sand content of the studied soil samples was increased with increasing soil depth where as in almost soil profiles, the coarse sand content (%) was recorded in 20-40 cm depth.

Data of the same Table indicate that, in 20-40 cm depth the highest fine sand content was found in site No. 4 (83.96%) while the lowest was recorded in site No. 6 (5.96%). In 0.0-40 cm depth, the highest fine sand content was found in soil site No. 5 while the lowest was in soil site No. 11, the recorded value for fine sand content were 79.23 and 20.24%, respectively. It was noticed that, the fine sand content was decreased with increasing soil profile depth where the highest value for fine sand content were recorded in 0-20 cm depth.

The silt content of soil samples at present study varies from 1.83 to 10.05 and from 1.88 to 7.53% for 0-20 and 20-40 cm depth respectively. The lowest silt content was found in soil site No. 4 and 13 while the highest values was found in soil site No. 21 and 18 for both depths (0-20 and 20-40 cm, respectively).

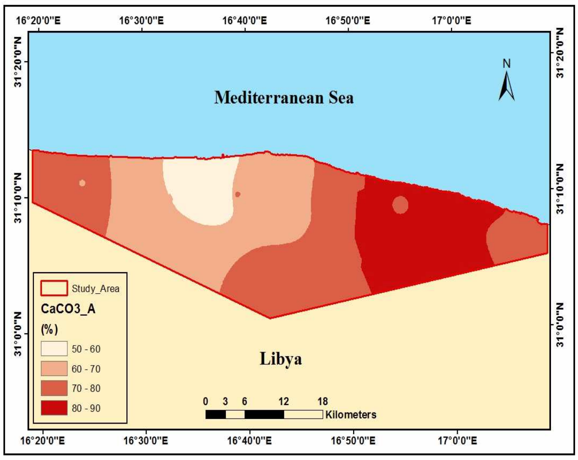

Fig 2. Spatial distribution of calcium carbonate percentage of taken soil samples at the depth of (0-20 cm) in the studied area.

The same data indicate that the values of clay fluctuated between 6.68 (site No. 3) to 18.94% (site No. 19) (0-20 cm depth) and 2.16 (site No. 10) to 17.7% (site No. 16) (20-40 cm depth). The data reveal that the clay content in almost soil samples was found to be higher in 0-20 cm depth than 20-40 cm depth.

It was observed that, the textural classes of soil samples under current study varied in both depth (0-20 and 20-40 cm). The data indicate that the texture of 14.29% (6 samples), 40.48% (19 samples) and 45.24% (19 samples) was sand, loamy sand and sandy loam, respectively.

Accordingly, the majority of soil textures in the investigated area were sandy loam.

Saturation percentage (SP) ranged between 30.48 and 41.69% for two depths. These values were increased with soil depth from 20 to 40 cm.

Also, data of the same Table and Fig (2and 4) reveal that the calcium carbonate content ($CaCO_3$) varies from 46.60 to 88.58 and from 42.39 to 87.42% in the depths 0-20 and 20-40 cm, respectively .The highest $CaCO_3$ values in the two depths were in soil site No. 4 while the lowest values of $CaCO_3$ content in the above mentioned depths were found in site No. 12 and 1, respectively. The most of investigated samples percentage at the two different depths (0-20 and 20-40) lie between fairly vigorous degree and very vigorous degree according to Dewis and Fertas (1970).

So all the area under study can be considered calcareous soil having high calcium carbonate content reached to 88.6% in some sites.

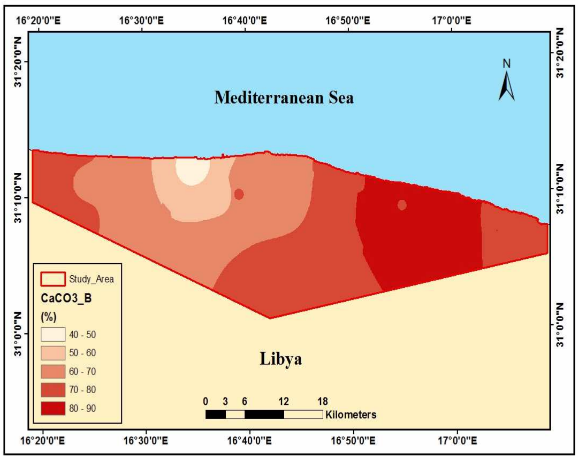

Fig. 3. Spatial distribution of calcium carbonate percentage of taken soil samples at the depth of (20-40 cm) in the studied area.

