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Evaluation of soil organic matter in different agro-system in Ouargla region

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Dedication

I dedicate my thesis work to my family and many friends.

*A special feeling of gratitude to my loving parents, my sisters and my brothers especially my older sister **Fatima** who have never left my side.*

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List of the abbreviation

ANOVA: Analysis of variance

BD: Bulk density g/cm^3

C: Carbon

CLTV: Cultivated

DA: Discriminant analysis

EVP: Evaporation (mm)

GH: Green house

H: Humidity (%)

INS: Insolation (h)

MAX: Maximal

MIN: Minimal

NC: No cultivated

P: Precipitation (mm)

PL: Palm groves

PV: Pivots

SOC: Soil organic carbon

SOCB: Soil organic carbon density

SOM: Soil Organic matter

W: Wind (m/s)

WB: Walkley-black

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Introduction

Introduction:

Soil is a non-renewable dynamic natural resource that is essential to life. Water movement, water quality, land use, and vegetation productivity all have relationships with soil (Jon *et al*, 2015).

Soil organic matter is a key factor controlling the welfare of humanity by its ability to provide agricultural resources (soil fertility and thus food) and a healthier environment at a local and global scale (e.g., attenuation of nitrate pollution and greenhouse gases emissions). However, 'sustainable' agriculture requires a clear understanding of the multiple drivers and treats to soil organic matter dynamics and associated elemental cycles in semi-arid and arid soils (Brahim *et al*, 2021).

An agro-ecosystem, also known as an agro-system or farmed ecosystem, is an environment that has been transformed by humans to use a portion of the organic matter it generates, usually for food.

Soil organic matter (SOM) is a component of soil that consists of plant and animal debris in various stages of decomposition, soil microbe cells and tissues, and chemicals synthesized by soil microbes (Gebreyes, 2019).

The Algerian Sahara is marked by a diversity of agro-systems, edaphic conditions and climatic differences; yet, data on biological markers of dry lands is scarce in this region (Omeiri, 2016; Karabi, 2016; Oustani, 2016 Mehda *et al*, 2021). The low organic matter content of dry soils has been highlighted by researchers who have researched their biological activity (Karabi *et al*, 2016).

In the Ouargla region, the most common agro-system type is phoenicultural (palm groves), with two additional new kinds comprising greenhouses and pivots.

SOM has an impact on agro-systems' productivity and environmental performance. Despite this, little is known about the distribution of SOM in the various agro- systems existing in the soils of the Ouargla region. In this study, we intend to compare the organic matter rates of different types of agro-systems.

The major goal of this research is to assess the organic matter in the Ouargla area in different agro-systems. We selected pivots, greenhouses and palm groves as agro-system's types, as well as no cultivated soil (control) to discover which had the highest rate of SOM. Furthermore, we intended to examine the soil organic carbon density.

The study is divided into 4 chapters:

- The 1st chapter: we mentioned some fundamentals of soil and organic matter, as well as bulk density.
- The 2nd chapter: provided The study's area
- The 3rd chapter: We detailed the content and approach we used in.
- The 4th chapter is divided into two parts: We put the results that we received in the 1st part. In the 2nd part, we discussed the outcomes.

Chapter I

Bibliographic Overview

Introduction

In this chapter we are going to look at some of the most important aspects of soil and how we relate it to our environment. We'll also be looking at the bulk density of soil and look for the relationship between the SOM, SOC and BD.

I.1. Soil definition

The Natural Resource Conservation Service (NRCS) defines soil as: "a natural body comprised of solids (minerals and organic matter), liquid and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment (Soil Survey Staff, 2014).

I.2. Soil proprieties

Soil is a substance made up of different components. It contains different solid materials, air, free and bound water. (Salam, 2020). It is a mixture of inorganic (mineral) and organic particles organized into layers (horizons) by physical, chemical and biological processes (Hutson,2016).

I. 3. Soil Quality

Soil is a dynamic, living natural body that is vital to the function of terrestrial ecosystem and represents a unique balance between physical, chemical and biological factors. Soils form slowly averaging 100 to 400 years per centimeter of topsoil, through the interactions of climate, topography, vegetation and mineral over time (Jenny, 1980; Lal, 1994).

Scientists use soil quality indicators to evaluate how well soil functions since soil function often cannot be directly measured. There are three main categories of soil indicators: chemical, physical and biological. (Doran and Parkin,1996).

Table I. Summary of soil health indicators used to asses soil function (Kinyangi, 2007)

Indicator	Soil function
Soil organic matter (SOM)	Soil structure, stability, nutrient retention; soil erosion.
Physical: soil aggregate stability, infiltration and bulk density	Retention and mobility of water and nutrients; habitat for macro and micro fauna.
Chemical: pH, extractable soil nutrients, N-P-K and base cations Ca Mg & K	Soil biological and chemical activity thresholds; plant available nutrients and potential for N and P as well as loss of Ca, Mg & K.
Biological: microbial biomass C and N; potentially mineralizable N	Microbial catalytic potential and repository for C and N; soil productivity and N supplying potential.

I. 4. Soil organic matter (SOM)

SOM is an important indicator of soil fertility and quality, which is why this parameter is often the first measured when studying a soil and its ecosystem (pare,2011).

SOM constituents of soil come from the decomposition of plant, animal and bacterial organic matter. These substances are constantly changing in the soil and are transformed by various geochemical processes over time. As it plays a major role in the properties of the soil, it is important that organic matter is constantly renewed. (Brady *et* Weil, 2008).

SOM is considered an important part of soil for its high contribution to soil productivity. Generally, SOM contains two main fractions: humic substances and labile soil organic matter. (Eduard Strosser; 2010).

I.5. Organic materials impact on soil proprieties

SOM exerts numerous positive effects on soil physical, chemical and biological properties. Particularly, the presence of SOM is regarded as being critical for soil functions and soil quality. The benefits of SOM result from a number of complexes, interactive, edaphic factors; a non-exhaustive list of these benefits to soil function includes improvement of soil structure, aggregation, water retention, soil biodiversity, absorption and retention of pollutants, buffering capacity the cycling and storage of plant nutrients (Mahendran and Yuvaraj, 2020).

SOM increases soil fertility by providing cation exchange sites and being a reserve of plant nutrients, especially nitrogen (N), phosphorus (P), and sulphur (S), along with micronutrients, which the mineralization of soil organic matter slowly releases. As such, the amount of soil organic matter and soil fertility are significantly correlated (Mahendran and Yuvaraj, 2020).

I.6. Composition of SOM

SOM is a highly variable entity because different organic compounds are found in different plant and animal residues and different organic compounds predominate at different stages of decomposition SOM includes materials that are added in plant and animal residues, those that are formed during decomposition, substances synthesized by microorganisms, and compounds in root exudates and microbial secretions (Osman, 2013).

I.7. Decomposition of SOM

The decomposition of SOM is biological breakdown and biochemical transformation of complex organic molecules of dead litter into simpler organic and inorganic molecules (Juma 1998 in Reddy, 2016). It is important for the release of nutrients held up in dead organic matter and returning it back to the soil. Decomposition of SOM leads to the release of bioavailable nutrients and CO2 and counteracts soil C sequestration (Lehmann and Kleber, 2015 in Reddy, 2016).

I.8. Soil organic carbon

Soil organic carbon (SOC) is one of the most important indicators of soil quality (Ghosh *et al*, 2012). Soils contain approximately three times the carbon found in the atmosphere or terrestrial vegetation (Schmidt *et al*, 2011), which accounts for 80% of the terrestrial carbon pool (Leifeld *et al*, 2005). Therefore, maintaining and enhancing soil carbon stocks is of great importance when considering both the promotion of soil health and the regulation of the global carbon cycle, (Minasny *et al*, 2017).

SOC pool involves a variety of physical, chemical, and biological processes and thus plays an essential role in soil ecosystem functions, such as maintaining soil fertility and agricultural sustainability (Tiessen *et al*, 1994), regulating global climate change, (Paustian *et al*, 1997) and sequestering pollutants in soil. (Chefetz *et al*, 2000).

I.9. The Bulk density

Soils are composed of solids (minerals and organic matter), and pores which hold air and water. The bulk density of a soil sample of known volume is the mass of that sample divided by the bulk volume. The "ideal" soil would hold sufficient air and water to meet the needs of plants with enough pore space for easy root penetration, while the mineral soil particles would provide physical support and plant essential nutrients. Soil bulk density is a basic soil property influenced by some soil physical and chemical properties (Bernoux, 1998).

I.10. SOM, SOC and Bulk density

Soil organic matter (SOM) and soil organic carbon (SOC) constitute usually a small portion of soil, but they are one of the most important components of ecosystems. Relationships among SOM, SOC and BD are used to estimate soil C pools (Erdal, 2011).

As the OM in soil increases, the BD of soil decreases which is required for the proper growth of plants. Researchers have shown that OM and soil BD are highly dependent on each other (Erdal, 2011).

The relationship between bulk density and OM is substantial. In general the lowest the bulk density the greatest SOM level. Greater aggregate stability, as a result of higher SOM levels, enhances soil porosity, resulting in a lower bulk density (Gebreyes, 2019).

Conclusion:

Soil consists of mineral and organic matter, the organic matter is the essential component of soil. SOM is mainly made up of carbon (58%).

SOM have a positive relationship with carbon levels, another side SOM and BD have a negative relationship as well.

Chapter II

Presentation of the study area

Introduction

The study region and its peculiarities, such as climate, geology, pedolgy, and flora, will be discussed in this chapter.

II.1. Study area

Ouargla is geographically located in the north of Algerian Sahara, in the arid domain of the great African desert (Salhi, 2017). The Wilaya of Ouargla (Fig. 1) covers an area of 163,323 km² and is bounded in the north by the wilaya Tougourt, in the northeast by the wilaya of El Oued and Tunisia country south by the wilaya of In saleh and southeast by the wilaya of Illizi , in the west by the wilaya of Menea,in the northwest by the wilaya of Ghardaia.

