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College of Science
Department of Applied Geology

Determination of the Temporal Changes on the Soil Samples Using ASD-Field Spectroradiometer in Sofia Area-Ramady City/Iraq.

A Thesis

Submitted to the Council of College of Science – University of Anbar in Partial Fulfillment of the Requirements of Master of Science in Geology

By
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B. Sc. in Applied Geology-
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بِسْمِ اللَّهِ الرَّحْمنِ الرَّحِيمِ

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The researcher

DEDICATION

I would like to dedicate this work to:

The best of human beings and the model of Islam. Our Prophet Muhammad, may God bless him and grant him peace.

To those who gave me life, hope, and upbringing with a passion of knowledge and to those who taught me to rise up the ladder of life with wisdom, patience, righteousness, and fidelity to them: dear father, dear mother.

To the ones who had always taught me a love of success in my scientific career......... Dear Auntie.

To the one who have given me his knowledge and put me on the right path..... my supervisor.

To those whom God has given me the grace of their existence in life for the solid decade, to those who have helped me on my research trip....... Brothers and sisters.

To all who helped me, and who had a part, near or far, in my research..... Dear Colleagues.

To those whom I had a light of knowledge…...... my teachers.

ABSTRACT

The aim of this study is to measure the effect of organic matter on soil reflectivity in the Sofia area-Ramadi city, especially when there are no standard reflective curves for the region .Soil reflectivity characteristics change with some factors, and lose their main properties, which can lead to errors in soil reflectivity interpretations for many applications. This study is the first step in designing these curves for area and others. To produce rabidly decomposing organic matter within the soil, leaves of orange and pear (different in characteristics) were selected and placed inside mesh bags and buried at depths of 40 cm and 100 cm to ensure that the samples were not affected by surface or underground moisture. The total range of reflectivity (visible to infrared) of both types of plant leaves and of surrounding soil before the burial by using the device " spectroradiometer-fieldspec®3". Also, the temperature and humidity of the samples and surrounding soil were measured before and after burials. In the laboratories of the chemistry department, total organic matter in the soil was measured using the method (hydrogen peroxide H_2O_2). And the measurement process was repeated approximately every two months until the total period of measurements was 247 days. Final readings showed decrease in soil reflectivity by rate 15% with relation of the increase organic matter by rate 5.3%. Also both types of leaves gave different reading with rate of 20% depend on type and shape of leaves . The reflectivity did not have fixed stander curves along the measurement period. Also, there was no clear effect of climate changes on the readings, especially humidity, because the measurement period was a dry, low-precipitation period in the region where the total amount of precipitation was (7.336 cm) during the measurement period. Therefore, moisture has no effect on reflectivity in the same location as buried samples. The samples gave different readings because at a depth of 40 cm, the environment for the fungi responsible for bio decomposition is more active than at a depth of less analytic activity. In general, the current study indicated that there are no standard reflectivity curves that can be used for all regions and times or for all plant species. But with similar soil conditions our recent readings can be the reference for new soil reflectivity studies to avoid any error in interpretations.

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Chapter One
Introduction

1.1 Preface

Spectral reflectance has been used to infer soil properties primarily in the visible and near-infrared (VNIR) and in the shortwave-infrared (SWIR) regions. Bare soil reflectance in these spectral regions has been obtained from airborne imagery or spectrometers under laboratory conditions and has been mainly related to soil texture, organic matter and associated nutrients, water content, salinity and crop residue cover (Stamatiadis et al., 2005). Remote sensing is the collecting of information about the status and condition of an target using sensors that are not in direct touch with it, Energy exchange between the target and the sensor is required for a distant observation. The signal received by the sensor might represent solar energy (from the Sun) released from the Earth's surface or self-emitted energy from the Earth itself(Chuvieco, 2019) .

1.2. Remote Sensing Principles

Detecting and recording radiant energy reflected or emitted by objects or surface material is what detection and discriminating of objects or surface features entails Fig(1.1). Varying things incidents on the electromagnetic spectrum return back different amounts of energy in different bands. This is determined by material properties (structural, chemical, and physical), surface roughness, angle of incidence, radiant energy intensity, and wavelength. Remote sensing is a multidisciplinary science that combines a variety of disciplines such as optics, spectroscopy, photography, computer, electronics, and telecommunications, as well as satellite launching. All of these technologies are combined to form the Remote Sensing System, which is a comprehensive system in and of itself. A Remote Sensing process has several steps, each of which is critical for proper functioning (Aggarwal, 2004).

