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Evaluation of Soils of Qasr Libya Region (Jabal Al Akhdar, Libya) Terms in their Morphological and Chemical Characteristics

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ABSTRACT

The current research work aims to investigate the morphology characteristics, classification and fertility of the Merad Radia soil, Qasr Libya region (Al-Jabal Al-Akhdar), Libya. To achieve the targets of this investigation, two selected profiles were dug in the soil to represent the soils of the studied area then were examined. The profile No.1 was done in a zone that is higher than sea level about 387 meters (32º 682631 N - 21º 341217 E), while the profile No.2 was done in a region that is 274 meters above sea level (32º 687835 N - 21º 3336672E). The study was done at two depths for each profile. The morphology description illustrated that both profiles were dark red (2.5YR3/6, dry), and brown tended to be dark red (2.5YR3/4, moist). The soil was clayey, bulky, compact, very sticky and formed when wet, very cohesive and solid when dry, non-calcareous, clear horizon boundaries to the next horizon as for both profiles, noting the presence of a solid deaf layer in profile No.2. The soil of profile No.1 and No.2 were classified as *Lithic Rhodoxeralfs* and *Typic Haploxeralfs*, respectively. Organic matter content was very high with a maximum value of 3.17% in surface layer of profile No.1. $CaCO_3$ was moderately with a maximum value of 3.70% in surface layer of profile No.1. The soils of the studied area were non-saline(EC from 0.11 to 0.27 dSm^{-1}) having a clayey texture and pH values ranging from 8.11 to 8.30.The drainage was somewhat good in the studied area.

Keywords: Morphology description, Merad Radia soil, vegetation cover, classification

INTRODUCTION

North East Libya is an area with a unique environment, as it is the wettest part of Libya, due to its proximity to the Mediterranean and its upland attribute with considerable vegetation cover (Hegazy *et al.* 2011). Many previous studies indicated that the soils of the Al-Jabal Al-Khader region are red soils called Terra Rossa and phodoxeralfs according to the American classification or red ferrous silicate soils (red ferrisiallitic soils) according to the Russian classification (Fig1) (Aburas and Abdalrahman 2016). The soils of Jabal Al-Khader originated from solid limestone (hard limestone), as it is rich in iron oxides and is mostly characterized by a clay or loamy texture and bulky construction (Mahmoud *et al.* 2021). It is distinguished by its red color and its relatively developed sector. It varies in depth from one region to another, as it is characterized by depth in the valleys and tends to shallowness and an increase in its content of gravel in the lands of the slopes (Alawamy *et al.* 2021).