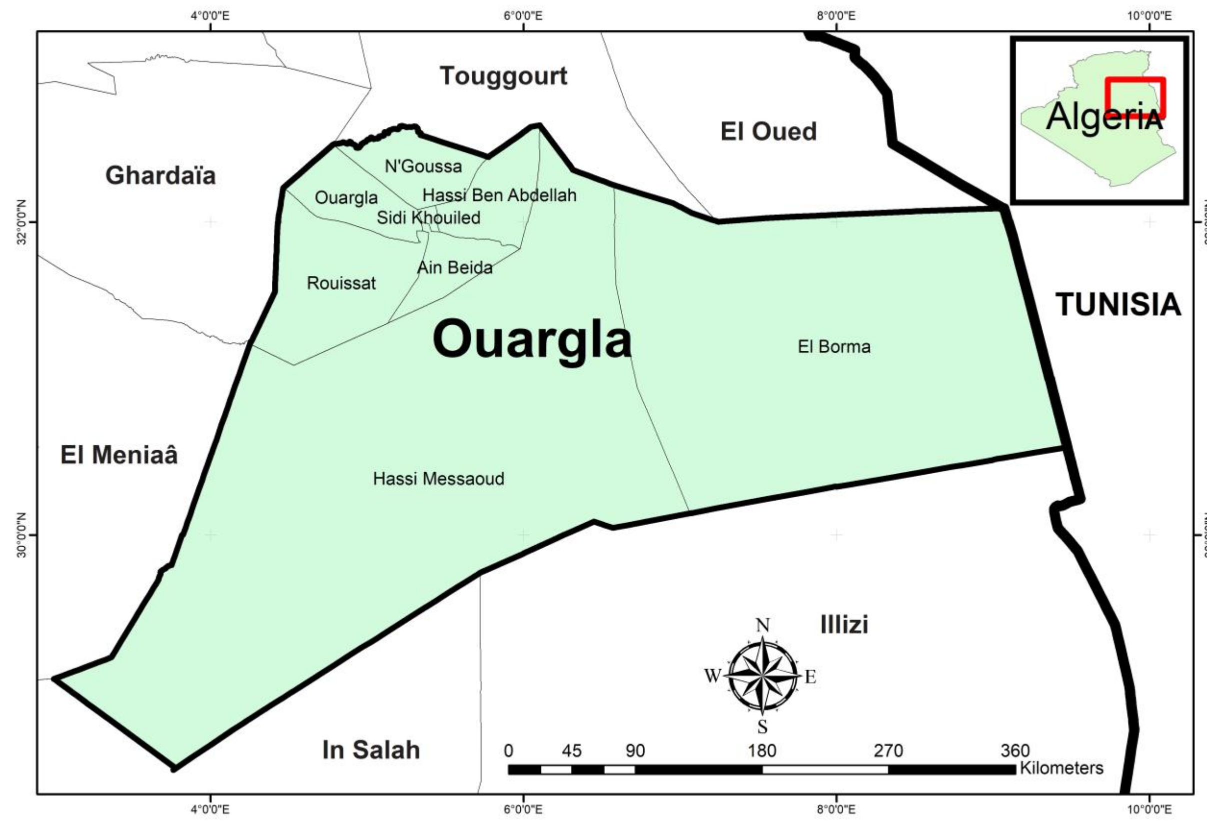

Fig1: geographical location of Ouargla region (created by Djili.B,2022)

II.2. Climate of Ouargla region

Like all the lower Sahara, Ouargla region is characterized by a desert climate, where the thermal amplitudes between the minima and the maxima are important, and by a very low rainfall (Khadraoui and Taleb, 2008).

Table II. Climatic data for Ouargla region (2011-2020)

	Temperature (°C)			W (m/s)	H %	EVP (mm)	P (mm)	INS (h)
	MIN	**MAX**	**AVE**					
January	4,58	19,41	12,00	7,90	52,30	101,09	2,09	255,36
February	6,43	20,94	13,69	9,30	45,90	122,08	3,53	242,05
March	10,44	25,47	17,96	10,30	40,95	188,74	5,98	267,8
April	15,65	31,04	23,35	10,80	34,10	247,06	1,78	285,29
May	20,35	35,65	28,00	11,00	28,05	317,86	2,52	312,36
June	24,95	40,58	32,77	10,30	24,50	373,11	0,22	225,18
July	28,13	43,99	36,06	9,30	20,90	456,96	0,13	315,33
August	27,46	42,5	34,98	9,70	24,65	392,37	0,36	338,9
September	23,78	38,57	31,18	9,30	32,85	277,82	3,97	268,81
October	17,31	31,1	24,21	8,40	39,60	215,96	3,59	269,84
November	10,56	24,4	17,48	7,70	48,80	130,28	2,75	243,08
December	5,83	19,53	12,68	7,40	57,95	88,84	3,74	234,58
Average	16,28	31,09	23,70	9,28	37,55	2912,17*	30,66*	3258,58*

II.2.1. Temperature

the annual average temperature is 23.70°C, the higher temperature recorded in July with 43.99°C and the minimum value recorded in January with 12.00°C, in Jun, July and August we see the higher maximum temperature there it was above 41°C we can say it’s too close to reach 50°C.

II.2.2. Wind

As we see in the table the wind was higher in May it recorded with 11.00 (m/s), the minimum was in December month with 7.40(m/s).

II.2.3. Humidity

The annual average of humidity is 37.55 (%), the higher recorded in December with 57.95(%) in other side the minimum humidity recorded with 20.90 (%) in July month.

II.2.4. Evaporation

The annual cumulative of evaporation recorded with 2912.17 (mm), the maximum value recorded in July with 456.96 (mm) and the minimum was in December with 88.84 (mm).

II.2.5. Precipitation

As we know the precipitation in Ouargla region is so rare, from the table we see the annual average is 30.66 (mm), we recorded the rainiest month is March with 5.98 (mm) and the minimum was in July with 0.13 it’s too low.

II.2.6. Sunstroke

Insolation is so much strong in August month recorded with 338.9(h) and really weak with 225.18 (h) in June.

II.2.7. Gaussen ombrothermic diagram

The gaussen indicator is one of the most used indicators that determines the dry month, especially the medium climate.Gaussen puts an equation that uses the temperature and precipitation to determine the dry month $P< 2T$, Where P represents «precipitation» and T represents «temperature».

We can summarize this equation and present it in a diagram and name it «diagram ombrothermic» if the temperature diagram was higher than the precipitation diagram, that means the month is the dry month, and if it was the opposite, that means that month is a wet month.

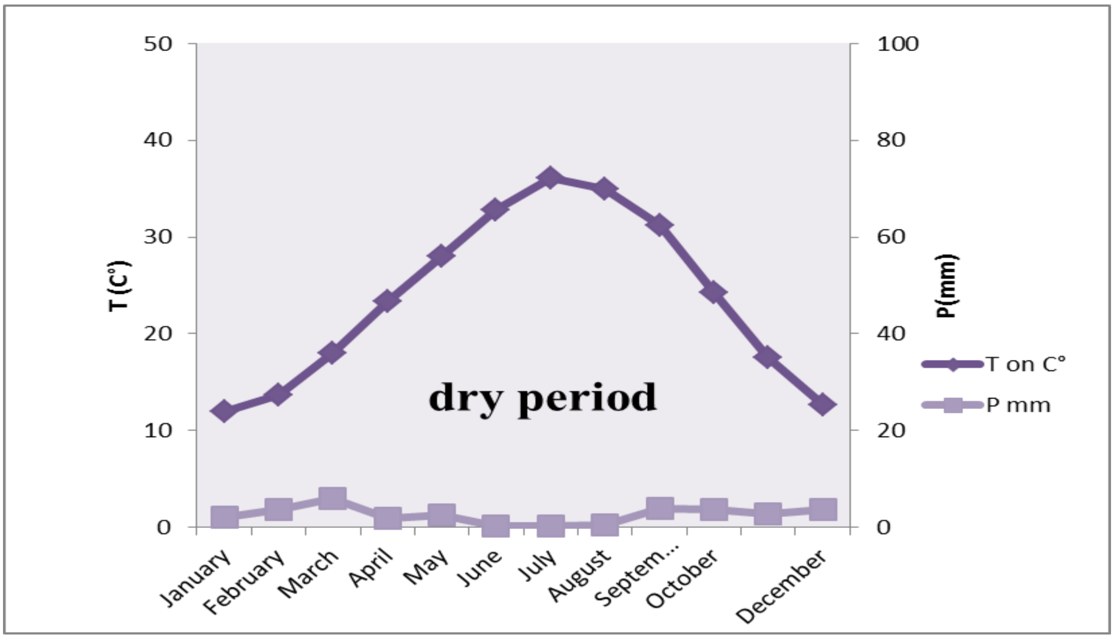

Fig 2. Ombrothermal diagram of ouargla region

II.2.8. Emberger climagram

Emberger climagram helps us discover the bioclimatic stage of the study station, it is summarized the equation:

Q=2000P/M2-m

Where

- P = precipitation
- M= temperature maximal of the hottest month
- m = temperature of the coldest month

The equation got evolved by STEWART for Algeria and morocco and we got this:

Q= 3.43(P/M-m)

After applying that equation we found **Q= 4.5** which mean the study station will be classified in the Sahara bioclimatic mild weather stage.

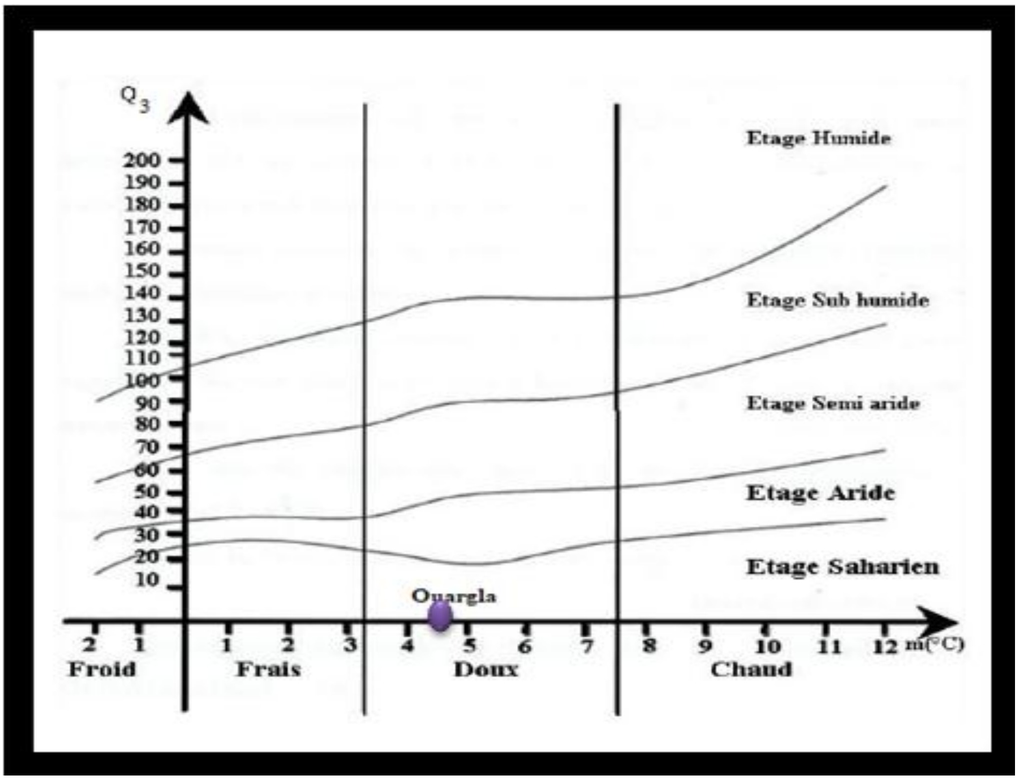

Fig 3. Emberger climagram of ouargla region

II.3. Geology of Ouargla region

The Ouargla area is part of the Lower Sahara, which is characterized by a more or less circular sedimentary infill with a diameter of 600 kilometers and appears as a synclinal basin. From the Cambrian to the Tertiary, all of the land outcrops on the borders, dropping behind the sedimentary layer mostly obscured by the vast eastern mountains. (A.N.R.H,2011).