Remote sensing techniques allow images of the earth's surface to be captured in a variety of wavelengths across the electromagnetic spectrum (EMS). The wavelength region represented in the EMS is one of the most important features of a remotely sensed image. Some of the satellite image show reflected solar radiation in the visible and near infrared wavelength parts of the electromagnetic spectrum, while others show measurements of the energy emitted by the earth's surface itself, in the thermal infrared wavelength region(Aggarwal, 2004).

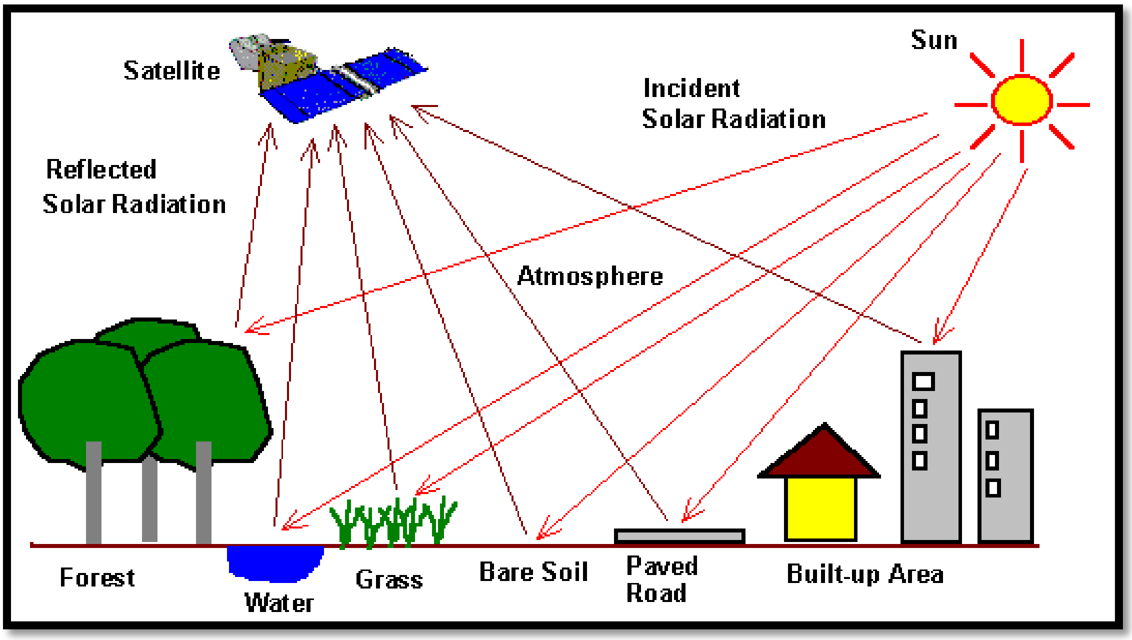


Figure1.1: Remote Sensing process, (Aggarwal, 2004).

