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The effect of soil management method on on some chemical and morphological characteristics of calcareous soils in the Muthanna desert

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Abstract

Four areas were selected in the Al-Rehab region, the desert of Muthanna Governorate, which differ in the management style, the duration of agricultural exploitation, and the quality of irrigation water. It was taken in each Pedon region and the morphological and chemical measurements were revealed and conducted, and it was found that the thickness of the A horizon ranged between 10-15 cm and the thickness of the B horizon between 25-45 cm in all study pedons. The administration style did not affect Hue, as all horizons were within the color (10YR) and chroma, as the colors ranged from light white to very bale brown (10 YR7/4) and white (10YR8/1), the soil texture was between Sandy loam, Sandy clay loam, Loamy Sand. As for the chemical properties, the percentage of carbonate minerals CaCO3 ranged between (25-40)% and the percentage of gypsum ranged between (2.1-8.1) % The electrical conductivity EC ranged between (3.8-18)ds.m^{-1}, while the organic matter was between (2.1-13.5)% and the CEC values ranged between (12-18Coml.kg), where the results showed that there are clear differences in the substance Organic, cation exchange capacity, carbonate distribution, and increased gypsum accumulation as a result of soil management.

Key words: soil management, calcareous soils , Muthanna desert

1

- Introduction

Calcium carbonate is one of the most important carbonate salts common in the soils of most dry and semi-arid regions (Al-Zubaidi, 1989 and Al-Ghanmi, 2015). Carbonate minerals are one of the most important components of the earth's crust, as they account for 4% of the earth's crust weight. It is either inherited from the material of rocks of origin or secondary, formed pedologically in the form of knots that the soils of dry areas and where the

rainfall rate is less than 500 mm annually in which carbonates, especially carbonates, accumulate Calcium and magnesium. (Al-Qaisi, 1989) found that the proportion of calcite in Iraqi soils constitutes 90% of the proportion of Iraqi soils, while the proportion of dolomite and calcite bearing magnesium reaches 10%.

Soil is one of the natural resources that is not equivalent to another natural resource, so it occupies an important place because of its wealth. Agricultural production depends mainly on the soil, as the good and permanent exploitation of agricultural soils means full use of it, as well as raising its fertility and increasing crop productivity through the application of technical means (Al-Ani, 2006).

Morphological studies are the basis from which the rest of the sciences related to soil are based, as it provides an important and reliable database. Soils, in reality, are independent physical entities that have a specific geographical distribution, and their chemical, physical and mineral properties and characteristics overlap in terms of influence this interference is reflected in the apparent morphological characteristics of interest to soil surveyors.

The soils of Al-Samawa desert in Al-Rehab area are fertile and productive and provide groundwater of acceptable quality for agriculture. It is considered among the limestone soils, as these soils suffer from many problems such as the fixation of elements such as phosphorous and the formation of compaction layers in addition to the alkaline conditions (Al-Ghanimi, 2015).

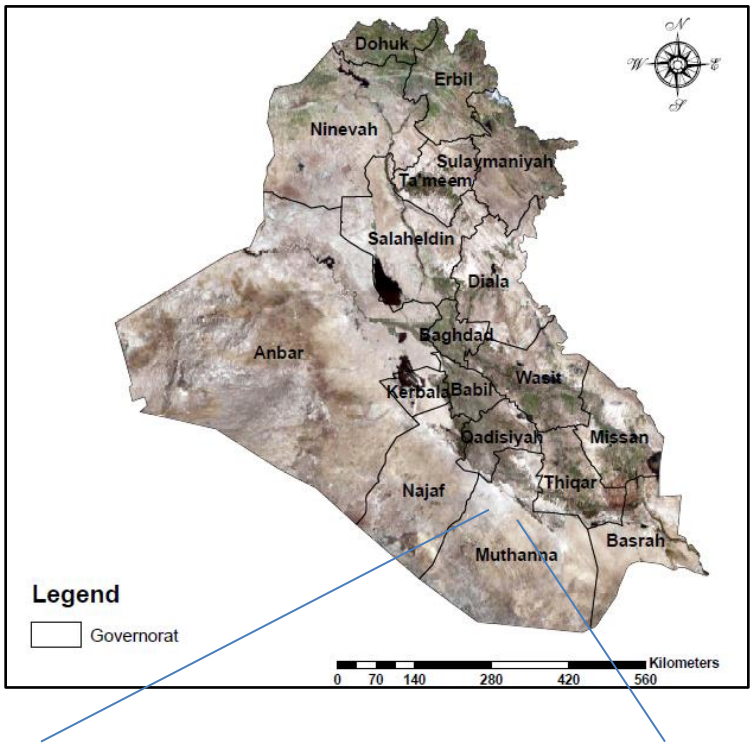
Calcium carbonate in Al-Rehab area between 25-40 % is considered a high percentage, so it needs special management to reduce the negative effects on production.