The organic matter (OM) content as presented in Table (3) and confirmed in Fig. (4 and 5) ranges from 0.19 to 1.00 and 0.20 to 0.80% in the depths of 0-20 and 20-40 cm, respectively. The highest OM content take place in the depth 0-20 and 20-40 cm of soil site No. 2 and 4, respectively, while the lowest values for OM content occur in the soil site No. 19 and 16, respectively for the above mentioned soil depths under current study. The present results are in agreement with those obtained by (El-Agrodi *et al*., 1998; Rahil and Qanadillo,2013;and AL-Jaboobi *et a.l*,2014)

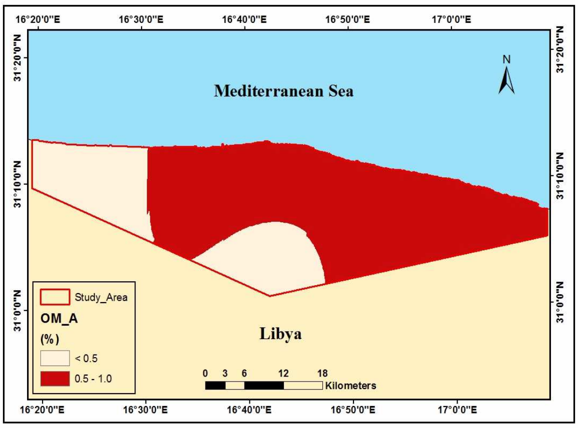

Fig. 4. Spatial distribution of organic matter percentage of taken soil samples at the depth of (0-20 cm) in the studied area.

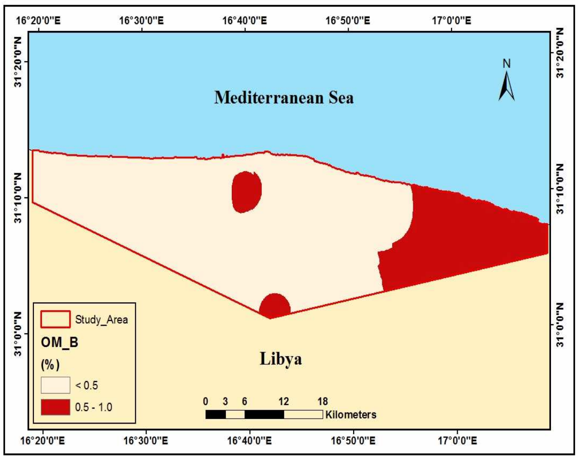

Fig. 5. Spatial distribution of organic matter percentage of taken soil samples at the depth of (20-40 cm) in the studied area.

Soil chemical properties of studied soil samples

Data illustrated in Table (3) show some soil chemical properties of the investigated soil samples which taken from different depths (0-20 and 20-40cm) in saturation soil extract. These properties include pH , electrical conductivity (EC), soluble cations(Na^{+}, K^{+}, Ca^{2+}, Mg^{+}) and soluble anions (CO_3^{2-}, HCO_3^{-}, Cl^{-} and SO_4^{2-}).

Data show that calcium (Ca++) content in the studied soil samples varies widely from 0.04 of site 18 to 0.59 of site No14 in 0-20 cm depth and from 0.04 of site No 21 to 0.62 of site No 14 in 20-40 cm depth , so studies observed that in both depth , the highest values of soluble Ca content was found in 20-40 cm depth i.e 0.62 meq/100g-1soil of site No 14 , while the lowest values were found in 20-40 cm depth which was 0.04 meq/100g-1soil in site No 21.

From data in Table (3), it was found that the highest values of the magnesium (Mg++) content was found in 0-20 cm depth ,the recorded value is 0.22 of site No 5 and the lowest value was found in 20-40 cm which is 0.01 of site No 14, however the values of (Mg++) content in soil samples range from 0.022 of site No 2 to 0. 224 of site No 5 in 0-20cm depth and range from 0.01 of site No 14 to 0.22 of site No 15 of 20-40 cm depth.

Table 3. Soluble cations, anions, pH and EC values in saturation soil extract of the investigated soil samples.