Evaporates have formed on the Saharan platform on multiple occasions, most notably in the Triassic, but also in the Senonian. During the region's many tectonic occurrences, these formations imbued the soil they came into touch with salt and gypsum, causing extensive salt diffusion. (Gaucher *et al*, 1974).

The Ouargla basin corresponds to Wadi Mya, a low fossil (Quaternary) valley that descends from the Tademat plateau and terminates 20 kilometers north of Ouargla. The valley stretches for about 30 kilometers. (Hamdi-Aissa *et al*, 2000; Hamdi-Aissa *et al*, 2004).

II.4. Hydrogeology

The Ouargla basin is really the lower valley of the Oued M'ya, which drains into the SebkhatSafioune with the Oued M'zab and the Oued N'sa. It begins in the south with the ruins of Sédrata, the Ibadites' ancient capital, and finishes 40 kilometers north at the entrance to the SebkhatSafioune. (Faci,2017).

The Ouargla region's principal water supply is groundwater, which comes from four major aquifers. The depth of these several strata ranges from 100 to 1800 meters.

- There are three tiers in use:A table with salty water.
- Part of the Terminal Complex, which includes the Miopliocene and Senonian water tables.
- He Continental Intercalaire believes that subsurface water sources are virtually limitless. The major source is the northern Sahara aquifer system (SASS), which covers more than 700,000 km2 and is shared with neighboring provinces. (Rebah, 2016).

Since the shores pass from 158 m on the sandy veneers of Sédrata to 103 m at the bottom of the SebkhatSafioune, the whole slope is close to 1%. (Dubost, 2002).

II.5. Pedology of Ouargla region

The soil landscape of the basin is dominated mainly by the saline character (Idder, 2007). After Hamdi-Aissa *et al.*, (2004) the Reg plateau soils are classified as Yermic Calcisol, consisting of a gypsic crust overlain by a petrocalcic horizon. Soils on the upper slopes are covered by Hypogypsic Petrocalcaric and sandstone bedrock Regosol. Loose aeolian sand mixed with colluvial material, classified as a Yermic Arenosol are present on the piedmont. On the edges of the playa, soils are characterized by a surface or subsurface gypsic crust underlain by a calcareous crust lying on a secondary gypsic crust. These soils are classified as Hypogypsic/Petrocalcaric Solonchak, and Hyper/Petrogypsic Solonchak. In the center of playa, the soils are characterized by a wavy and bumpy surface salt crust, characterized by efflorescence and is classified as a Hypogypsic/Gypsiric Solonchak .

II.6. The flora

According to Ozenda (1983), plants are dispersed according to the type and structure of the soil, and we may locate Acacia vegetation in riverbeds, valleys, and the gueltas' surrounds.

Mostly "Drinn" or "Aristidapungens" in the Great Eastern Erg, with "Retamaretam", "Ephedra", "Genistasaharae" and "Caliganumazel" as shrub vegetation. - "Fagonia glutinosa" and "Fredolia arestoides" are found in Hamadas. Natural vegetation abounds in the oasis and farmed regions.

II.7. Palm groves

The palm grove, also known as the phoenicicole orchard, is a three-layered ecosystem. The date palm represents the most significant tree layer. (Idder *et al*, 2011).

The phoenicultural orchard (palm grove): It is a series of gardens that differ from one another in terms of design, fauna, flora, age, management, maintenance, microclimatic conditions, and so on... and which constitute a pretty large area that resembles a forest. (Idder *et al*, 2006 in Bouammar, 2007).

The Ouargla basin oasis is one of Algeria's most promising horticultural sites; it is made up of multiple palm groves covering a total area of 23,300 hectares and containing roughly 2,507,000 palm trees that produced 1,131,300 quintals of dates in 2015. (Sidab, 2015). Traditional gardens in this oasis, on the other hand, are characterized by chaotic and thick plantings, as well as excessive fragmentation. (Omeiri, 2016).

Chapter III

Materials and Methods

Introduction

In this chapter, we'll look at the SOM Principle and bulk density samples, as well as the approach we used for analysis. Finally, we'll look at the statistical research tests.

III.1. Experiments

III.1.1. Soil sampling

From February through March 2022, we began collecting soil samples. We obtained soil samples from different types of agro-system, both of cultivated and uncultivated soils, located at Hassi Ben Abdaalh and Hassi-Sayeh (Fig.4). We considered three types of agro-systems: greenhouse culture (GH), pivots culture (PV) and palm groves (PL) and no cultivated soil “control” (NC) (Fig.5). The sampling principle was that for each 1 hectare surface unit, we randomly selected 5 sub-samples at 10cm depth from different locations. The sub-samples were combined to have one sample per hectare (AFNOR, 1999) (Fig.5). We collected a total of 50 samples: 16 pivot (PV), 13 greenhouse (GH), 12 palm groves (PL) and 9 no cultivated soil “control” (NC) (Table IV).