The researcher (Al-kassy, 1983) has shown that most of the carbonate minerals are distributed in the Iraqi soil in the form of separate particles within the soil content, and the other percentage of these minerals is in the form of binding materials for other soil separations. Calcium carbonate's prevalence rate varies from one soil to another.

Therefore, these soils need special management and different cultivation methods in order to be productive and can be cultivated and preserved from deterioration and desertification, especially since these lands have very large areas, amounting to 20 million dunums in the Samawah desert alone, most of them are suitable for agriculture and others need special management in order to become productive and some lands It needs a specific reclamation, part of the lands of the Badia can be used for grazing and the other part can be for recreation and wildlife while preserving, sustaining and developing the existing resources.

2- ***Materials and methods***

1- The study area was selected within the administrative boundaries of the Muthanna Badia in the Al-Rehab area, some of which are planted for long or medium periods and the pedon is not planted with the availability of natural vegetation and All pedons are irrigated from artesian wells, and the locations of the pedons representing the selected sites were determined using a GPS device and were described fundamentally according to Ditzler et al. (2017) Soil surveying and sampling began on 30-4-2021 (Fig. 1).



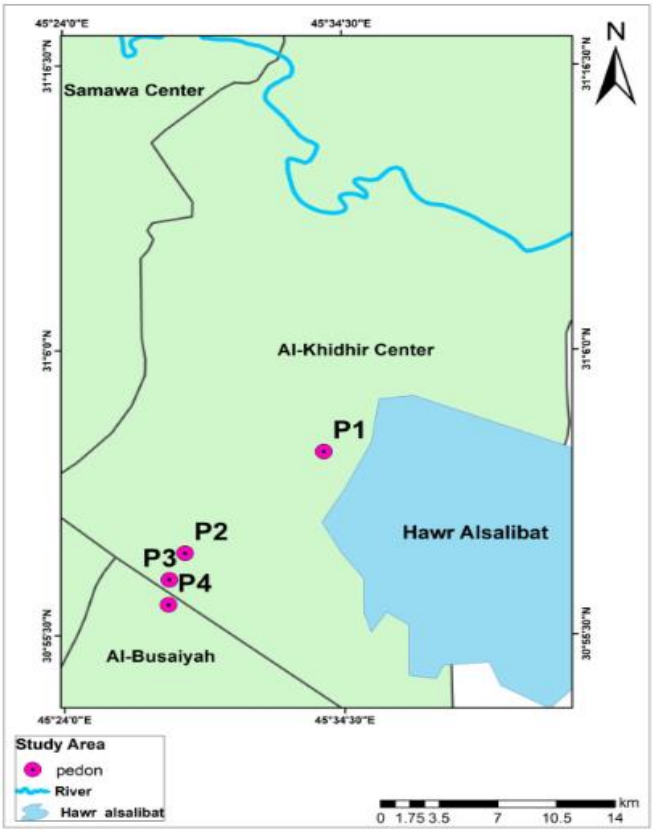


Figure 1. Locations of pedons in the study area.

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2- Soil samples were air-dried, crushed manually and with a wooden hammer and passed through a sieve with holes 2 mm in diameter and kept in plastic containers, after which the following laboratory analyzes were carried out:

A- chemical properties

1- pH: The degree of soil reaction in the soil sample extract with water was estimated 1:1 according to what was mentioned in (Richards, 1954).

2- Electrical conductivity: The electrical conductivity of a soil sample extract with water was estimated 1:1 using the Conductivity bridge device according to what was mentioned in (Richards, 1954).

3- Calcium Carbonate minerals: they were estimated by Calcimmeter according to (Hesse method, 1972).