Site No.	Depth (cm)	Soluble cations (meq $100g^{-1}$ soil)				Soluble anions (meq $100g^{-1}$ soil)				pH	EC
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}		dSm^{-1}
1	0-20	0.19	0.10	0.61	0.07	-	0.05	0.28	0.64	8.30	1.13
	20-40	0.25	0.16	0.75	0.07	-	0.09	0.37	0.77	8.28	1.52
2	0-20	0.19	0.02	0.39	0.07	-	0.10	0.13	0.44	8.60	0.75
	20-40	0.05	0.06	0.19	0.09	-	0.06	0.07	0.26	8.54	0.46
3	0-20	0.10	0.05	0.33	0.05	-	0.07	0.10	0.36	8.53	0.54
	20-40	0.05	0.04	0.24	0.02	-	0.04	0.06	0.24	8.64	0.32
4	0-20	0.06	0.07	0.27	0.03	-	0.07	0.08	0.28	8.54	0.41
	20-40	0.05	0.08	0.26	0.03	-	0.07	0.08	0.27	8.54	0.42
5	0-20	0.11	0.22	0.59	0.07	-	0.11	0.27	0.62	8.23	0.93
	20-40	0.29	0.15	0.58	0.11	-	0.07	0.41	0.65	8.11	1.20
6	0-20	0.06	0.08	0.24	0.04	-	0.08	0.08	0.26	8.66	0.42
	20-40	0.10	0.01	0.17	0.03	-	0.07	0.05	0.19	8.63	0.36
7	0-20	0.07	0.06	0.25	0.01	-	0.07	0.07	0.25	8.76	0.39
	20-40	0.06	0.09	0.27	0.01	-	0.07	0.09	0.27	8.56	0.46
8	0-20	0.14	0.07	0.36	0.06	-	0.10	0.13	0.39	8.36	0.60
	20-40	0.12	0.05	0.38	0.05	-	0.07	0.12	0.41	8.42	0.56
9	0-20	0.06	0.09	0.16	0.02	-	0.09	0.06	0.17	8.67	0.44
	20-40	0.07	0.04	0.23	0.02	-	0.05	0.07	0.23	8.52	0.35
10	0-20	0.07	0.15	0.61	0.02	-	0.07	0.19	0.59	5.54	0.75
	20-40	0.12	0.12	0.57	0.02	-	0.13	0.14	0.56	5.53	0.79
11	0-20	0.25	0.06	0.48	0.04	-	0.12	0.22	0.48	8.15	0.86
	20-40	0.19	0.16	0.54	0.04	-	0.13	0.25	0.54	8.17	0.89
12	0-20	0.12	0.04	0.33	0.02	-	0.07	0.11	0.33	8.19	0.53
	20-40	0.10	0.05	0.32	0.02	-	0.07	0.09	0.33	8.47	0.56
13	0-20	0.08	0.11	0.43	0.02	-	0.11	0.12	0.42	8.35	0.59
	20-40	0.13	0.13	0.60	0.02	-	0.10	0.19	0.58	8.11	0.85
14	0-20	0.59	0.03	0.44	0.25	-	0.25	0.33	0.72	7.32	1.54
	20-40	0.62	0.01	0.41	0.29	-	0.16	0.22	0.95	7.30	1.60
15	0-20	0.22	0.22	0.84	0.04	-	0.09	0.39	0.83	8.08	1.27
	20-40	0.34	0.22	0.94	0.03	-	0.17	0.44	0.93	8.00	1.61
16	0-20	0.09	0.10	0.32	0.03	-	0.13	0.09	0.33	8.19	0.54
	20-40	0.08	0.06	0.28	0.03	-	0.07	0.08	0.29	8.28	0.43
17	0-20	0.08	0.10	0.31	0.02	-	0.12	0.08	0.31	8.13	0.55
	20-40	0.07	0.11	0.35	0.03	-	0.09	0.11	0.35	8.24	0.55
18	0-20	0.04	0.06	0.13	0.02	-	0.06	0.04	0.14	8.69	0.36
	20-40	0.07	0.04	0.20	0.02	-	0.05	0.07	0.20	8.71	0.43
19	0-20	0.08	0.05	0.16	0.03	-	0.08	0.06	0.18	8.67	0.36
	20-40	0.07	0.07	0.22	0.02	-	0.07	0.07	0.23	8.76	0.45
20	0-20	0.06	0.04	0.16	0.02	-	0.05	0.06	0.18	8.57	0.38
	20-40	0.09	0.02	0.19	0.02	-	0.05	0.07	0.20	8.60	0.43
21	0-20	0.06	0.05	0.16	0.02	-	0.05	0.07	0.17	8.60	0.40
	20-40	0.04	0.05	0.14	0.02	-	0.04	0.05	0.15	8.71	0.34

Also, data of the same Table reveal that sodium (Na^{+}) ranges in soil sample of 0-20cm from 0.13 of site No 18 to 0.84 of site No 15, while in 20-40 cm ranges from 0.14of site No 21 to 0.94 of site No 15. Data revealed that the highest values of soluble Na^{+} in soil sample were found in 20-40 depth of site No 14 and the lowest value was found in 0-20 cm of site No 18 where was recorded that 0.94 and 0.13,respectively .

Data given in Table (4) show that potassium (K^+) ranged from 0.01of site No 7 to 0.25 of site No 14 of 0-20 cm depth, whereas 0.01of site No 7 to 0.29 of site No 14 of 20-40 cm in soil samples under studied .So the pervious observation confirms that the highest values of soluble K content were found in 20-40 cm depth .in contrast, the lowest values were found in 0-20 cm depth.

Data in Table 3 show also, the soluble anions concentrations in the collected soil samples. The soluble carbonates ($CO^{=}_{3}$) are undetected. The values of bicarbonates (HCO^{-}_{3}) content vary from 0.04 in site No 21 to 0.25 meq100g^{-1}soil of site No 14 in the 0-20 cm depth while vary from 0.04 in site No 3 to 0.17 of site No 15 in 20-40 cm depth . So the observed results indicated that , the highest values of (HCO^{-}_{3}) content in the studied soil samples were found in 0-20cm depth where the value is 0.25 ,also the lowest values were found in 0-20 cm depth which recorded 0.04 meq 100g^{-1} soil .