1.3.Spectral signature

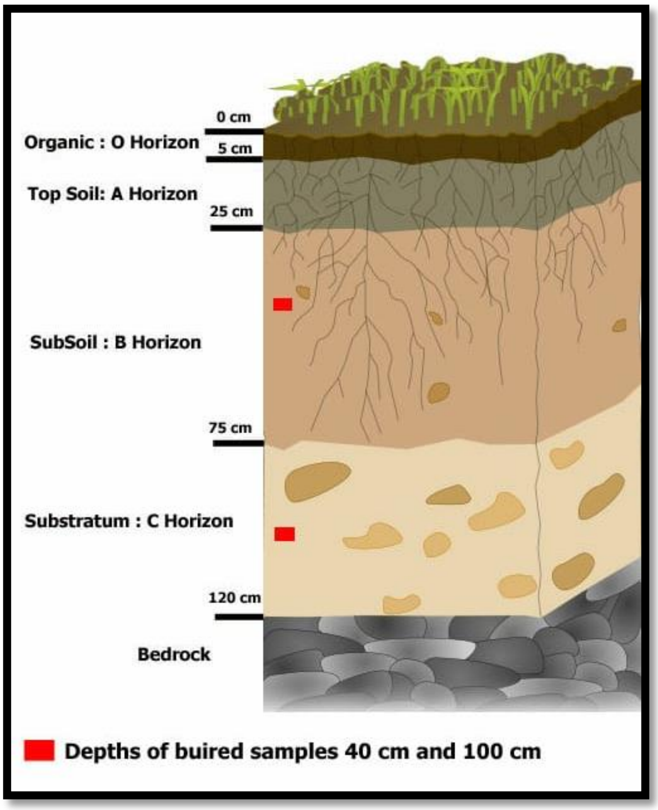
Spectral signatures are a mixture of reflected, absorbed, transmitted, or emitted electromagnetic radiation (EMR) by objects of various wavelengths that may be used to uniquely identify an element (Hooshyar et al., 2021).

When the quantity of EMR (typically intensity of reflected radiation or reflectance in percentage) emitted by a material is plotted over a range of wavelengths, the linked dots form a curve known as the material's spectral signature or spectral response curve. A fundamental grasp of spectral signature, which describes how diverse such as water, rock, soils, and plants interact with the EMR's various wavelengths (bands) (Hooshyar et al., 2021).

The incident EMR and the region of the electromagnetic (EM) spectrum in which they are interacting determine the spectral signature of an item. Instruments such as task specific spectrometers are used to measure the energy reflected back from an item. As demonstrated all spectral reflectance measurements are unique to the material and environment in which they are measured. Mineral/rock signatures, for example, might differ from one sample to the next. Vegetation is considerably more varied, since it is affected by plant health, growth stage, and moisture content(Hooshyar et al., 2021).

1.4. Soil

The soil us the product of biological weathering . It is the part of the weathering profile which is the domain of biological processes . Pedologists divide the vertical profile of asoil into three zones , as show in Fig(1.2). the upper part is termed "A zone" in this part of the profile organic content is richest and chemical and biochemical weathering generally most active. Below the A zone is the "B zone" at this level downward percolating solutes are precipitated and entrap clay particles filtering down from the A zone. Below B zone is the "C zone" This is essentially the zone where physical weathering dominates over chemical and biological processes (Boden,2005).



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Figure(1.2): Terminology and processes through a soil profile(Boden,2005).

A typical soil may have 50% pore space, with different quantities of gas and liquid in different places and at different times. The solid phase is made up of a complex genetic mix of fundamental minerals, clay minerals, organic polymers, and secondary mineral coatings found in the sand and silt fractions. Roughness conditions are added to the surface, the reflectance response from soil surfaces becomes more complicated, with additional spatial and temporal variation patterns at all scales(Huete & Escadafal, 1991).

1.4.1.Spectral Signature of Soil

Soils make up a significant component of the Earth's land surface, they have an impact on the composite land surface's reflectance. Remote sensing of the ground surface requires studies of soil reflectance in the visible (VIS), near infrared (NIR), and middle infrared (MIR) areas of the electromagnetic spectrum. Soil texture (percentage of sand, silt, and clay), soil moisture (dry, wet, saturated), organic matter content, iron-oxide concentration, and surface roughness are all factors that influence soil reflectance(Streck et al., 2003).

To determine the response of soil features from spectral characteristics, quantitative spectral analysis of soil utilizing VIS and NIR reflectance spectroscopy necessitates advanced statistical approaches. To link soil spectra to soil properties, a variety of approaches have been utilized (Gholizadeh et al., 2014).

After atmospheric and solar (source) effects are removed, a soil spectrum is a collection of discrete energy spanning a wide spectral range of photons that travel through the sun (or other equivalent source)-surface-sensor pathways. The soil reflectance spectrum is a set of values derived from the ratio of radiance (E) and irradiance (L) fluxes over the solar emittance function's spectral region. From a practical standpoint, the values are traditionally described as a relative ratio against a perfect reflector spectrum obtained at the same geometry and position of the soils. The electromagnetic waves in issue comprises the visible (0.4-0.7 mm), near-infrared (0.78-2.5 mm), middle-infrared (2.5-50 mm) and far-infrared (50-1000 mm) spectral ranges(Ben-Dor et al., 1999).