4- Gypsum: The gypsum was estimated by the method of sedimentation by means of an acetone solution, and then the electrical conductivity of the formed precipitate was measured, as stated in Richards, 1954).

5- CEC: was estimated by the simplified methylene blue method, which is presented in (Savant, 1994).

6- Organic matter: It was determined by wet oxidation method according to Walkely and Black method described in (Jackson, 1958).

7- Calcium and magnesium ions: they were estimated by 1:1 extraction by slaking method with Versenate, according to what was mentioned in Jackson, 1958).

8- Sodium: The dissolved sodium ion was estimated with 1:1 extract and a photometer flame was used according to the method described in Richards, 1954)).

B- Morphological characteristics: Morphological characteristics (color, texture, structure, and texture) A description Landon, J. R. (2014).

1- pedon No1. (not planted) coordinates 45°33'45.54" E 31°2'15.66" N near Umm Al-Rouj Bridge and the presence of halophytic plants.

2- pedon No.2 45°28'32.012" E 30°58'32.011" N planted with barley for 15 seasons, coordinates (Al-Ashali area), 16 km from Mar Sulaibiyat

3- pedon No. 3 45°57'33.48" E 30°57'33.48" N Wheat 15 years old

4- pedon No. 4 45°27'47.58" N 30°56'43.98" E Cultivated wheat 30 years old, Matlab Al-Asi region.

The following is a table of management methods:

Table 1. Area management methods.

management type	uncultivated	wheat planted	Wheat planted with corn
plowing	nothing	superficial	deep alternation with superficial
fertilization	nothing	chemical	chemical
irrigation	nothing	Wells	Wells
Agricultural rotation	natural plants	porridge in summer	Wheat with white corn

Table 2. Chemical properties of the water wells of the study area.

HCO_3	$S0_4$	CL	K	NA	Mg	Ca	PH	EC ($ds.m^{-1}$)	well site
$Mg.L^{-1}$									P1
uncultivated									
33	1700	990	23	570	159	580	7.6	5.5	P2
40	1690	1100	18	640	165	600	7.4	6.1	P3
46	1800	1130	15	710	160	620	7.6	5.7	P4
40	1890	1040	22	620	166	520	7.5	6.0	P5

1- Results and discussion

3-1. Morphological characterization of the study pedons

The results of the morphological description showed relative differences as a result of the environmental conditions and the material of origin, As well as the difference in management systems, the quality of crops and the length of cultivation , as well as there was a difference in the natural plant, where Schanginia arbuscula and Tamraxix Aphylla appeared in the uncultivated soils. What are the long-cultivated soils, Artemisia and Malva appeared.

The depths of horizons varied in the study pedons. They also varied, as the depth of the horizon A ranged from 10-15 cm in all the pedons, and the depth of the surface horizon was 15 cm in the uncultivated soils. As for the rest of the pedons, it was 10 cm. As for the other horizons, the thickest of the horizons was B in all the pedons as a result of the accumulation of Calcium carbonate transferred with irrigation water With regard to soil color, all study areas were within Hue of 10YR only. Chrom values and chromium values differed, as the color ranged between Very pale brown (10 YR7/4), Light Yellowish (10YR6/4 White (10YR8/1), where the colors were light between light white and yellowish, and this

It reflects the desert conditions and the lack of organic matter as a result of the hot climate and the oxidation of organic matter, as well as the accumulation of calcium carbonate and salts, especially in uncultivated soils where limestone soils are a result of the original material and irrigation water.

Soil texture is one of the important morphological characteristics that have direct effects on soil management and other characteristics. The textures ranged between Loam, Silt loam, Silty clay loam, sandy loam. These tissues are within the coarse and medium textures as a result of sedimentation conditions and the coarse-grained limestone parent material, as well as the materials transported by torrents and rain, where pedon was distinguished Cultivated for a long time with a relatively fine texture where the horizon was A for all without studying Silty loam. The composition is generally characterized as Angular blocky or devoid of structure as a result of the accumulation of salts and calcareous materials. The roots of the plants appeared on the cultivated horizons and were generally medium and soft as a result of cultivation with fibrous-rooted field crops and some annual natural plants. Some horizons showed a granular structure with no sub angular blocky as a result of long cultivation and the availability of percentages of organic matter and plant roots.