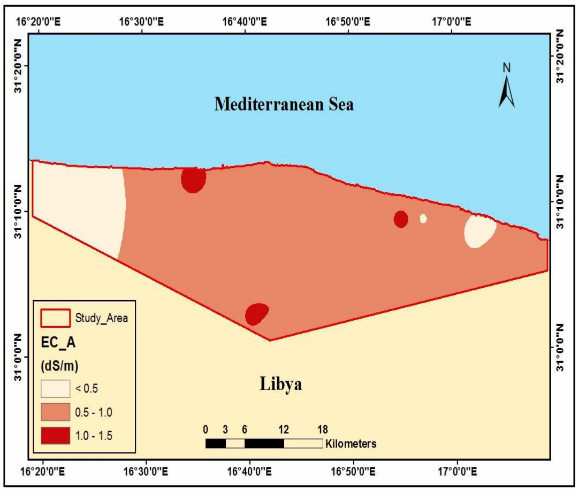

Fig. 6. Spatial distribution of electric conductivity (dS/m) of taken soil samples at the depth of (0-20 cm) in the studied area.

Data given in Table (3) show that chloride (Cl^-) content ranged from 0.04 in site No 18 to 0.39 in site No 15 of 0-20 cm depth ,whereas ranged from 0.05 in site No 6 to 0.41 in site No 5 of 20-40 cm in soil samples. So it can be said that the highest value of soluble Cl^- in soil samples was found in 20-40 cm depth where it was recorded 0.41.In contrast the lowest values were recorded 0.04meq100g^{-1}soil in 0-20 cm depth.

Also, data of Table 3 reveal that, The Sulphate ($SO_4^{=}$) content ranges in soil samples of 0-20 cm depth from 0.1 in site No 18 to 0.83 in site No 15, while in 20-40 cm ranges from 0.15 of site No 21 to 0.95 of site No 14. So the highest values of ($SO_4^{-\,-}$) content in soil sample were found in 20-40 depth of site No 14 which recorded 0.95 meq100g^{-1}soil and the lowest value was found in 0-20 cm of site No 18 where was recorded 0.14meq100g^{-1}soil.

As shown from the data in Table 3 and Figs 6 and 7 ,all the soil samples have low values of the electrical conductivity (EC) .Most of the EC values are less than 0.1 dSm^{-1} ,only site No 1,14 and 15, the EC value increased to reach 1.61dSm^{-1} in site No15(20-40 cm depth).So all the area under study is non saline soil .

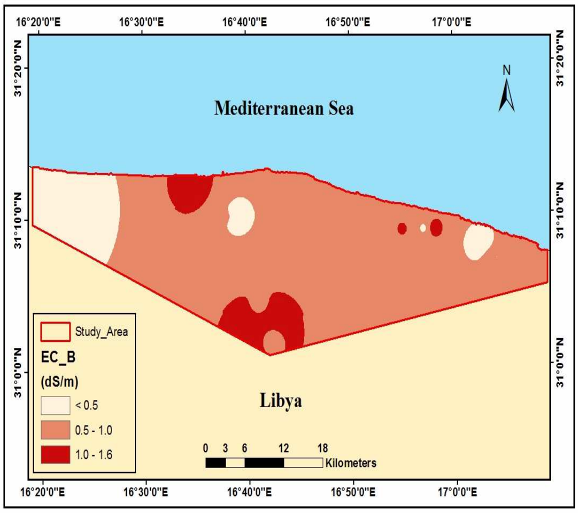

Fig. 7. Spatial distribution of electric conductivity (dS/m) of taken soil samples at the depth of (20-40 cm) in the studied area.

Data of the same table indicate that the pH of soil surface (at the depth of 0-20 cm) and subsurface samples (at the depth of 20-40 cm) ranged between 7.30and 8.76 in the alkaline side .

The present results agree with those obtained by (El-Agrodi *et al.,* 1998; Rahil and Qanadillo,2013;and AL-Jaboobi *et al*.,2014)

Forms of soil potassium:-

Data of Table (4) present the amounts of total, available, water soluble, exchangeable and non exchangeable potassium content in the investigated soil samples.

Total potassium K: meq 100 g^{-1} soil

The obtained data in Table (4) and Figs(8 & 9) show that the total potassium content in soils of depth 0-20 cm varied from 9.62 of site No 12 to 18.82 of site No 11 (meq 100 g^{-1} soil) ,while varied in 20-40 cm depth from 9.62 of site No 1 to 18.80 meq 100 g^{-1} soil of site No 11 . The highest value of total k was found in 0-20 depth which recorded 18.82 in site No 11 and the lowest value was found in 0-20 and 20-40 depth which recorded 9.62 meq 100 g^{-1} soil of site No 1 and 12 ,respectively .