1.4.1.1.Visible and Near-Infrared Soil Spectroscopy

Soil may be successfully characterized using visible and infrared spectroscopy. Spectroscopic measurements are quick, accurate, and low-cost. The spectra encode information on the minerals, chemical molecules, and water that make up soil's natural makeup. Minerals and firmly bound water are characteristics that soil inherited from its parent material and acquired during its creation in reaction to its surroundings and treatment by man. All of these encodings are represented in spectra as absorptions at certain wavelengths of electromagnetic light, and we may use measurements to subjectively and quantitatively define soil , Increasing the amount of organic matter reduces the reflectivity(Rossel et al., 2016), so that ,by increasing the percentage of organic matter by 0.5%, the reflectivity value is reduced by 1%, as shown in Fig(1.3).

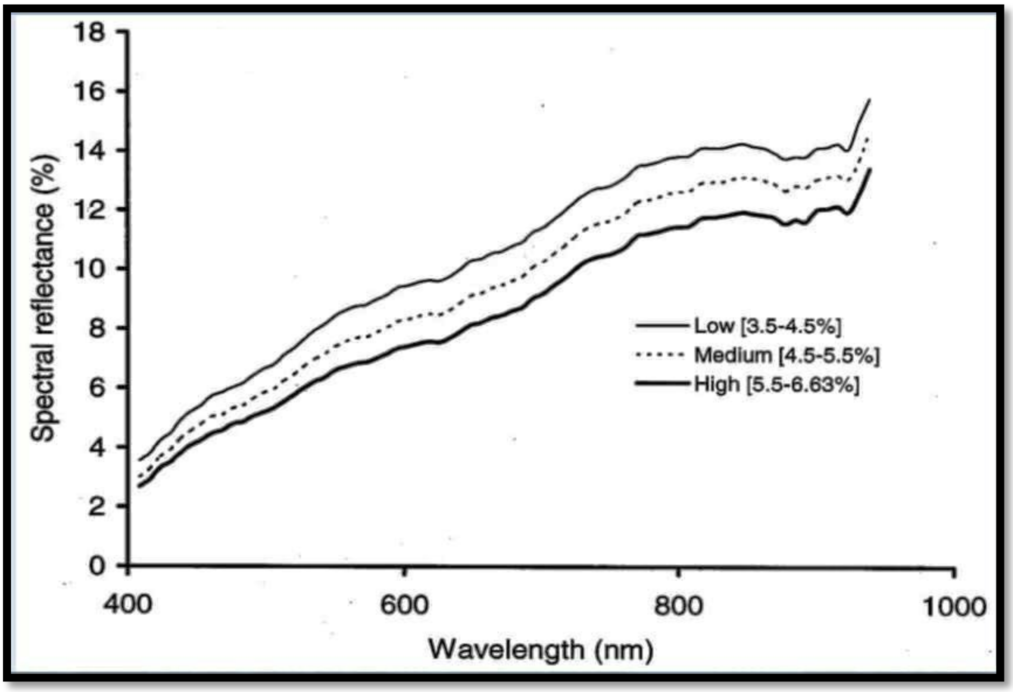

Figure1.3: Spectral signature of soils with three different soil organic matter rates (Uno et al., 2005).

1.4.2.Spectral Signature of Vegetation

Vegetation's spectral reflectance may be found in the three primary areas of the electromagnetic spectrum.

*Low reflectance, strong absorption, and minimal transmission in the visible band (400-700 nm). Plant pigmentation is the primary determinant of energy-matter interactions with plants in this portion of the spectrum.

*Near Infrared (700-1350 nm): High transmittance and reflectance with extremely low absorption. Internal leaf structures are the physical control.

* Middle Infrared (MIR) (1350-2500 nm): As wavelength increases, reflectance and transmittance drop from medium to low, while absorption rises from low to high. In these mid-infrared wavelengths, in vivo water content is the major physical control for plants. Spectral reflectance properties of plants in various circumstances.