Table 3. Morphological description of the studied pedons.

Horizon	Depth (cm)	Description
A_p		Very pale brown (10YR7/4d) ; Sandy loam ; moderate very fine sub angular blocky ; Slightly hard(d) ; very friable (m) ; slightly sticky and slightly plastic (w) , few fine pores , non Roots , accumulation of Salt clear smooth boundary .
B_{kz}	15- 45	Very pale brown (10YR7/4 d) loamy Sand; moderate very fine sub angular blocky; slightly hard (d)very friable (m) sticky and slightly plastic (w);few fine pores ,no Roots ; accumulation of Salt , clear smooth boundary .
B_z	45 -75	Very pale brown (10YR7/4 d) ; Sandy loam ; moderate fine sub angular blocky ; slightly hard (d) very friable (m) sticky and slightly plastic (w) ; few fine pores ;few fine roots ; accumulation of Salt , clear smooth boundary.
C	75 +	Very pale brown(10YR8/3)loamy sand ; moderate sub angular blocky ; slightly hard (d);very friable (m) slightly sticky and slightly plastic (w) ; few very fine pores ; few fine roots

Pedon 1

Pedon 2

Horizon	Depth cm	Description
A_p	0-10	Very pale brown (10YR7/3 d) Sandy loam ; Moderate fine angular blocky ; soft (d)very Friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; many medium roots, Clear smooth boundary .
BA	10- 40	Very pale brown(10YR7/3 d) loamy Sand ; week fine sub angular blocky ; soft (d) very friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; few medium roots ; clear smooth boundary.
B_k	40-7 5	Very pale brown (10YR7/4 d) loamy Sand ; week very fine sub angular blocky ; slightly hard (d)very friable (m) slightly sticky and slightly plastic (w) ; very fine pores ;non Roots, clear smooth .
C_{k1}	7 5 +	Very pale brown (10YR7/3d) Sandy ; week fine sub angular blocky ; slightly hard (d) very friable (m) slightly sticky plastic (w) ; very few fine pores non Roots ; clear smooth boundary .

Pedon 3

Horizon	Depth cm	Description
A_p	0-10	Very pale brown (10YR7/3 d) Sandy loam ; Moderate fine angular blocky ; soft (d)very Friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; many medium roots, Clear smooth boundary .
BA	10-37	Very pale brown(10YR7/3 d) loamy Sand ; week fine sub angular blocky ; soft (d) very friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; few medium roots ; clear smooth boundary.
B_k	37-72	Very pale brown (10YR7/4 d) loamy Sand ; week very fine sub angular blocky ; slightly hard (d)very friable (m) slightly sticky and slightly plastic (w) ; very fine pores ;non Roots, clear smooth boundary.
C_{k1}	72-100	Very pale brown (10YR7/3d) Sandy ; week fine sub angular blocky ; slightly hard (d) very friable (m) slightly sticky plastic (w) ; very few fine pores non Roots ; clear smooth boundary .

Pedon 4

Horizon	Depth cm	Description
A_p	0-10	Very pale brown (10YR7/3 d) Sandy loam ; Moderate fine angular blocky ; soft (d)very Friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; many medium roots, Clear .
BA	10-37	Very pale brown(10YR7/3 d) loamy Sand ; week fine sub angular blocky ; soft (d) very friable (m)slightly sticky and slightly plastic (w) ; few very fine pores ; few medium roots .
B_k	37-72	Very pale brown (10YR7/4 d) loamy Sand ; week very fine sub angular blocky ; slightly hard (d)very friable (m) slightly sticky and slightly plastic (w) ; very fine pores ;non Roots, smooth
C_{k1}	72-100	Very pale brown (10YR7/3d) Sandy ; week fine sub angular blocky ; slightly hard (d) very friable (m) slightly sticky plastic (w) ; very few fine pores non Roots ; clear smooth boundary .

3-2 Chemical characteristics of the study area

3-2-1 Electrical conductivity EC

Table 4 shows that the electrical conductivity values of the study peduncles ranged from 3.8-18 ds.m^{-1} and these values varied according to the length of the cultivation period, it was 18 in the uncultivated soils down to 3.8 in the soils that were cultivated for 30 years, and it was clear the effect of cultivation and irrigation on Reducing the degree of soil salinity, where the pedon No. 4 was distinguished by a somewhat low electrical conductivity, ranging between 4-3.8, according to the horizons of the pedon.