Available K (meq 100 g^{-1} soil)

Data given in Table (4) and Figs(10&11) reveal that the available (K meq 100 g^{-1}soil) ranged from 1.27 of site No 12 to 3.37 of site No 14 in 0-20 cm depth ,whereas it ranged between 1.1 of site No 7 to 3.36 meq 100 g^{-1}soil of site No 14 in 20-40 cm in soil samples. So from pervious observed it can be said that, the highest values in soil samples were found in 0-20 cm depth .In contrast the lowest values were found in 20-40 cm depth .The data of Table 4 indicate that, the available K represents from 13.2 to 18.8% of the total K in the surface soil samples, whereas it represents 6.5 to 20.3% of the total K in the subsurface soil samples.

Table 4. Total, Available, water soluble, Exchangeable and Non exchangeable potassium content in the investigated soil samples.

Site No	Depth (cm)	Total K meq 100g^{-1}soil	Available K meq 100g^{-1}soil	water soluble K meq 100g^{-1}soil	Exchangeable K meq 100g^{-1}soil	Non exchangeable K meq 100g^{-1}soil
1	0-20	10.51	1.357	0.068	1.290	9.15
	20-40	9.62	1.134	0.069	1.065	8.49
2	0-20	13.34	1.868	0.070	1.798	11.47
	20-40	12.38	2.906	0.086	2.820	9.47
3	0-20	13.25	1.765	0.046	1.719	11.49
	20-40	13.25	1.403	0.016	1.386	11.85
4	0-20	16.03	1.996	0.026	1.970	14.03
	20-40	16.49	1.995	0.026	1.969	14.49
5	0-20	16.02	2.040	0.071	1.969	13.98
	20-40	16.03	2.448	0.114	2.334	13.58
6	0-20	16.46	1.630	0.036	1.594	14.83
	20-40	18.77	1.722	0.026	1.696	17.04
7	0-20	18.36	1.454	0.009	1.445	16.90
	20-40	17.04	1.095	0.009	1.086	15.95
8	0-20	16.12	2.418	0.061	2.357	13.70
	20-40	16.49	2.358	0.052	2.307	14.13
9	0-20	16.47	1.495	0.018	1.477	14.98
	20-40	16.96	1.725	0.018	1.707	15.24
10	0-20	15.11	1.588	0.017	1.571	13.53
	20-40	15.10	1.314	0.024	1.289	13.78
11	0-20	18.82	1.454	0.037	1.417	17.36
	20-40	18.80	1.771	0.037	1.734	17.03
12	0-20	9.62	1.270	0.022	1.248	8.35
	20-40	13.72	1.313	0.022	1.292	12.41
13	0-20	16.55	1.548	0.017	1.531	15.01
	20-40	17.85	1.359	0.017	1.343	16.49
14	0-20	17.92	3.367	0.246	3.121	14.55
	20-40	17.87	3.631	0.286	3.344	14.24
15	0-20	18.35	1.681	0.042	1.639	16.67
	20-40	17.45	1.591	0.034	1.557	15.86
16	0-20	18.34	1.907	0.027	1.880	16.43
	20-40	17.44	1.999	0.026	1.973	15.44
17	0-20	16.41	1.444	0.019	1.426	14.96
	20-40	16.03	1.452	0.027	1.424	14.58
18	0-20	15.17	1.684	0.015	1.669	13.48
	20-40	16.50	1.679	0.015	1.665	14.82
19	0-20	15.98	2.441	0.032	2.410	13.54
	20-40	16.48	1.587	0.017	1.570	14.89
20	0-20	16.03	1.633	0.023	1.610	14.40
	20-40	15.12	1.134	0.023	1.111	13.98
21	0-20	7.33	1.634	0.022	1.611	5.70
	20-40	15.11	1.769	0.023	1.745	13.34

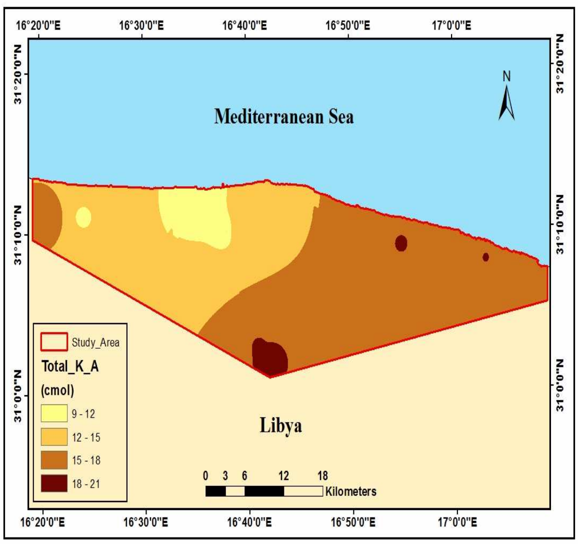

Fig. 8. Spatial distribution of Total potassium K of taken soil samples at the depth of (0-20 cm) in the studied area.