The presence of the chlorophyll pigment in plant leaves causes green light to reflect in the case of vegetation. In an optical/near-infrared picture, the presence of the chlorophyll pigment results in a distinct spectral signature of vegetation, allowing us to clearly identify it from other forms of land cover (non-living) elements. Due to the absorption of blue and red wavelengths by chlorophyll for photosynthesis, vegetation has a poor reflectance in both the blue and red parts of the EM spectrum , as showing in Fig(1.4)(Awad et al., 2019).

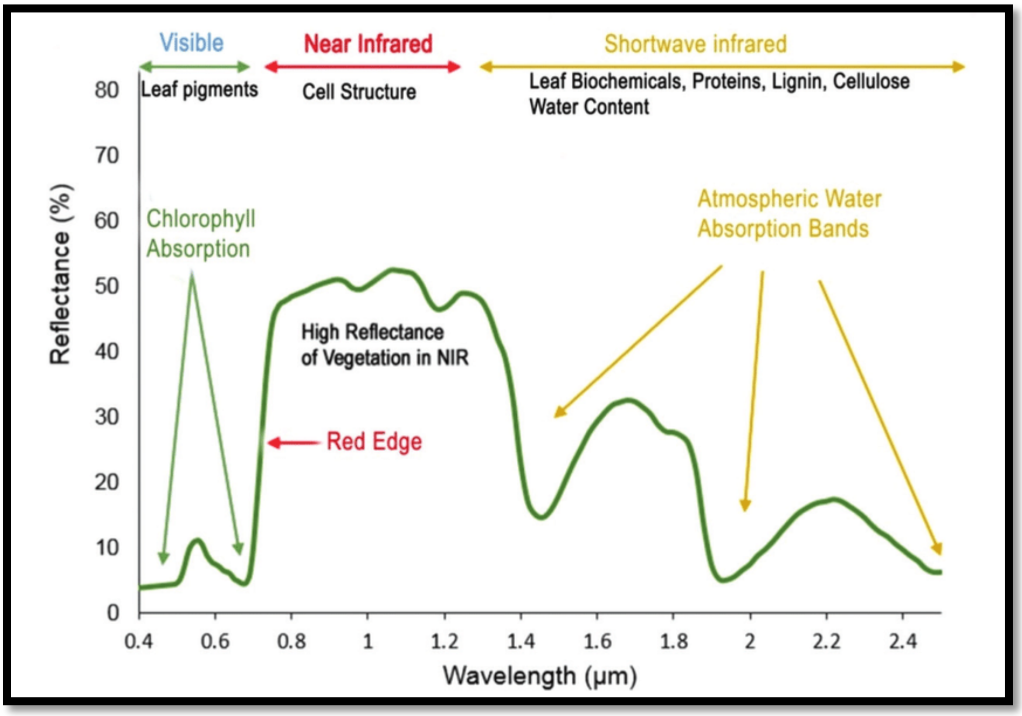

Figure1.4: standard-spectral-reflectance-curve-of-vegetation-The-major-absorption-and-reflectance(Roman & Ursu, 2016).

1.4.3.Spectral Signature of Water

Unlike soil, water absorbs or transmits the bulk of the radiative energy that strikes it. At visible wavelengths of EMR, relatively little energy is absorbed, only a small percentage is reflected (typically less than 5%) , as showing in Fig(1.5). You can see your foot/toes through the water if you are standing in it. At near-infrared wavelengths, water absorbs a lot of light, leaving little to be reflected or transmitted(Wu & Sun, 2013).