3-2-2 The degree of reaction pH

The degree of reaction in all study pedons and horizons was almost neutral to slightly basal, where the values ranged between 7.2-8.0 (Table 4) and this is consistent with the conditions of drought, high temperatures and conditions of the limestone material, which works on the accumulation of lime (Al-Ghanmi, 2015 and Hurayga , *et al*. 2018).

3-2-3 Calcium sulfate Gypsum (gypsum)

The values were generally low and indicate that the soil is not gypsum, and the results (Table 4) ranged between 2.1-8.1% and it was the lowest value in the uncultivated soil bedon and increased significantly in the cultivated soil donuts and the increase was proportional to the length of the period Agriculture This refers to the accumulation of percentages of gypsum from the irrigation water containing this substance, and in general, the percentage of gypsum is few and harmless.

3-2-4 Organic matter O.M

It was observed that the organic matter decreased in general and in all the study pedons, and this reflects the conditions of the dry region and the high temperatures where the organic matter was oxidized (Konen, et al. 2003 , Al-Azzawi 2017, and Jaib 2019). The values of the organic matter ranged between 0.2-13.5 $gm.kg^{-1}$ (Table 4), and the lowest in the horizon was A_z of the uncultivated pedon and the highest value on the horizon AP in the cultivated pedon for a period of 30 years. The length of the cultivation period and soil management was clearly on the increase The accumulation of organic matter, and the percentage of organic matter decreased with increasing depth, and this is due to the depth reached by the roots of the cultivated plants.

3-2-5 CEC Cations Exchange Capacity

This characteristic is important, as it shows the ability of the soil to retain nutrients, prepare it for plants continuously, and retain nutrients and preserve them from washing and loss (Waheeb and Ibrahim, 2012). The study soils were characterized by a lack of exchange capacity, and this characteristic increases the proportion of clay, type of clay and organic matter, and the ratio ranged between 12-18 $Cmol.kg^{-1}$ (Table 4) This percentage is considered low and this is due to the coarse sandy soils and the low percentage of clay and organic matter, as well as the increase in the percentage of Coca 3 which encapsulates the soil particles and reduces the surfaces subject to interaction. However, there was an increase in CEC with the increase in the number of years of cultivation and this is due to Increased accumulation of organic matter (Kati' and Majeed 2013).

3-2-4 Calcium Carbonate (Lime) Coca3

The study showed a high percentage of calcium carbonate in all the pedons and horizons of the study and that the soil is clear limestone and this is attributed to the limestone mother and the existing lime deposits, as well as the irrigation water and torrents carrying these compounds. The proportions (Table 4) ranged between 250-400 % The percentage of carbonates increased in The middle horizons of the study soils, which refers to the pedogenic movement of lime mineral and the formation of the calcic horizon and the ptrocalcic horizon This is within the horizon B and despite the increase in the percentage of lime, its effect on production is limited due to the lack of lime melting and its limited osmotic effect.

Table 4. Some chemical properties of pedons of the study area.

P1	Depth	PH	EC (ds.m-1)	CEC Coml.kg	$Caco_3$ $^1gm.kg^-$	$Caso_4$ %	O.M $gm.kg^{-1}$
A_Z	0-15	7.6	18	15	300	2.2	2.0
B_K	15-45	7.4	16	12	400	2.1	3.5
C_K	45 +	7.8	10	13	350	2.5	2.5

P2							
AP	0-10	8.0	8.0	16	250	6.0	6.0
B_K	10-50	7.8	6 .2	14	390	5.0	5.8
C_K	50 +	7.7	5.8	12	300	4.0	5.5
P3							
AP	0-10	7.6	6.4	16	320	4.2	9.1
B_K	10-45	7.7	6.0	15	400	5.0	8.9
C_K	45 +	7.5	5.5	13	400	5.8	9.0
P4							
AP	0-10	7. 2	4. 0	18	300	8.1	13.5
B_K	10-60	7.5	3.8	16	400	6.2	9.8
C_K	60 +	7.6	3.9	15	340	5.5	9.6

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