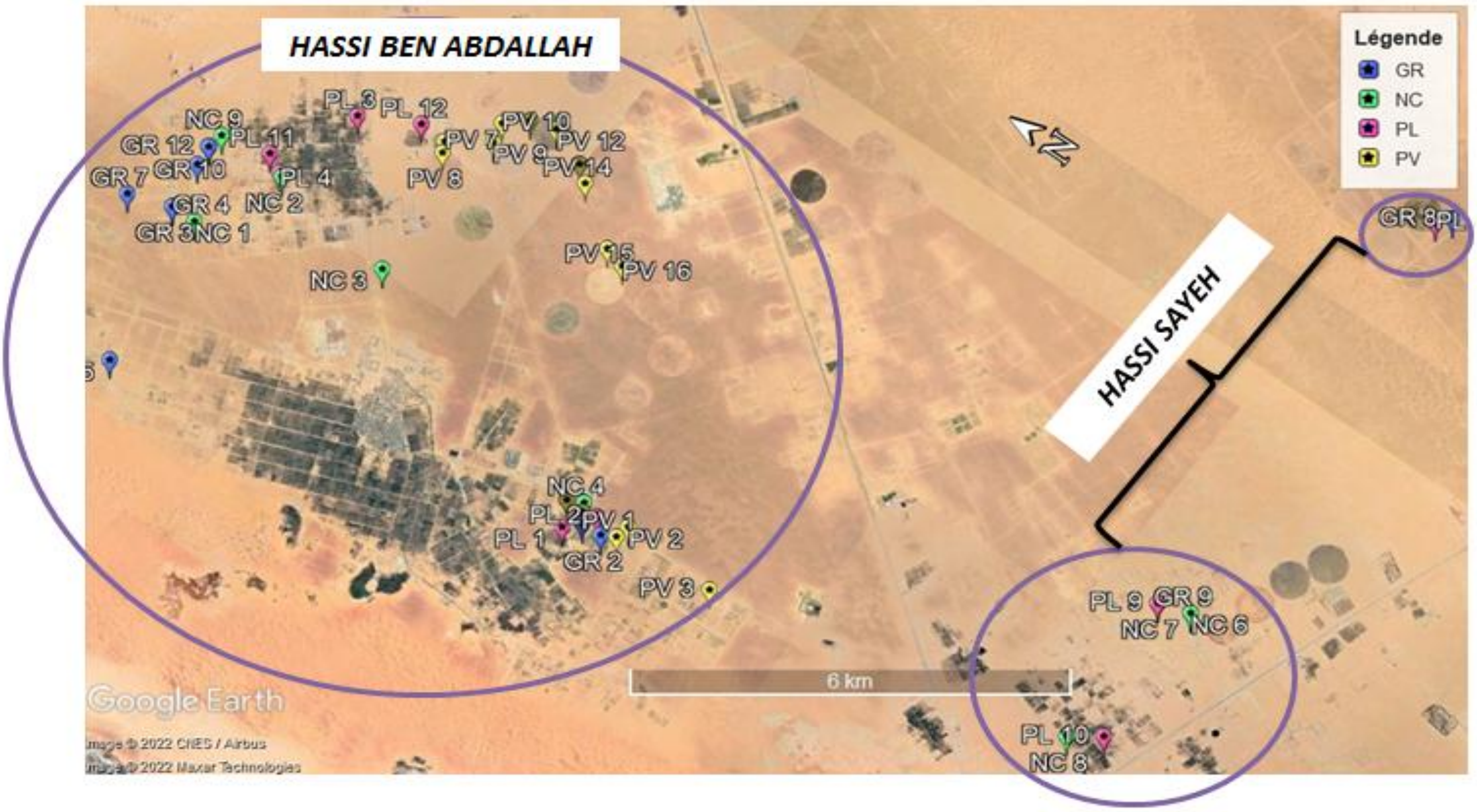

Fig 4 : The location of the studied sites

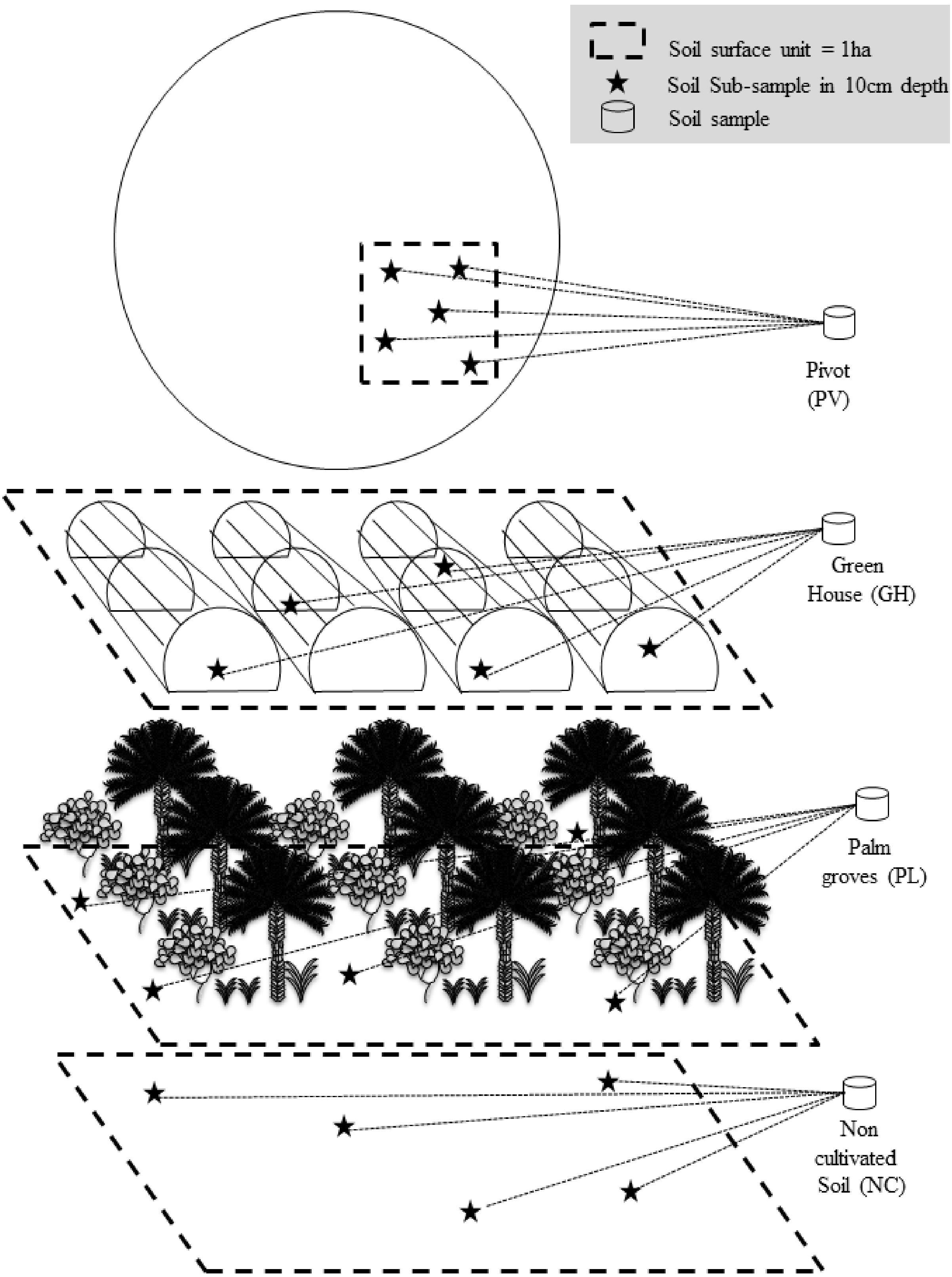

Fig 5. Sampling scheme at the four sub-surface unit in the study site

Table III. The different places of sampling

The soil's type	The sites chosen										
	HASSI BEN ABDELLAH										HASSI SAYEH
	BABZIZ	AGRODIVE 16	AGRODIVE 2	AGRODIVE 6	AGODIVE N	KHALIDJ	GENIFIDA1	GENIFIDA 2	GOURKOW	WIFAK	
Cultivated soil	PV1	PV7	PV9	PV11	PV13	GH3	GH5	GH7	GH10	PL6	GH9
	P V2	PV8	PV10	PV12	PV14	GH4			GH11	PL7	PL8
	PV3				PV15	GH6			GH12	SR8	PL9
	PV4				PV16	PL3			GH13		PL10
	PV5					PL4			PL11		
	PV6					PL5			PL12		
	GH1										
	GH2										
	PL1										
	PL2										
No cultivated soil						NC3	NC1			NC5	NC6
						NC4	NC2				NC7
											NC8
											NC9

Photo1.1. No cultivated soil
(HASSI BEN ABDELLAH)

Photo1.2. Cultivated soil “Palm”
(HASSI BEN ABDELLAH)

Photo1.5. Cultivated soil “greenhouse”
(HASSI BEN ABDELLAH)

Photo1.4. Cultivated soil “Pivot”
(HASSI BEN ABDELLAH)

Photo 1. Different studied Agro-system

III.1.2 Analyses of soil organic matter content in the soil

The Walkley-Black (WB) method was used to analyze SOM in the soil.

III.1.2.1. Walkley-black method

By oxidizing carbon with acidic dichromate, the Walkley-Black (WB) method (Walkley and Black, 1934) estimates soil organic carbon (OC) (Cr2O72-). Excess dichromate is titrated with ferrous sulfate after the oxidation stage. The difference between the total dichromate added and the quantity of dichromate remaining unreacted after OC oxidation is used to compute the OC. With assumptions on the proportion of soil OC reacted and the quantity of OC in soil OM, the approach yields an estimate of soil OM from OC determination. After its creation, this method was widely regarded as a standard method for OM, but its usage has been reduced due to the introduction of thermal decomposition equipment. In addition, loss on ignition and thermal decomposition procedures are becoming increasingly popular due to their capacity to test samples more quickly.

III.1.2.2 Calculate the SOC and the SOM rate

a. Easily Oxidizable Soil Organic C

$$\mathrm{SOC\%} = \frac{(\mathrm{B}-\mathrm{S}) \times \mathrm{M\ of\ F}e^{+2} \times 100}{\mathrm{g\ of\ soil.}\,4000}$$

B = mL of Fe^{2+} solution used to titrate blank.

S= mL of Fe^{2+} solution used to titrate sample.

12/4000 = mill equivalent weight of C in g.

b. Soil organic matter total

S**OM (%) =** % total C x 1.72

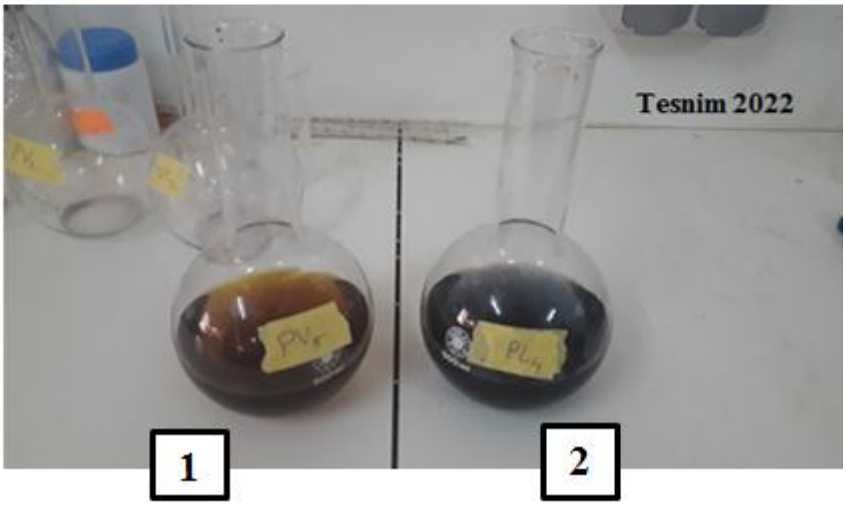

Photo 2. the color obtained of sampling before titration (1) and after titration (2)

III.2.2.3The Bulk density

One of the soil's properties is bulk density, often known as apparent density. The bulk density is defined as the weight of the soil particles divided by the overall weight of the soil (g/cm^3).

The bulk density soil samples were collected using a cylindrical ring with a base diameter of 5 cm and a height of 5cm, and then dried at 105°C for 24 hours

bulk density is important for understanding the physical, chemical, and biological properties of soil.(Ahmed Abed Gatea *et al*,2018).

According to Katharine Brown and Andrew Wherrett,(2022) the BD will be calculate by using the equation bellow**:**

$$\text{Bulk density g/cm}^3 = \frac{\text{Oven dry weight of soil}}{\text{Volume of soil}}$$

III.2.2.4 Calculate the SOCD

SOC density (kg·m-2) was estimated based on SOC content (g g-1), soil Bulk Density (BD, g cm-3), and soil depth (cm) by using the following equation:

SOC density= SOC x BD x soil depth x10

Soil BD was estimated based on soil texture using a soil parameter calculator (Sardegna, 2018 in Boubehziz *et al* ,2020).

III.2.3 The statistic study

Data were analyzed using the statistical analysis software (XLSTAT 2014.5.03). Analysis of variance (ANOVA) and the Discriminant analysis were conducted to test the significance of OM, OC and BD rate in the different agro-systems sampled.

Chapter IV

Results and Discussions

IV.1. Results

IV.1.1. Soil organic matter

We summarized the results of SOM and SOC at different agro-systems of the studied area in the diagrams.

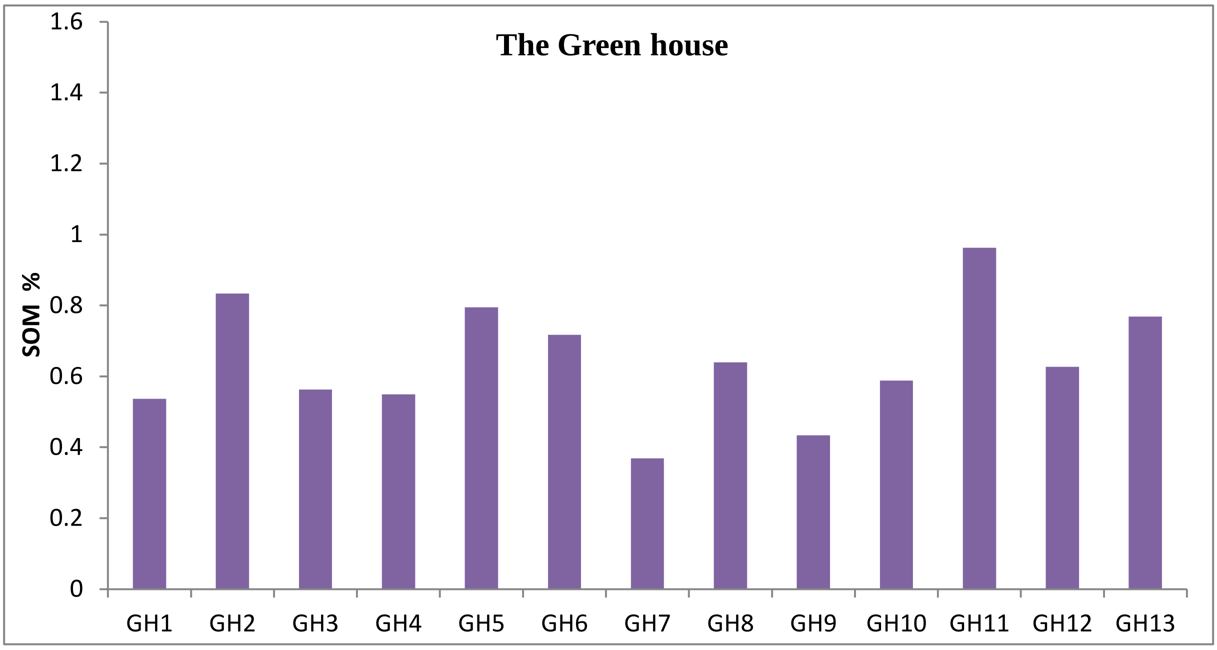

Fig 6.The rate of SOM in the greenhouse.