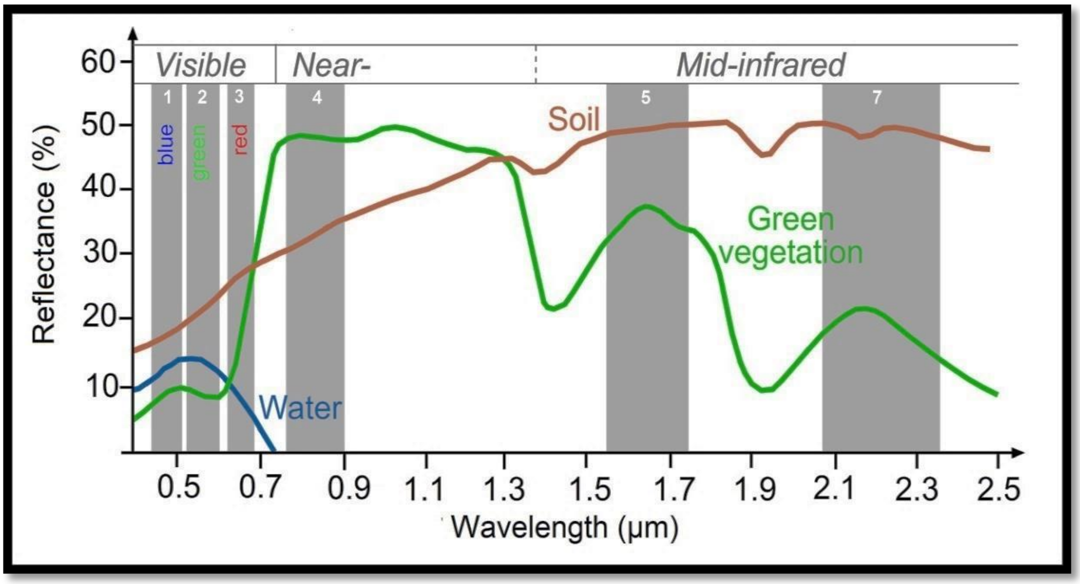

Figure1.5: Spectral signatures of soil, vegetation and water, and spectral bands of LANDSAT 7(Zaed, 2017).

1.5. Remote Sensing Applications in Soil Science

One of the basic features of soil is spectral reflectance, which varies depending on the physical and chemical properties of soil. The spectral reflectance affected by its parent material, organic matter concentration, wetness, and surface roughness. They give a different means of extracting soil properties and a new indicator for the quantitative inversion of soil properties, and they represent the physical foundation of soil remote sensing technology. Soil science is technology of one initial applications of remote sensing. Spectral data allows for the monitoring and comparison of various landscape aspects over a large area, as well as the recording of changes, because it presents geographic information within a region and can reflect the distribution and properties of different soils independently or in combination(Xie & Xiao, 2018)..

The use of hyperspectral remote sensing data to detect surface or shallow surface soil attributes, as well as the building of various types of analytical models based on field measurements, will be aided by the study of soil spectrum(Xie & Xiao, 2018).

1.6. Literature Review

This study is considered to be the first in both concept and practice to bury the leaves of plants in order to accelerate their decomposition and thus measure the reflectivity of the soil in contact with them. We haven't seen a similar approach globally.

1- Krishnan et al., (1980) studied the spectral reflectance of the selected soils in the infrared and visible wavelength regions and to identify optimal wavelengths for predicting the soil's organic matter content. The study show that no absorption peak due to soil organic matter was found in the infrared and visible regions of the spectrum scanned.

2- Thomasson et al., (2001) the purposes: (1) to understand the relationships between soil properties and reflectance spectra, and (2) to understand the sources of variability in the reflectance spectra. From the raw reflectance spectra, 50nm band averages were calculated. There were significant correlations between groups of the averaged spectra and soil properties, but no single 50nm band was highly correlated to any soil property. Soil nutrients were better correlated with spectra in one field, but texture was better correlated with spectra in the other.

3- (Lobell & Asner, 2002) studied the effects of moisture on soil reflectance, The findings of this work aid in the quantification of moisture's considerable effect on spectral reflectance and absorption properties

4- (Weidong et al., 2002) the study was to explore the relationship between soil reflectance in the solar domain (400–2500 nm) and soil moisture. the results show that for low soil moisture levels, the reflectance decreased when the moisture increased. Conversely, after a critical point, soil reflectance increased with soil moisture, It also shows that the relationships are generally nonlinear.

5- (Lehmann et al., 2008) studied the Spatial complexity of soil organic matter forms at nanometre scales, this study find that organic carbon forms of total soil were remarkably similar between soils from several temperate and tropical forests with very distinct vegetation composition and soil mineralogy.

6- (Lehmann & Kleber, 2015) The exchange of nutrients, energy and carbon between soil organic matter, the soil environment, aquatic systems and the atmosphere is important for agricultural productivity, water quality and climate, this study suggests that soil organic matter is composed of inherently stable and chemically unique compounds.