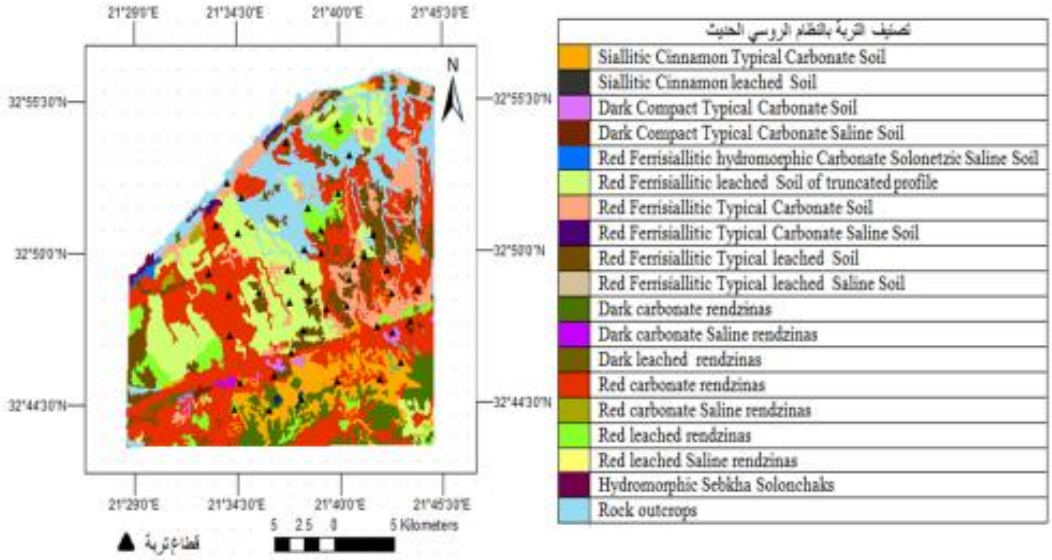

Fig 1. The Russian classification (citation from Aburas and Abdalrahman 2016)

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The depth of the surface layer rich in organic matter ranges between 8-41 cm, and its content of calcium carbonate varies, which may exceed 18% in some lands, while it decreases to less than 0.22% in soils that have been subjected to intensive washing processes (Aburas et al. 2022).

The main objectives of this investigation were the assessment of some morphology characteristics as well as the classification and fertility of the Merad Radia soil and knowing how permanently suitable it is for agriculture.

MATERIALS AND METHODS

The current research work was performed in 2022 aiming to investigate the morphology characteristics as well as classification and fertility of the Merad Radia soil, Qasr Libya region (Al-Jabal Al-Akhdar), North East Libya. To achieve the targets of this investigation, two selected profiles were dug in the soil and were examined to represent the soils of the studied area. The first profile (profile No.1) was done in a zone that is higher than sea level about 387 meters, while the second profile (profile No.2) was done in a region that is 274 meters above sea level. The study was done at two depths for each profile (0.0-15.0 and 15.0 -50.0 cm for profile No.1 and 0.0-20.0 and 20.0-80.0 cm for profile No.2).

1.Location, general description, vegetation cover and climate conditions

Merad Radia area is located near the Qasr Libya region (Al-Jabal Al-Akhdar) to the left of the coastal road at the road leading to the Jarjar Ummah area until the shores of the sea. Fig 2 shows the location of the studied area. While Table 2 illustrates the general description of the study area. Al-Jabal Al-Akhdar is a region of high mountains covered with forests in northeastern Libya. It is distinguished by its height above most of the regions of Libya. It is characterized by high rates of rainfall, in addition to the availability of fertile arable soil.

The dominant climatic system in Libya is the Mediterranean, with warm summers and mild winters. Desert winds can greatly reduce relative moisture. The winds seldom persist for more than one. Libya lies within the subtropical range with receiving a great amount of solar radiation; therefore, there are high air temperatures. The average temperature is mostly 15-17 ºC in February and 25-28 ºC in summer (Elzouki and Elfigih 2020). Sea surface water temperature is strongly affected by seasonal air temperature variations. Temperatures in some areas of Al Jabal Al Akhdar may reach higher than normal levels, in the summer, where the maximum temperature exceeds 40 degrees Celsius, although they are high mountain areas, the recent years the length of the heat wave, its duration increased from several days to several weeks(Schilling *et al.* 2020). Table 1 shows the climatological elements of Qasr Libya region (Jabal al Akhdar, Libya).

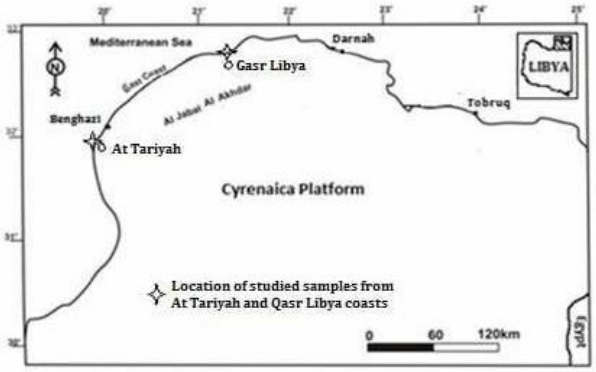

Fig 2. Location of the studied area (citation from Elzouki and Elfigih 2020)