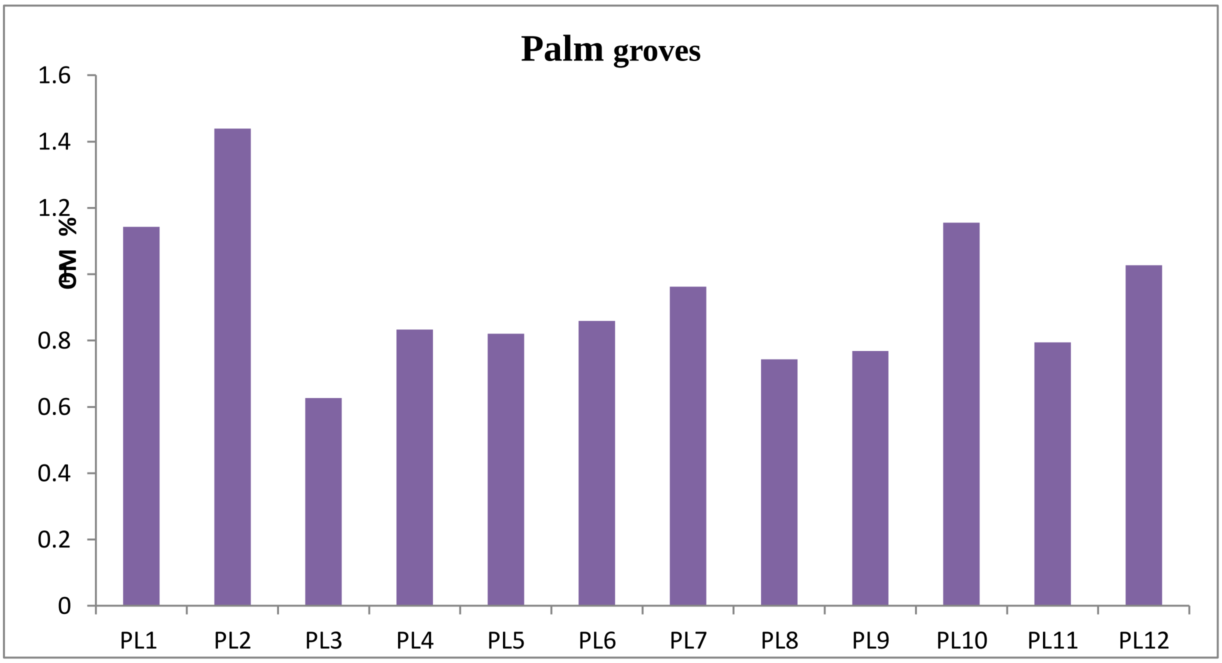

Fig 7. The rate of SOM in the palm groves.

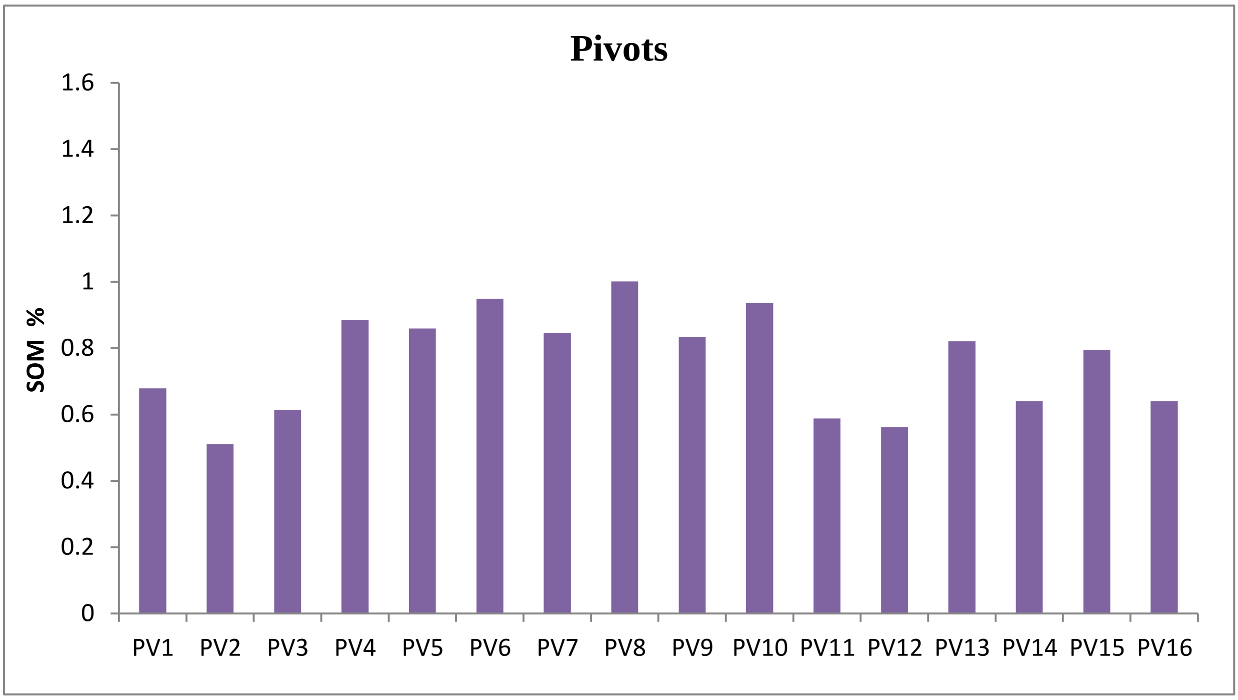

Fig 8.The rate of SOM in the pivots

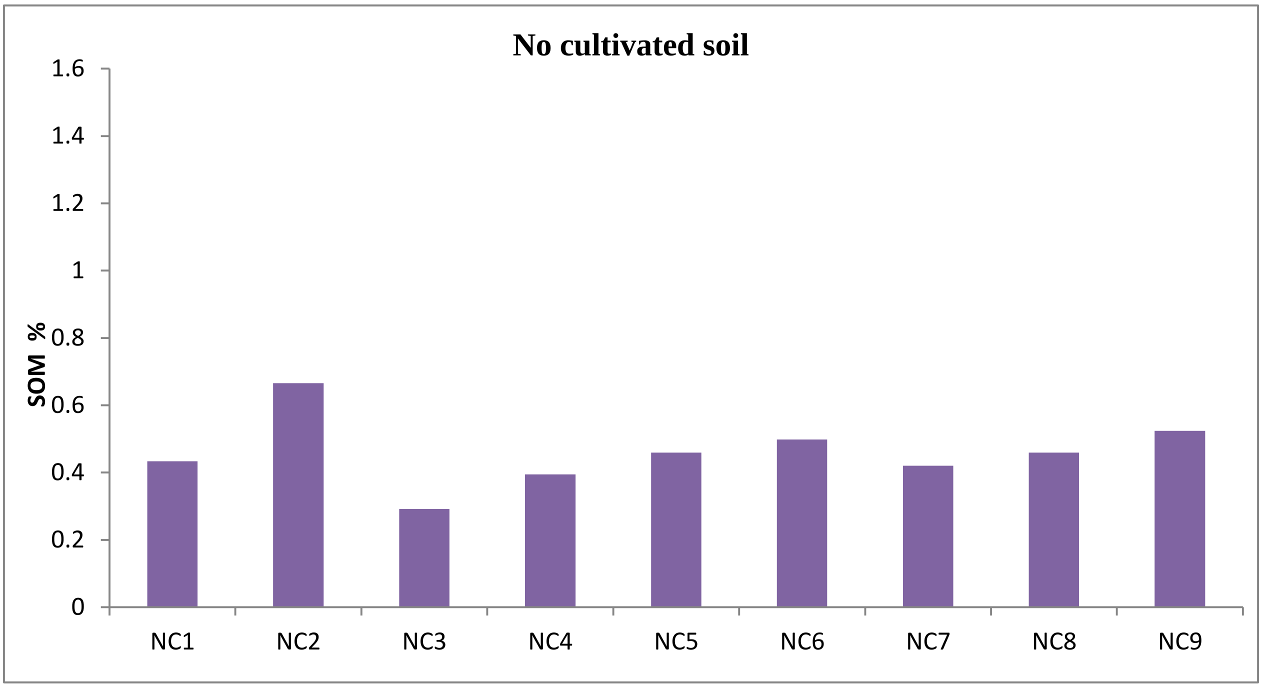

Fig 9. The rate of SOM in the naturel soil.

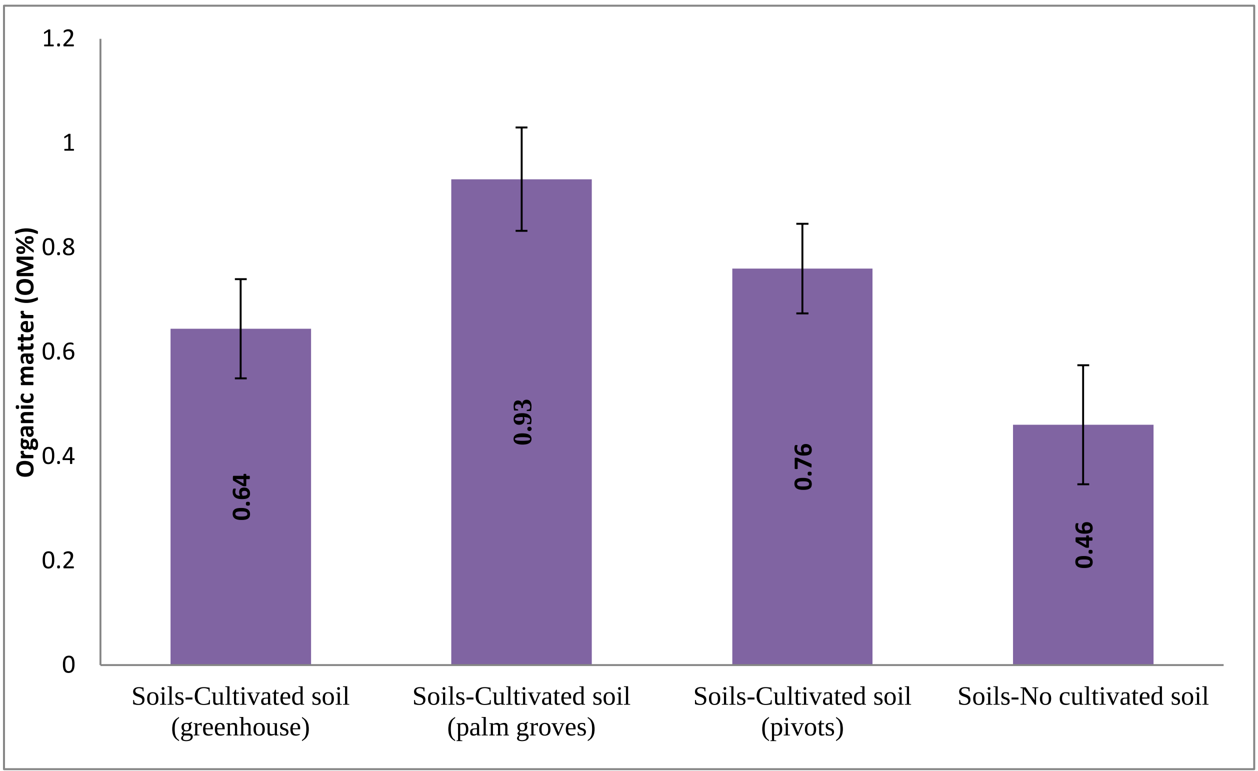

Fig 10.The total rate of SOM (%)

The diagrams represent the rate of the SOM (%) and SOC (%) in all the studied sites, the (Fig 6,Fig7, Fig8 and Fig 9) show the cultivated soil in different agro-system chosen, the greenhouse, palm groves, pivot and the no cultivated soil respectively, The total rate of SOM in the different Agro- systems represents in (Fig10).