7- (Wang et al., 2016) The study was to estimate soil organic matter (SOM) and evaluate the performance of a SOM prediction model with two different soil particle sizes (sieved soil and nonsieved soil). Multivariate statistical analysis is applied to construct an SOM model with absorption peak parameters derived from the continuum-removed (CR) method, The results indicated that the SOM models based on the nonsieved soil ($R^2 > 0.692$; RMSE < 6.018) had better performance than the sieved soil ($R^2 < 0.627$; RMSE > 6.732).

8- (Xie & Xiao, 2018) used remote sensing technology to estimate the content of soil organic matter, It finds that there is a close relationship between soil organic matter content and each band, and the estimation model is sound in stability and accurate measurement.

1.7. Organic Matter

Organic matter is an important component of soil, and its fertility and reflectance spectrum. It accounts for 10% or less of total soil composition, yet it's required for agricultural productivity, soil environmental protection, and plant development. As a result, while measuring the level of organic matter in soil, we must guarantee that the estimation is efficient and accurate(Xie & Xiao, 2018).

Organic matter enhances the soil chemically by acting as a storage for plant nutrients. Organic nitrogen makes up the majority of the nitrogen in the soil. When organic matter decomposes, it releases nutrients in a plant-available form. To keep this nutrient-cycling system running, the rate of organic matter input from crop leftovers, manure, and other sources must meet the rate of decomposition, taking into consideration plant uptake and erosion losses(Bot & Benites, 2005).

The majority of organic chemicals that enter the soil, including many man-made contaminants, are degradable by local microbes. The molecular structure of the chemicals determines not only their potential absorption and metabolic transformation by microbial cells, but also their Sorption which is a physical and chemical process by which one substance becomes attached to another. And desorption activity, is the physical process where a previously adsorbed substance is released from a surface, which affects mass transport within the soil matrix(Neumann et al., 2014).

1.8. Soil Organic Matter

Soil organic matter and the mix of organic components have a considerable impact on soil reflectance; prior studies examining soil organic matter content indicated that this feature influenced a wide spectral range, implying that organic matter is a major chromosphere over the whole spectral area(Vlasova, 2019).

The bulk of soil organic matter comes from the decomposition of leftovers left over after plants have perished. Root remnants in the soil matrix, as well as leaves, stems, and stubble that remain as litter on the soil surface, are examples of these residues. Animals also contribute to the organic matter content of the soil in variable degrees, depending on ecological conditions .As show in Fig(1.6),(Murphy, 2014).

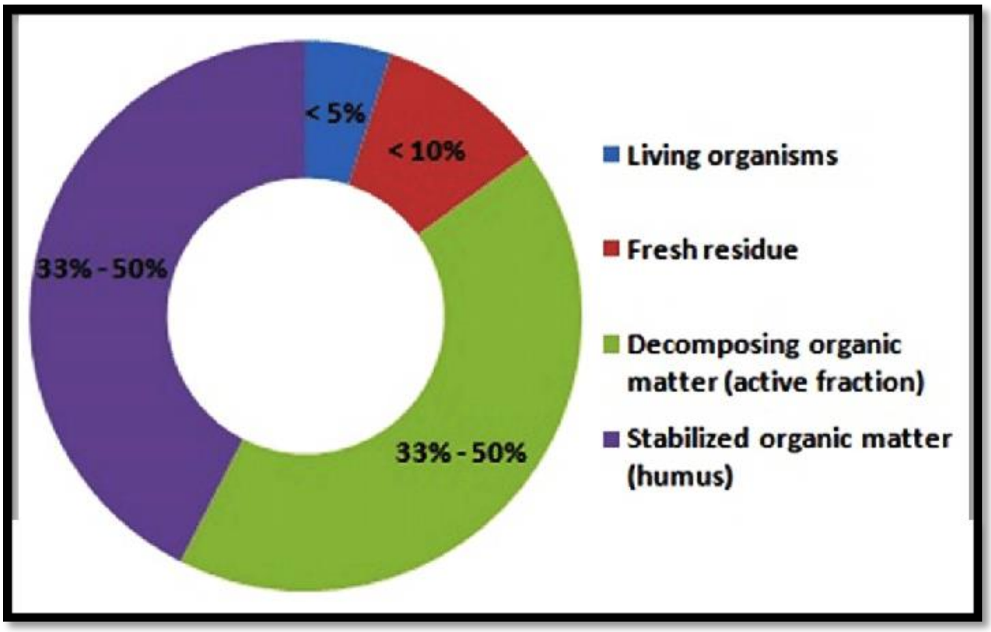

Figure1.6: Major soil organic matter components Source(Khare & Yadav, 2017).