Table 1. The climatological elements of Qasr Libya region (Jabal al Akhdar, Libya)

Polygon area, km	Annual rainfall rate, mm	Largest amount of annual precipitation, mm	Lowest amount of annual precipitation, mm	Temperature, °C	Wind speed, km h^{-1}
519.0309	293	484.4	123	15-17 ºC in February 25-28 ºC in summer	14-22

Table 2. General description of the study area

Soil profiles No.	Farm name	Examination date	Landforms	petroglyphs	Tilt and direction	Height above sea level	Natural vegetation cover	Drainage state	Current soil usage
1	Yasser Alzaalok Farm	12th of October, 2022	between valleys	10%	1% N-S	387 m	- Ericaceae -Phoenicean- juniper -Lentisk -Carob	Good	Cultivation of wheat and barley
2	Yasser Alzaalok Farm	12th of October, 2022	between valleys	10%	1% N-S	274 m	- Ericaceae -Phoenicean- juniper -Lentisk -Carob	Good	Cultivation of wheat and barley

The studied soil profiles were classified according to the soil taxonomy in USDA, (1998). The coordinates of the study area is shown in Table 3.

Detailed morphological description of both soil profiles (No.1 and 2) were recorded on the basis outlined by FAO (2006).

Also, coordinates of the studied area were shown in the same Table, while Table 4 indicates the vegetation cover of the studied area. Longitudes, latitudes, elevations and location were defined using GPS system "Corporation MAGELLAN"- NAV DLX-10 TM.

Table 3. Studied area coordinates

Soil profiles No.	Coordinates
1	32º 682631 N - 21º 341217 E
2	32º 687835 N - 21º 3336672 E

Table 4. Vegetation cover of the studied area

Common name	Scientific name	Photo
Phoenicean juniper or Arâr	*Juniperus Phoenicea*	
Lentisk or mastic	*Pistacia lentiscus*	
Carob	*Ceratonia Siliqua*	
Olive	*Olea Europaea*	
Phlomis	*Phlomis Floccosa*	

2. Laboratory analysis

Physical properties

Particle-size distribution analysis was executed using pipette method as described by Day (1965). Soil texture was known by texture triangle (Dewis and Freitas 1970). Bulk density was measured via core method as described by Dewis and Freitas (1970). Soil moisture was measured using electric oven according to according to Hesse (1971).

Chemical properties

Organic matter (O.M) content was determined via Walkely's Black method as described by Mathieu and Pieltain, (2003).Total carbonate ($CaCO_3$) was determined based on the procedures described by Hesse (1971) using by calcimeter method. pH was measured in the saturated paste using pH-meter, while electric conductivity (EC) was measured in soil paste extract using EC-meter according to the procedures of Hesse (1971).Available nutrients *i.e.*, potassium (K) and phosphorus (P) were determined using flam photometer and spectrophotometer, respectively (Hesse 1971).Cation exchange capacity (CEC) was determined using acetate sodium and ammonium as described by Chapman, (1965).Sodium adsorption ratio (SAR) was calculated according to equation of Dewis and Freitas (1970):

$$\mathrm{S.A.R.} = \frac{Na^{+}}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Exchangeable sodium percentage (ESP) was calculated according to Rashidi and Seisepour (2008). Soluble cations and anions as well as exchangeable cations were determined using the stander methods described in Dewis and Freitas (1970).

RESULTS AND DISCUSSION

1.Morphology description

The morphological features of the soils of both studied profiles (Table 5) revealed that that both profiles were dark red (2.5YR3/6, dry), and brown tended to be dark red (2.5YR3/4, moist). The soil was clayey, bulky, compact, very sticky and formed when wet, very cohesive and solid when dry, non-calcareous, clear horizon boundaries to the next horizon as for both profiles, noting the presence of a solid deaf layer in profile No.2.The drainage was somewhat good in the studied area. The results also indicate that wheat and barley were the best crops in the studied area.