The first diagram (Fig6) shows the rate of SOM (%) in the greenhouse culture. The higher rate recorded in GH11 (GOUR KOW), HASSI BEN Abdellah station with 1(%), and the low rate of SOM% recorded in GH7 in (Genifida), Hassi Ben Abdellah station (AnnexI).

the second diagram (Fig7) reveals t the SOM % rate in the palm groves, the higher is 1.4 (%) recorded in PL2 (BABZIZ farm), Hassi Ben Abdellah station and the low rate of SOM(%) in PL3 in khalidj region with 0.6(%)(annex I).

The third diagram is showing the rate of SOM% in the pivots culture (Fig 8), we observe that the higher rate is 1% listed in Agrodive 16, Hassi Ben Abdallah station. The low rate of OM% recorded in PV2 (Fig 16) with 0.5(%) in Babzize farm,Hassi Ben Abdallah station (annex I).

The fourth diagram represents the rate of SOM (%) in natural soil we notice that the higher rate was in NC2 with 0.7% in the Genifida, Hassi Ben Abdullah Station. NC3 (Fig9) got the low rate with 0.3% in Khalidj Ocean, Hassi Ben Abdellah station (annex I).

(Fig 10) shows the total rate of SOM% in the two types of soil the cultivated soil and the no cultivated soil, it's also shows the agro-system chosen as we can see that the palm groves (PL) got the higher rate of SOM% with 0.9, then after it the pivots (PV) culture that recorded 0.7.the next is the greenhouse culture (GH) (annexIII) that got 0.6. The last is the no cultivated soil recorded between 0.4 and 0.5 (%).

IV.1.2. Distribution of SOM in different Agro-systems

The significance difference and the relationship between SOM and the different Agro systems' soils (pivots, greenhouse, palm groves and no cultivated soil) was analyzed by the discriminate analyses and ANOVA test.

In the discriminate test, the three Agro-systems in each sample plot were close to each other but were far away from those in other sample plots (no cultivated soil) (Fig11).

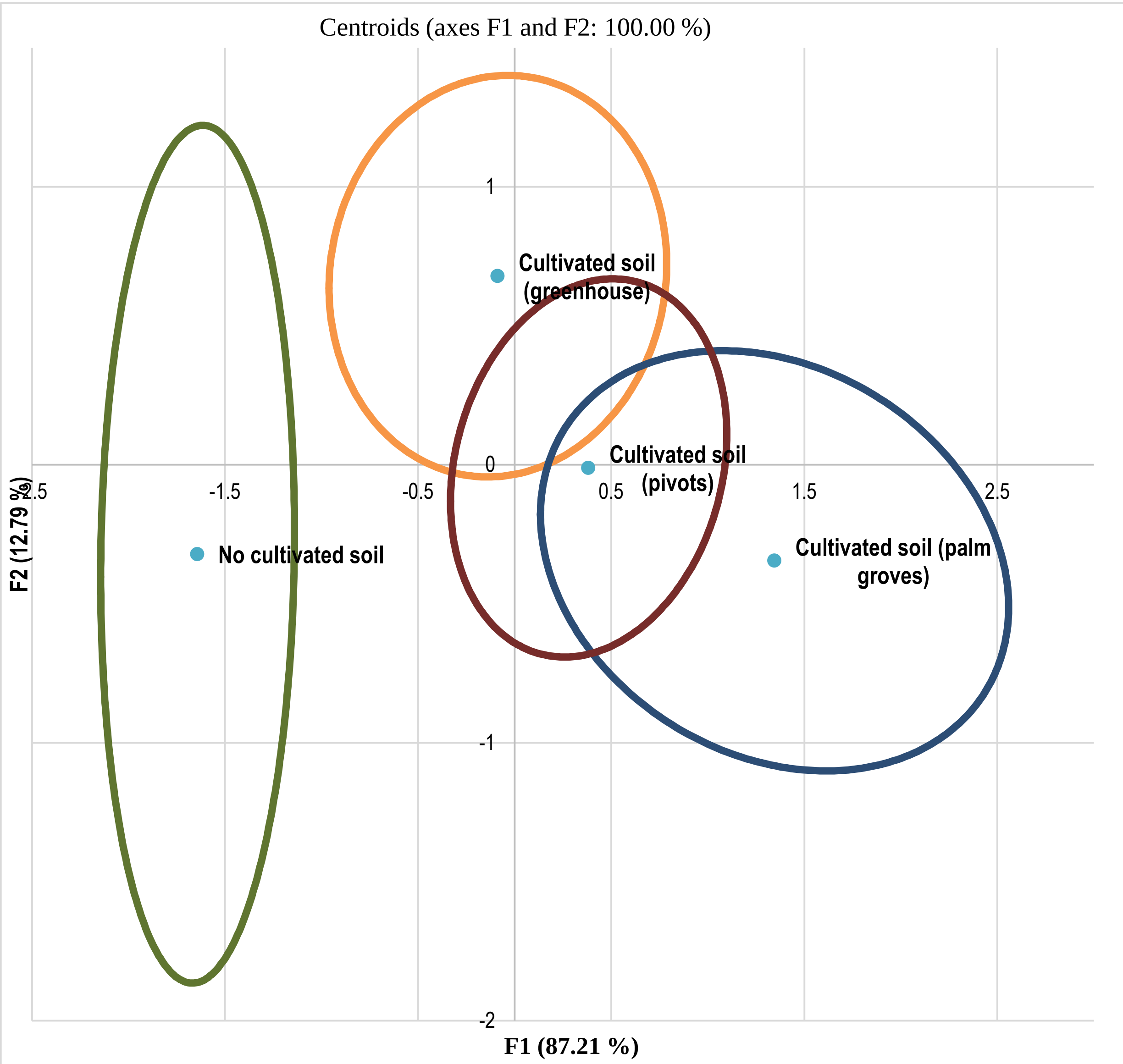

Fig 11.The discriminant results test

Table IV. Fisher test (LSD) Analysis of the differences between the categories

Category	LS Means
No cultivated soil	0,46[A]
Cultivated soil (greenhouse)	0,64[B]
Cultivated soil (pivots)	0,76[A, B]
Cultivated soil (palm groves)	0,93[C]

LSD-value (0.05) =0.14 Means carrying the same alphabets are not significantly different

The LSD mean of SOM in the different Agro-system showed they were significantly different from each other.

This may suggest that SOM is significantly different among the different Agro-system and the SOM distribution was affected by land use and is mainly influenced by the sparse vegetative cover, we observed during sampling.

IV.1.3.The bulk density results

The bulk density results of the samples summarized in the diagram bellow:

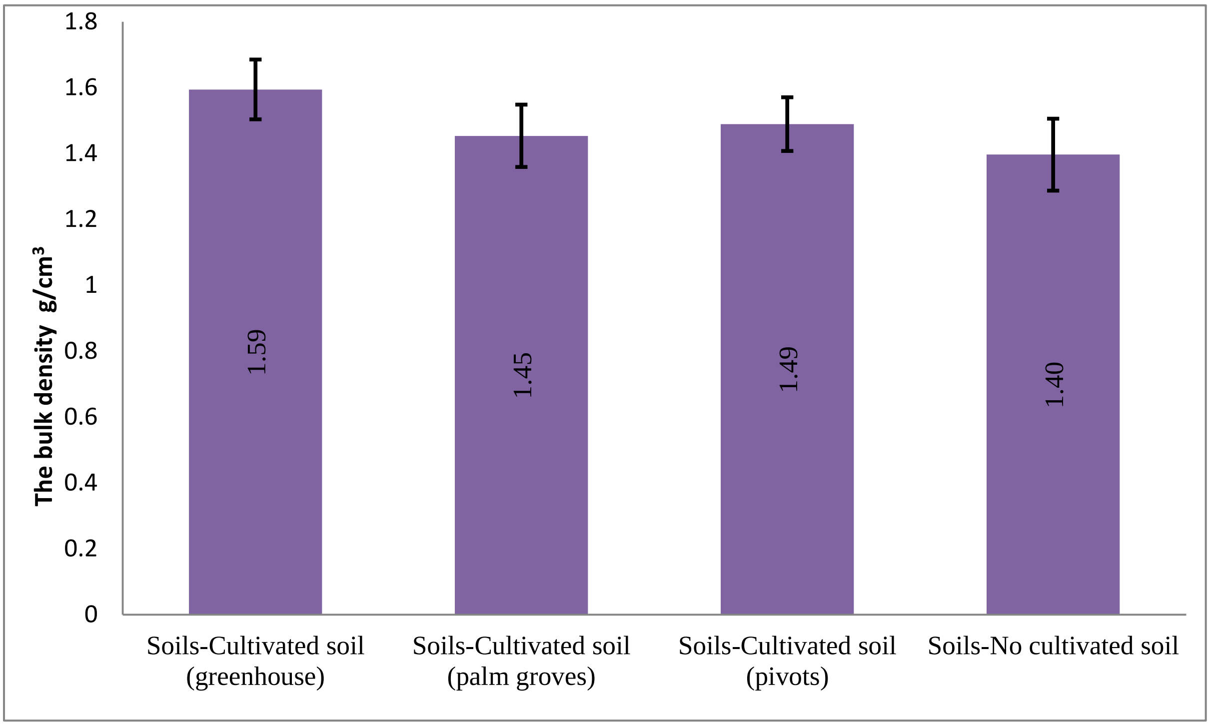

Fig 12. the bulk density total

(Fig 11) shows the bulk density of soil, we notice that the higher rate of BD recorded in NC with BD (1.53g/cm^3), the pivot (PV) with BD (1.52g/cm^3), the greenhouse (GH) recorded BD (1.50g/cm^3) and the palm groves (PL) recorded the low rate with BD (1.48g/cm^3).