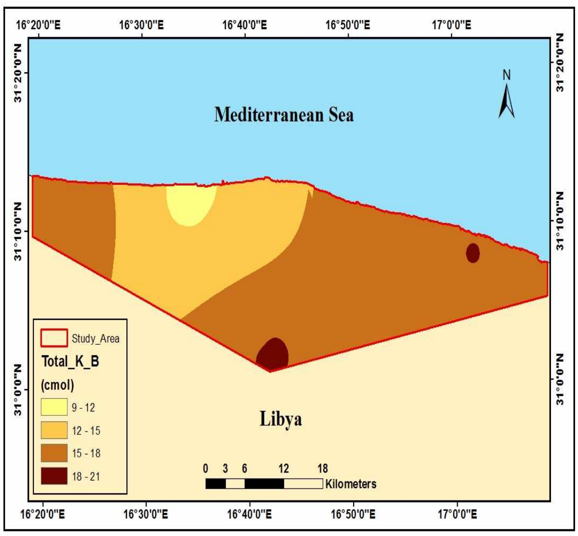

Fig. 9. Spatial distribution of Total potassium K of taken soil samples at the depth of (0-40 cm) in the studied area.

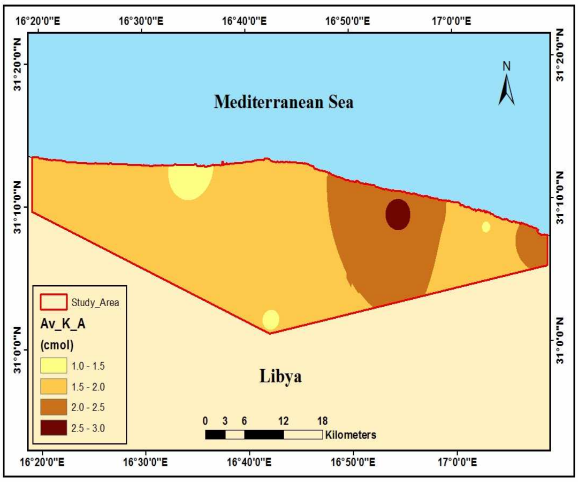

Fig. 10. Spatial distribution of available potassium K of taken soil samples at the depth of (0-20 cm) in the studied area

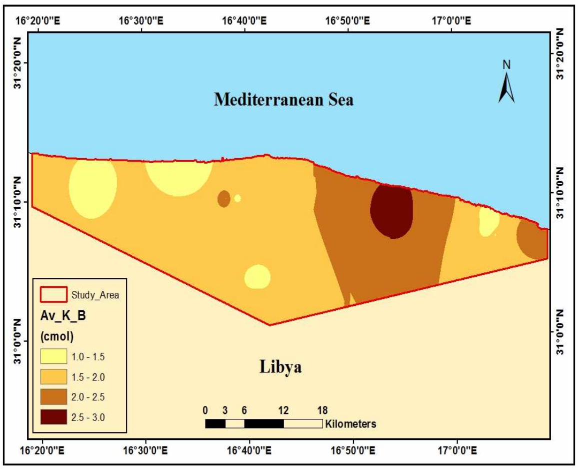

Fig. 11. Spatial distribution of available potassium K of taken soil samples at the depth of (20-40 cm) in the studied area

Water soluble K (meq 100 g^{-1} soil)

Data of Table (4) and Figs(12&13) show that the values of water soluble K (meq 100 g^{-1} soil) in the studied soil samples vary from 0.009 of site No 7 to 0.24 of site No 14in the 0-20 cm depth and from 0.009 of site No 7 to 0.28 of site No 14 in 20-40 cm depth. The highest values of water soluble K(meq 100 g^{-1} soil) in soil sample of both depth were found in 20-40 cm depth where was recorded 0.28 ,also the lowest values were found in 0-20 and 20-40 cm depth, respectively which recorded 0.009 of site No 7.The water soluble K represents only 0.62to 3.31%of the available K in 0-20 cm depth and from 0.82 to 7.88% in 20-40 cm depth. So more than 90% of the available K is in the form of exchangeable K.

Exchangeable K (meq 100 g^{-1} soil)

As shown from the data of Table 4 and Fig (14&15), the values of exchangeable K are higher than the values of soluble K. It represents more than 90 % of available K as said before.

The values of exchangeable K in 0.0-20 cm depth ranged from 1.29 in site No 1 to 3.12 meq 100g^{-1} soil in site No 14 and ranged between 1.05 in site No 1 and 3.34 meq100g $^{-1}$ soil in site No 14 in 20-40 cm depth .