The soil classification (Table 6) revealed that the soil of profile No.1 and No.2 were classified as *Lithic Rhodoxeralfs* and *Typic Haploxeralfs*, respectively under order of Alfisols.

Table 5. Morphology description

Depth (cm)	Morphology description	
	Profile No.1	
0-15	Dark red (2.5YR3/6, dry) - Brown tended to dark red (2.5YR3/4, moist) In the wet state, clayey, bulky, compact, very sticky and formed when wet, very cohesive and solid when dry, non-calcareous, clear horizon boundaries to the next horizon	
15-50	The same description morphology	
	Profile No.2	
0-20	Dark red (2.5YR3/6, dry) - Brown tended to dark red (2.5YR3/4, moist) In the wet state, clayey, bulky, compact, very sticky and formed when wet, very cohesive and solid when dry, non-calcareous, clear horizon boundaries to the next horizon	
20-80	The same description morphology, noting the presence of a solid deaf layer	

Table 6. Soil classification in the study area

Order	Soil profiles No.	Sub great group
Alfisols	1	Lithic Rhodoxeralfs
	2	Typic Haploxeralfs

2. Physical and chemical properties

The soil physicochemical attributes of the studied profiles are registered in Tables 7 and 8. It can be noticed that sand fraction percentage ranged from 15.1to 18.9% and silt fraction ranged from 31.4 to 35.7%, while clay fraction from 48.2 to 50.7%. Generally, the obtained data illustrate that soils of both studied profiles had clayey texture. Soil bulk density ranged between 0.98 to 1.01 g cm^{-3}, where the differences between both profiles at both depths were slightly. While soil moisture values ranged between 1.50 to 3.49 % , where the differences between both profiles at both depths were highly.

Table 7. Soil physical properties under the study area

Soil profiles No.	Depth, cm	Particle size distribution (%)			Soil texture	Bulk density, g cm^{-3}	Moisture, %
		Sand	Silt	Clay			
1	0-15	17.9	31.4	50.7	Clay	0.98	2.27
	15-50	16.1	35.7	48.2	Clay	1.00	3.49
2	0-20	18.9	32.7	48.4	Clay	1.01	1.50
	80-20	15.1	35.3	49.6	Clay	1.01	2.17

Table 8. Soil chemical properties under the study area

Soil profiles No.	Depth, cm	O.M, %	$CaCO_3$, %	pH	EC, dSm^{-1}	Available K, mg kg^{-1}	Available p, mg kg^{-1}	CEC, meq 100 g $soil^{-1}$	SAR,%	ESP,%
1	0-15	3.17	3.70	8.29	0.20	13.5	3.3	16.09	1.86	4.90
	15-50	3.04	2.00	8.30	0.27	7.80	7.5	22.60	1.38	7.74
2	0-20	1.10	0.25	8.11	0.11	21.0	6.5	23.60	0.78	2.65
	80-20	1.17	0.25	8.24	0.19	11.0	13.4	20.80	0.87	1.44

Cont. Table 8

Soil profiles No.	Depth, cm	Soluble cations meqL^{-1}				Soluble anions meqL^{-1}				Exchangeable cations, meq 100 g soil^{-1}			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
1	0-15	0.9	0.5	1.3	0.25	--	0.55	1.7	1.70	13	3.8	0.79	1.5
	15-50	1.1	0.4	1.5	0.25	--	0.40	2.25	1.60	12	4.8	1.75	3.51
2	0-20	2.0	2.7	1.2	0.30	--	0.75	3.55	1.90	20	0.95	0.6	2.05
	20-80	1.8	2.7	1.3	0.55	--	0.65	3.9	1.80	17	1.4	0.3	2.10

Also, the same Tables show that organic matter content was very high with a maximum value of 3.17% in surface layer of profile No.1 and 3.04 at depth of 15-50 cm. While profile No.2 possessed organic matter content of 1.10 and 1.17 at both studied depths, respectively.