IV.2. Discussion

IV.2.1.rates of organic matter in the agro-system's type

The Ouargla region's soils have a low organic matter level (0.1-0.9 %) (Halilat, 1993)

When comparing the many stations evaluated after a walkley-black analysis, we noticed that the organic matter content ranged between low and very low levels.

According to (Djili, 2002), the organic matter rates in the examined region are low to extremely low

The following are the several types of organic matter content:

2 (%) >OM (%) < 1(%) will be classified in low content classes.

OM (%) < 1(%) will be classified in Very low content classes.

Table X. the samples classes

The soil	the class	The samples
PALM GROVES	Low content classes	PL1 PL2 PL10 PL12
	Very low content classes	PL3 PL4 PL5 PL6 PL7 PL8 PL9 PL11
GREEN HOUSE	Very low content classes	GH1 GH2 GH3 GH4 GH5 GH6 GH7 GH8 GH9 GH10 GH11 GH12 GH13
PIVOTS	Low content classes	PV8
	Very low content classes	PV1 PV2 PV3 PV4 PV5 PV6 PV7 PV9 PV10 PV11 PV12 PV13 PV14 PV15 PV16
NATURAL SOIL	Very Low content classes	NC1 NC2 NC3 NC4 NC5 NC6 NC7 NC8 NC9

(Table X) shows the SOM (%) sample classes. We notice that the palm groves had a greatest rate of SOM% comparing to the pivots, greenhouse and no cultivated soil were they all categorized as extremely low content of SOM (%) class.

According to Daddi Bouhoun (2010) soils of the Sahara have a coarse texture, weak structure, and low organic matter content and according to Schjonning *et al* (2004), soil's ability to retain organic matter is influenced by a variety of elements including climate, geography, and texture. Furthermore, sandy soils are too aerated, allowing organic matter to decay more quickly (Karabi *et al*, 2016). Sandy soils in dry places have poor fertility due to a very low nutritional supply, which can be explained by a lack of organic matter. (Babaarbi, 2013).

All of the soils in the Ouargla region have low levels of O.M organic matter, with rates ranging from 0.1 to 0.9. (HALILAT, 1993).

The climatic conditions in these areas did not allow for the storage of organic matter, and the few that did were swiftly destroyed by physico-chemical factors, preventing microorganisms from contributing to the evolution of soil organic matter. **(**Sasson, 1967;Zombre, 2006; Nicolas *et al*, 2012).

Organic matter contents are very low and nearly zero in certain sections of bare soils, according to Al-Busaidi *et al*, 2014 and Bekkari *et al*, 2016. This is owing to the absence of organic matter sources; the vegetative cover in spontaneous plants is quite sparse. In a developed environment SOM is mostly derived from manure used in palm groves and crop leftovers, primarily palm date; this explains the wide range of organic matter content in the agro-system palm groves.

Because of the sandy texture, the carbon sequestration potential and water retention capacity are both reduced (Kösters *et al*, 2013). Because of the coarse texture, soil organic carbon levels are vulnerable to erosion and fast mineralization (Lobe *et al*, 2001; Bruand *et al*, 2005 in Mlih *et al*, 2015)**.** In the case of able soils, up to 4.7% of organic carbon might be lost yearly in the Sahara area (Karabi, 2016).

The development of well-humified soil organic matter and stable organo-mineral complexes is limited by the coarse texture of the soils. It is well understood that in coarse-textured soils of dry and semi-arid regions, organic matter turnover is quick, and that only a tiny quantity of new organic waste contributes to the creation of SOM (Karabi, 2016).

IV.2.2.The bulk density rates

Bulk density is a fundamental soil attribute that is influenced by soil texture, mineral density (sand, silt, and clay), and organic matter density. (Tanveera *et al*, 2016).

Bulk density is affected by factors such as water, aeration status, root penetrate, clay content, texture, land use and management, therefore it is a very important soil parameter (Sakin, 2012).

According to Katharine Brown and Andrew Wherrett sandy soils usually have higher bulk densities (1.3–1.7 g/cm^3) than fine silts and clays (1.1 – 1.6 g/cm^3) because they have larger, but fewer, pore spaces. In clay soils with good soil structure, there is a greater amount of pore space because the particles are very small, and many small pore spaces fit between them.

So we can have this classification for our soil samples:

The three agro-system: pivots, greenhouse and palm groves in the cultivated soil will be classified in sandy soil group because their densities between 1.1 g/cm^3 to 1.80 g/cm^3. The no cultivated will classified also in the sandy soil group because the BD between 1.2g/cm^3 to 1.85 g/cm^3.

Organic matter-rich soils can have densities of less than 0.5 g/cm^3.(Katharine *et al* 2018).

The quantity of organic matter in soils, as well as the texture, component minerals, and porosity, all impact it. Soil bulk density is crucial for soil management, and knowledge of it is crucial in both soil compaction and the development of current agricultural systems (Chaudhari *et al*, 2013).

Sand content has a greater impact on soil bulk density than the other soil parameters (Tanveera *et al*, 2016).

Table VI. The difference of SOCD (kg.m−2) in the different Agro-system.

SOC Density ($kg.m^{-2}$) (Mean ± Standard Error Mean)			
NC	PL	GH	PV
0,37 ± 0,02	0,78 ± 0,05	0,59 ± 0,04	0,65 ± 0,03

IV.2.2.1 Soil Organic Carbon Density

By combining SOC concentration, bulk density and soil depth thickness, we estimated the SOC density Equation (2).

The mean SOCD values for the different agro-system ranged from 0, 78 $kg·m^{-2}$ under Cultivated soil palm groves, 0, 65 $kg·m^{-2}$ under Cultivated soil pivots, 0, 59 $kg·m^{-2}$ Cultivated soil greenhouse and 0, 37 $kg·m^{-2}$ under No cultivated soil (Table XI).

According to Li *et al*, 2012 land-use and vegetation cover have a major influence on the global C balance through different SOC accumulation and turnover. The finding shows that the distribution of the organic carbon density in the Ouargla region is mainly affected by land use type. The high-density areas are most closely associated with palm groves and the low-density areas are most closely associated with No cultivated soil. However, the result of Brahim *et al*, 2021 in oasis agro-system of southern Tunisian shows an important rate of SOC density (3.14 $kg.m^{-2}$) comparing with our results, we suggest that is related to the production of seasonal adjacent crops underlying palm groves.

SOC in dry lands has been shown to be related to the vegetation type and particularly to the presence of trees and their biomass production (Olsson and Ardö, 2002).

Conclusion

Conclusion

As a final observation we made this work to evaluate the SOM in two types of soil cultivated soil and no cultivated soil in Ouargla area, in the cultivated soil. This research focuses on the evaluation of the OM in different agro-system's type, Greenhouse (GH), Palm groves (PL) and pivots (PV), also the no cultivated soil (control).

From the study it can be conclude that the SOM in palm groves was higher (1%), the greenhouse had the lowest SOM (0.6%) and the pivots had the medium rate of SOM (0.8%), the uncultivated soil has the poor rate of SOM (0.4%).

Generally the palm groves are one of the effective measures to sequester organic carbon comparing to the greenhouse, pivots and no cultivated soil in the Sahara agro-system. The results obtained shows that the palm groves (PL) is the most conservator of SOC we found (0.80 $kg.m^{-2}$). Moreover the greenhouse (GH) is the lowest agro-system's type when it comes to the conservation of SOC (0.60 $kg.m^{-2}$), furthermore the no cultivated soil is so much poor SOC<0.4 $kg.m^{-2}$.

The bulk density that we got it in the end that the palm groves had the lowest rate of BD (1.4g/cm^3), the greenhouse had the higher rate of BD (1.7 g/cm^3).

In short whenever the OM rate is higher we find the bulk density is low and the opposite

Recommendation

We began this work to compare the SOM in Ouargla region in different agro-system's presents in the Ouargla area, and we found that the greenhouse and pivots had the lowest rate of SOM on a final note:

In the perspective of this work we suggest the evaluation of SOM within each studied agro-system (i.e. PL, GH and PV) considering crop's type, seasonal variation, agricultural practice and soil typology

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Annex

Annex I. Represent SOC% and SOM% in different agro-system of Hassi Ben Abdallah station.

HASSI BEN ABDALLAH			
Station	**Soil samples**	**SOC (%)**	**SOM (%)**
BABZIZ	PV1	0.39	0.67
	PV2	0.29	0.51
	PV3	0.35	0.61
	PV4	0.51	0.88
	PV5	0.49	0.85
	PV6	0.55	0.94
	GH1	0.31	0.53
	GH2	0.48	0.83
	PL1	0.66	1.14
	PL2	0.83	1.43
AGRODIVE 16	PV7	0.49	0.84
	PV8	0.58	1
AGRODIVE 2	PV9	0.48	0.83
	PV10	0.54	0.93
AGRODIVE 6	PV11	0.34	0.58
	PV12	0.32	0.56
AGRODIVE N	PV13	0.47	0.82
	PV14	0.37	0.63
	PV15	0.46	0.79
	PV16	0.37	0.63
KHALIDJ	NC3	0.16	0.29
	NC4	0.22	0.39
	GH3	0.32	0.56
	GH4	0.31	0.54
	GH6	0.41	0.71
	PL3	0.36	0.62
	PL4	0.48	0.83
	PL5	0.47	0.82

GENIFIDA	NC1	0.25	0.43
	NC2	0.38	0.66
	GH5	0.46	0.79
GENIFIDA	GH7	0.21	0.36
GOUR-KOW	GH10	0.34	0.58
	GH11	0.55	0.96
	GH12	0.36	0.62
	GH13	0.44	0.76
	PL11	0.46	0.79
	PL12	0.59	1.02
WIFAK	NC5	0.26	0.45
	PL6	0.49	0.85
	PL7	0.55	0.96
	GH8	0.37	0.63

Annex II: Represent SOC (%) and SOM in different agro-system of HASSI SAYIEH station.