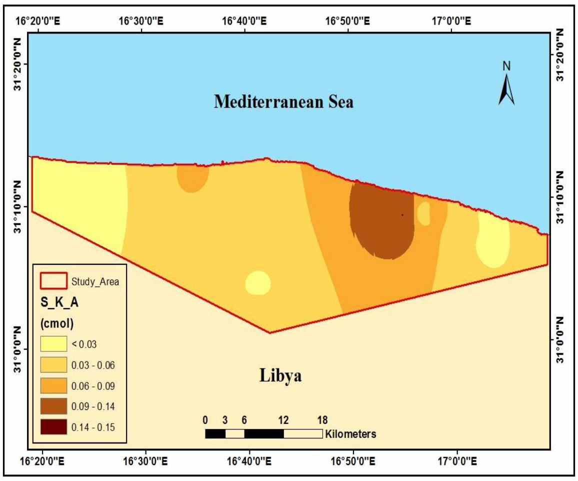

Fig. 12. Spatial distribution of soluble potassium K of taken soil samples at the depth of (0-20 cm) in the studied area

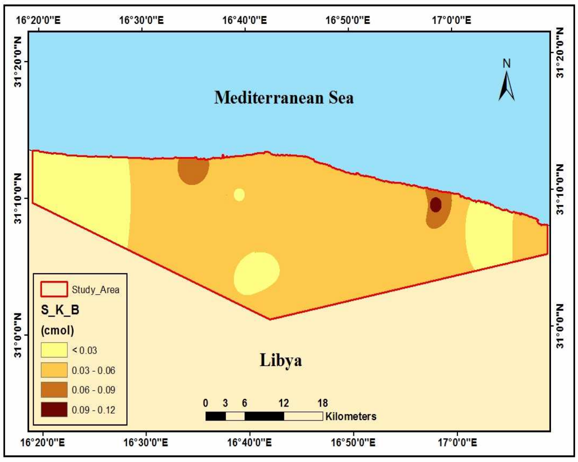

Fig. 13. Spatial distribution of soluble potassium K of taken soil samples at the depth of (20-40 cm) in the studied area

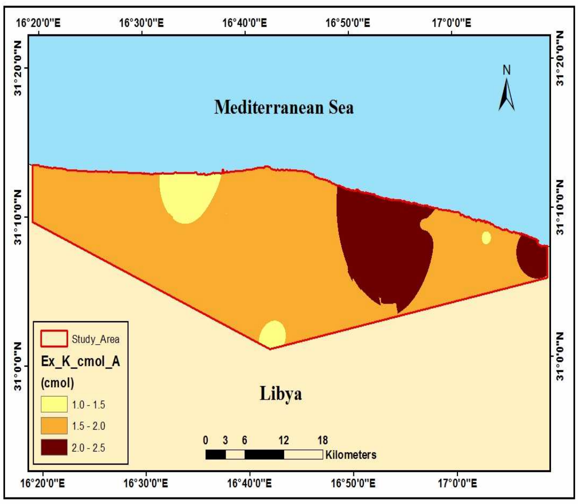

Fig. 14. Spatial distribution of exchangeable potassium K of taken soil samples at the depth of (0-20 cm) in the studied area

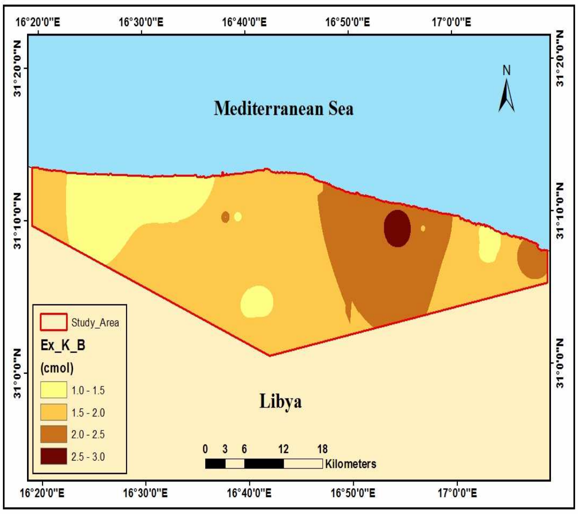

Fig. 15. Spatial distribution of exchangeable potassium K of taken soil samples at the depth of (20-40 cm) in the studied area

Non exchangeable K (meq 100 g^{-1} soil)

Non exchangeable K is the difference between the total K and the available K expressed in meq $100g^{-1}$ soil, it consist of 1- the unavailable form which found in primary minerals like micas and feldspars, 2- the slowly available K which found between the layers of montmorillonite clay or bound in the crystals of illite and vermiculite clay minerals.

From data of Table (4) and Figs (16&17) ,it was found that the values of non exchangeable K meq 100 g^{-1} soil content vary from 5.70 site No 21 to 17.36 of site No 11, in the 0-20 cm depth, respectively and 8.49 of site No 1 to 17.03 of site No 11 in 20-40 cm depth, respectively. The highest values of non exchangeable K content in the studied soil samples of both depth were found in 0-20cm depth which recorded 17.36 ,also the lowest values were found in 0-20 cm depth which recorded 5.70 meq 100 g^{-1} soil.