$CaCO_3$ was moderately with a maximum value of 3.70% in surface layer of profile No.1 ($CaCO_3$ content< 7% = non-calcareous soil). The soils of the studied profiles were non-saline (EC from 0.11 to 0.27 dSm^{-1}) having a soil pH values ranging from 8.11 to 8.30 (moderately alkaline reaction). Also the studied soils haven't sodicity effect, where the ESP values of both profiles at each studied depth were less than 15%. The cation exchange capacity (CEC) differs from 16.09 to 23.0%, as it is depending on the fine fractions and organic matter contents.

Content of available potassium was very low and ranged from 13.5 to 21 mg kg^{-1}. Also, content of available phosphorus ranges from medium to very high with profile No.2 with value of 13.0 mg kg^{-1} at the second depth. Mg^{++} and Ca^{++} were the predominant cation in both studied horizons followed by other cations *i.e.,* Na^{+} and K^{+}, while the Cl^{-1} ion dominate the anions then SO_4^{--} and lately HCO_3^{-}.

CONCLUSION

The obtained results illustrated that the soils of the studied area are non-saline having high organic matter content with clayey texture and suitable pH value. Generally, it can be concluded that the studied area is permanently suitable for agriculture with the design of an appropriate soil and water management system, where texture, salinity and slope were the limiting factors. The results also indicate that wheat and barley were the best crops in the studied area.

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تقييم أراضي منطقة قصر ليبيا (الجبل الأخضر، ليبيا) من حيث خواصها المورفولوجيا والكيماوية

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الملخص

يهدف العمل البحثي الحالي إلى دراسة الخصائص المورفولوجية وتصنيف وخصوبة أراضي ميراد راضية بمنطقة قصر ليبيا (الجبل الأخضر)، ليبيا. ولتحقيق أهداف هذا البحث تم حفر قطاعين في التربة لتمثيل أراضي المنطقة المدروسة ومن ثم فحصهما. تم إجراء القطاع الارضي الأول في منطقة أعلى من مستوى سطح البحر بحوالي 387 مترًا (682631' 32° شمالًا-341217' 21° شرقًا)، بينما تم إجراء القطاع الأرضي الثاني في منطقة يبلغ ارتفاعها 274 مترًا فوق مستوى سطح البحر (687835' 32° شمالًا-3336672' 21° شرقًا). تم إجراء الدراسة على عمقين لكل قطاع ارضي. تم إجراء بعض التحليلات الفيزيائية والكيميائية.أوضح الوصف المورفولوجي أن كلا القطاعيين الارضيين كان لونهما احمر داكن في الحالة الجافة، وبني يميل إلى الأحمر الداكن في الحالة الرطبة. كانت التربة طينية ذات بناء كتلي، مندمج شديد الالتصاق والتشكل عند الابتلال، شديد التماسك والصلابة عند الجفاف، غير جيرية، حدود الأفق واضحة الي الأفق التالي لكلا القطاعين المدروسين، مع ملاحظة وجود طبقه صماء في القطاع الأرضي الثاني فقط. تم تصنيف القطاع الأرضي الاول والثاني على أنها *Lithic Haploxeralfs* و*Typic Rhodoxeralfs*، على التوالي. كان محتوى المادة العضوية مرتفعًا جدًا بقيمة قصوى قدرها 3.17 ٪ في الطبقة السطحية للقطاع الأرضي الأول. كان محتوي كربونات الكالسيوم معتدل بقيمة قصوى قدرها 3.70٪ في الطبقة السطحية للقطاع الأرضي الأول. كانت اراضي المنطقة المدروسة غير مالحة بقيمه توصيل كهربي تراوحت من 0.11 إلى 0.27 ملي موز. أيضا يتصف القطاعين بقوام طيني وقيم pH تتراوح من 8.11 إلى 8.30 وكان الصرف جيدًا إلى حد ما في المنطقة المدروسة.