HASSI SAYEH		
Soil Samples	**SOC (%)**	**SOM(%)**
GH9	0.43	0.43
PL8	0.43	0.74
PL9	0.44	0.76
PL10	0.67	1.15
NC6	0.28	0.49
NC7	0.24	0.42
NC8	0.26	0.45
NC9	0.30	0.52

Annex III. The total rate of SOC (%) and SOM (%) in cultivated and no cultivated soil

Soil samples	SOC (%)	SOM (%)
PL	0.931165	0.541375
GH	0.64480154	0.37488462
PV	0.75997125	0.44184375
NC	0.46067333	0.26783333

Annex VI. The bulk density of the sampling

The soil samples	The bulk density
PV1	1.50 g/cm^3
PV2	1.19 g/cm^3
PV3	1.56 g/cm^3
PV4	1.55 g/cm^3
PV5	1.41 g/cm^3
PV6	1.49 g/cm^3
PV7	1.21 g/cm^3
PV8	1.46 g/cm^3
PV9	1.46 g/cm^3
PV10	1.57 g/cm^3
PV11	1.79 g/cm^3
PV12	1.53 g/cm^3
PV13	1.64 g/cm^3
PV14	1.71 g/cm^3
PV15	1.38 g/cm^3
PV16	1.38 g/cm^3
GH1	1.60 g/cm^3
GH2	1.60 g/cm^3

GH3	1.60 g/cm^3
GH4	1.54 g/cm^3
GH5	1.50 g/cm^3
GH6	1.50 g/cm^3
GH7	1.81 g/cm^3
GH8	1.44 g/cm^3
GH9	1.70 g/cm^3
GH10	1.28 g/cm^3
GH11	1.70 g/cm^3
GH12	1.73 g/cm^3
GH13	1.73 g/cm^3
PL1	1.18 g/cm^3
PL2	1.51 g/cm^3
PL3	1.66 g/cm^3
PL4	1.28 g/cm^3
PL5	1.40 g/cm^3
PL6	1.44 g/cm^3
PL7	1.60 g/cm^3
PL8	1.58 g/cm^3
PL9	1.46 g/cm^3
PL10	1.49 g/cm^3
PL11	1.41 g/cm^3
PL12	1.43 g/cm^3
NC1	1.24 g/cm^3
NC2	1.15 g/cm^3
NC3	1.85 g/cm^3
NC4	1.47 g/cm^3
NC5	1.35 g/cm^3
NC6	1.31 g/cm^3
NC7	1.23 g/cm^3
NC8	1.62 g/cm^3
NC9	1.33 g/cm^3

Annex V. the bulk density total

The soil	BD g/cm
PL	1.49 g/cm^3
GH	1.50 g/cm^3
PV	1.52 g/cm^3
NC	1.52 g/cm^3

Annex VI: the location of all sites.

HASSI BEN ABDEALLAH			
Station	**Soil Samples**	**Latitude N**	**Longitude E**
BABZIZE	PV1	31°59'32.53''N	05°28'21.76''E
	PV2	31°59'31.53''N	05°28'29.74''E
	PV3	31°59'36.65'N	05°28'25.99''E
	PV4	31°59'51.52''N	05°28'22.8''E
	PV5	31°59'53.94''N	05°28'27.35''E
	PV6	32°00'00.44''N	05°28'23.43''E
	GH1	31°59'48.33''N	05°28'17.23''E
	GH2	31°59'3867''N	05°28''17.84''E
	PL1	31°59'54.7''N	05°28'09.8''E
	PL2	31°59'45.18''N	05°28'24.94''E
AGRIDIVE16	PV7	32°02'24.17''N	05°30'29.44''E
	PV8	32°02'21.8''N	05°30'23.62''E
AGRODIVE2	PV9	32°02'06.37''N	05°30'43.7''E
	PV10	32°02'08.49''N	05°30'55.21''E
AGRODIVE6	PV11	32°01'59.03''N	05°31'05.1''E
	PV12	32°01'47.26''N	05°31'08.98''E
AGRODIVE N	PV13	32°01'28.94''N	05°31'00.1''E
	PV14	32°01'21.62''N	05°30'52.96''E
	PV15	32°00'55.45''N	05°30'29.82''E
	PV16	32°00'45.3''N	05°30'26.46''E
ELKHALIDJ OCEAN	GH3	32°03'44.47''N	05°28'36.87''E
	GH4	32°03'44.47''N	05°28'36.87''E

	GH6	32°04'10.87"N	05°31'34.13"E
	PL3	32°03'02.96"N	05°30'14.68"E
	PL4	32°03'15.29"N	05°29'24.99"E
	PL5	31°56'23.84"N	05°29'24.74"E
	NC3	05 32°02'11"N	05°29'12.22"E
	NC4	31°59'53.53"N	05°28'27.44"E
	GH5	32°03'23.93"N	05°27'08.27"E
GENIFIDA1	NC1	32°03'32.25"N	05°28'36.91"E
	NC2	32°03'13.24"N	05°29'23.74"E
GENIFIDA2	GH7	32°04'04.38"N	05°28'29.08"E
	GH10	32°03'47.33"N	05°29'03.64"E
	GH11	32°03'48.15"N	05°29'15.36"E
	GH12	32°03'48.12"N	05°29'15.19"E
GOUR-KOW	GH13	32°03'41.75"N	05°29'24.24"E
	PL11	32°03'24.08"N	05°29'30.72"E
	PL12	32°02'37.49"N	05°30'30.31"E
	NC9	32°03'46.66"N	05°29'24.27"E
	PL6	31°55'26.39"N	05°34'35.5"E
WIFAK OCEAN	PL7	31°56'03.46"N	05°34'53.23"E
	GH8	31°55'58.22"N	05°35'00.07"E
	NC5	31°53'54.23"N	05°34'53.2"E
	GH9	31°55'45.78"N	05°30'40.41"E
	PL8	31°53'54.23"N	05°35'49.24"E
	PL9	31°56'00.28"N	05°30'34.95"E
HASSI ELSAIEH	PL10	31°55'43.69"N	05°29'18.6"E
	NC6	31°55'45.78"N	05°30'40.41"E
	NC7	31°56'00.28"N	05°30'34.95"E
	NC8	31°55'57.01"N	05°29'07.41"E
	GH9	31°55'45.78"N	05°30'40.41"E
	PL8	31°53'54.23"N	05°35'49.24"E
	PL9	31°56'00.28"N	05°30'34.95"E
HASSI ELSAIEH	PL10	31°55'43.69"N	05°29'18.6"E
	NC6	31°55'45.78"N	05°30'40.41"E
	NC7	31°56'00.28"N	05°30'34.95"E
	NC8	31°55'57.01"N	05°29'07.41"E

Abstract:

Many scientists' attention has been drawn to the spatial distribution of carbon in the terrestrial ecosystem as a result of global change research. Meanwhile, the distribution of SOM in the various agro-systems of the Ouargla region's soils is poorly known. The research aims the evaluation SOM in the Ouargla region considering two types of soils: cultivated and uncultivated soil. We chose three types of agro-systems for the cultivated soil: palm groves (PL), greenhouses (GH) and pivots (PV). Soil samples were collected at HASSI BEN ABDELLAH and HASSI SAYAH stations. We adopted the Walkley-Black method to analyze the organic matter rate. The soil bulk density was determined in order to identify the soil organic carbon density, $Kg.m^{-2}$. The result shows that the SOM in cultivated soil was higher than in uncultivated soil. Palm groves had the highest rate of organic matter (1%) in cultivated soil types. Pivots had the second highest rate of organic matter (0.8%), and the greenhouse had the lowest rate of organic matter (0.6%). The uncultivated soil has the poorest rate of SOM (0.4%). The findings show that the palm groves (PL) are the greatest sequestration of SOC (0.80 $kg.m^{-2}$). Moreover, the greenhouse (GH) is the lowest agro-system type when it comes to the conservation of SOC (0.60 $kg.m^{-2}$).

KEY WORDS: soil organic carbon, agriculture, oasis, land use, Sahara desert, Ouargla.

Résumé : Evaluation de la matière organique du sol dans les différents agrosystèmes de la région d'Ouargla

La recherche sur le changement global a attiré l'attention de nombreux scientifiques sur la distribution spatiale du carbone dans les écosystèmes de la Terre. D'autre part, on sait peu de choses sur la répartition de la matière organique dans les différents Agro-systèmes de la région d'Ouargla L'étude s'est concentrée sur l'évaluation de la matière organique dans deux types de sols dans la région de Ouargla : les sols cultivés et non cultivés. Nous avons sélectionné trois types d' Agro-systèmes pour le sol Cultivé : Palmeraie, Serre et Pivot. Des échantillons de sol ont été collectés aux stations HASSI BEN ABDUAALH et HASSI SAIEH. Nous avons utilisé la méthode Walkley-Black pour analyser le taux de matière organique. La densité apparente du sol a été déterminée pour calculer la densité de carbone organique du sol, Kg.m-2. La teneur en matière organique du sol cultivé est plus élevée que celle des sols non cultivés (0,4 %). Les palmeraies ont la teneur en matière organique la plus élevée (1%) des types de sols cultivés. Le Pivots est en deuxième (0,8 %) et la serre a la plus faible teneur en matière organique (0,6 %). Les résultats ont montré que l'Agro-système palmeraie (PL) est le plus grand conservateur de COS (0,80 $kg.m^{-2}$). De plus, l'Agro-système serre (GH) est le type de système agricole le moins séquestreur de COS (0,60 $kg.m^{-2}$).

Mots Clés : carbone organique de sol, Agriculture, Oasis, terrain, Sahara désert, Ouargla.

الملخص: تقييم المادة العضوية في التربة في مختلف أنواع الأنظمة الزراعية في ولاية ورقلة

تم لفت انتباه العديد من العلماء إلى التوزيع المكاني للكربون في النظام الإيكولوجي الأرضي نتيجة لأبحاث التغيير العالمي. وفي الوقت نفسه، فإن توزيع المادة العضوية في مختلف الأنظمة الزراعية لتربة منطقة ورقلة غير معروف بشكل جيد. يركز البحث على تقييم المواد العضوية في منطقة ورقلة في نوعين من التربة: التربة المزروعة والتربة غير المزروعة. اخترنا ثلاثة أنواع من الأنظمة الزراعية للتربة المزروعة: بساتين النخيل، البيوت البلاستيكية والمرش المحوري . تم جمع عينات التربة في منطقتي حاسي بن عبد الله و حاسي السايح . لقد اعتمدنا طريقة Walkley-Black لتحليل معدل المادة العضوية. تم تحديد كثافة التربة السائبة من أجل تحديد كثافة الكربون العضوية في التربة، $Kg.m^{-2}$. وكان معدل المواد العضوية في التربة المزروعة أعلى منه في التربة غير المزروعة. كان للنخيل أعلى معدل للمواد العضوية (1. كان لدى المرش المحوري ثاني أعلى معدل للمواد العضوية (0.8٪)، وكان لدى البيوت البلاستيكية أقل معدل للمواد العضوية (0.6٪). التربة غير المزروعة لديها المعدل الأقل فيما يخص بالمادة العضوية في التربة (0.4٪).

النتائج أظهرت أن النخيل هم الأفضل في الاحتفاظ بالكربون العضوي 0.80 $kg.m^{-2}$ علاوة على ذلك فإن البيوت البلاستيكية هي النظام الزراعي الأقل فيما يخص الاحتفاظ بالكربون العضوي 0.60 $kg.m^{-2}$

الكلمات المفتاحية :

الكربون العضوي في التربة، الزراعة، الواحات ، النخيل، إستخدام الأراضي ،الصحراء ،ورقلة