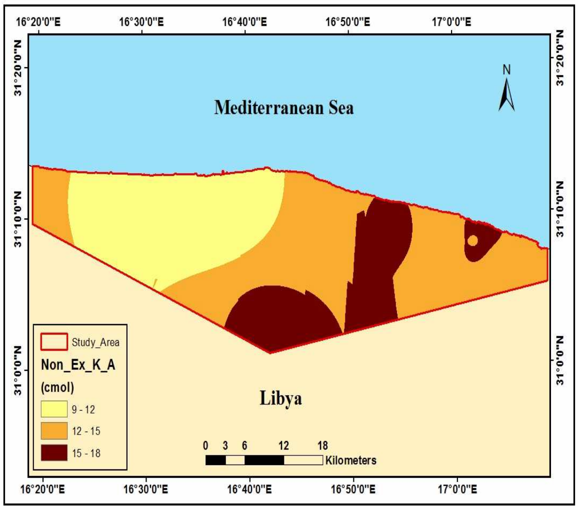

Fig. 16. Spatial distribution of Non exchangeable potassium K of taken soil samples at the depth of (0-20 cm) in the studied area

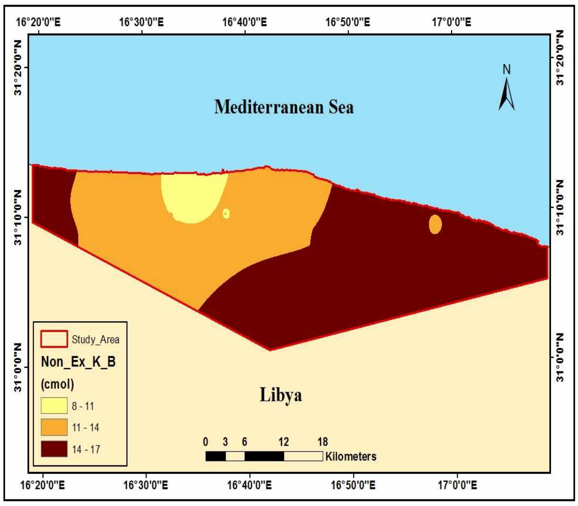

Fig. 17. Spatial distribution of Non exchangeable potassium K of taken soil samples at the depth of (20-40 cm) in the studied area

The present results agree with those obtained by (Mc Lean and Watson, 1985; El-Agrodi *et al*, 1998; Raheb and Heidari, 2011; Huang *et al*., 2005; Kotb and El-Hady, 2006; Rahil and Qanadillo, 2013; AL-Jaboobi *et al*, 2014; Adamo *et al.,* 2016 and Rawat, *et al*., 2016).

CONCLUSION

It can be concluded that most of the studied soils are considered poor in their potassium content , thus Attention should be given to those crops which need high potassium requirements and potassium fertilization in order to have the optimum yield in Libya soils. Also, the irrigation should be applied by modern irrigation methods (fertigation and spraiy method) to the potassium become available for plants. The soil in the studied area is non saline with pH higher than 7 and reach to 8.5.Also the soil is highly calcareous having high $CaCO_3$ content.

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دراسات عن بعض الخواص الطبيعية والكيماوية للأراضي المنزرعة بمنطقة سرت

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نفذت هذه الدراسة بمنطقه سرت التي تقع علي بعد 450 كم من شرق العاصمة الليبية طرابلس وكانت إحداثيات المنطقة 16° 35´ N 12°31´ E بغرض فهم ودراسة حاله البوتاسيوم ببعض أراضي ليبيا . خلال هذه الدراسة تم تقييم 42 عينة تربه زراعيه مختلفة مأخوذة علي عمقين مختلفين (0-20 و20-40) من21 موقع بمنطقة سرت وذلك لتقييم بعض المعايير الطبيعية والكيماوية مثل التحليل الميكانيكي والكربونات الكلية والتوصيل الكهربي والحموضة وتركيز الكاتيونات والانيونات و كذلك جميع صور البوتاسيوم بالتربة (البوتاسيوم الكلي- البوتاسيوم الصالح – البوتاسيوم الذائب في الماء – البوتاسيوم المتبادل –البوتاسيوم الغير متبادل) . تم اختيار المواقع المدروسة باستخدام نظام تحديد المواقع العالمية (GPS)).أيضا تم توضيح الصفات المدروسة بعمل خرائط كنتورية توضح التوزيع المكاني للمكونات الكيميائية لعينات التربة المنزرعة المأخوذة. هذه النتائج أشارت إلي أن قوام معظم العينات المدروسة كان رملي جيري. كذلك كل العينات فقيرة في محتواها من المادة العضوية. كما أن التوصيل الكهربي لكل العينات مناسب للأغراض الزراعية. بالنسبة للبوتاسيوم وجد ان اعلي قيمه للبوتاسيوم الكلي وجدت عند العمق من 0-20 واقل قيمه وجدت عند كلا العمقين. البوتاسيوم الذائب اعلي قيمه له وجدت عند العمق من 20-40 واقل قيمه وجدت عند كلا العمقين.البوتاسيوم الغير متبادل اعلي قيمه له واقل قيمه وجدت عند العمق من 0- 20. كل العينات المدروسة فقيرة في جميع صور البوتاسيوم .