1.9.Natural Factors Influencing on The Content of Organic Matter In Soil

Some of the environmental factors that control soil organism activity, and thus the balance between the accumulation and decomposition of organic matter in the soil, will be explained:

1.9.1.Temperature

Increased temperature reduces the organic matter content of the soil, increased temperature leads to increased decomposition of organic matter due to increased activity of the microorganisms responsible for decomposing organic matter, and increased temperature converts organic matter into material that is not used by plants(Bot & Benites, 2005).

1.9.2.Soil Moisture and Water Saturation

As mean annual precipitation rises, soil organic matter levels usually rise as well. Increased biomass production, which offers more residues and hence more potential food for soil biota, occurs when soil moisture levels are high.

Water saturation, on the other hand, causes poor aeration, Because most soil organisms require oxygen, a decrease in oxygen in the soil results in a decrease in mineralization rate as these organisms become dormant or die(Bot & Benites, 2005).

1.9.3.Climate

Because organic matter decomposes more quickly at higher temperatures, soils in warmer climates have less organic matter than soils in colder climates(Louwagie et al., 2009).

1.9.4. Soil Texture

Fine-textured soils have more organic matter than coarse soils, and they store nutrients and water better, allowing plants to thrive. The presence of oxygen causes organic matter to degrade more quickly in coarse soils(Louwagie et al., 2009).

1.9.5.Soil Ventilation

Increasing the moisture content of the soil to the point of saturation results in reduced air pores, i.e. poor soil ventilation, which does not result in the activity of organisms responsible for organic matter decomposition, and thus does not result in low soil organic matter content, whereas good soil ventilation increases organic matter degradation, which reduces soil content(Bot & Benites, 2005).

1.9.6.Use of Land (Tillage)

Tillage introduces oxygen into the soil and elevates its average temperature, accelerating the decomposition of organic materials. Erosion sweeps away topsoil and humus, resulting in organic matter loss(Louwagie et al., 2009).

1.10.Source of Organic Matter in Soil:

1-Plant Remains

After decomposition, plant remnants such as roots, stems, and deciduous leaves constitute a primary source of organic soil matter. The composition of plant remains and their organic matter content must be known in order to comprehend the importance of plant remains for organic matter. Water and a hard part, or dry matter, make up plant remains. Plants' water content differs according to a variety of factors, including plant type and age(Carpenter et al., 2013).

2-Green Fertilizer

Green fertilizers are often utilized as legumes and, to a lesser extent, quasi. These plants vary in their soil at some time throughout their growth to improve soil organic matter and nutrients supplies(Carpenter et al., 2013).

3-Organic Fertilizers Added to Soil

Organic Fertilizers include, waste from field animal, waste from slaughterhouses and factories, and waste from the city are all examples(Carpenter et al., 2013).

4-Organism

Both from their waste and from their decomposing bodies, including the large organism and microorganism (Carpenter et al., 2013).

1.11. Soil Carbon Standard : Organic Carbon Inputs and Losses

Depending on the quantity and kind of management, organic carbon in soil fluctuates in a number of ways. Organic Carbon intake and losses calculate the amount of net organic carbon contained in soil at any given moment. Crop residue, plant roots, leaves, and stubble, root exudates, , green manure, and animal manure, among other sources of Organic Carbon in soil, are input sources. Microbial decomposition, soil erosion, and land conversion are one of the ways in which Organic Carbon is lost in soil. Microbial mediated nutrient changes occur in soil, it uses C as an energy source and converts it to CO2. Such microbial decomposition things happen in soil all of the time, and if Organic Carbon is not provided from various input sources, the level of Organic Carbon in soil will decrease(Ramteke & Ghosh, 2020).

1.12.The Potential for Organic Carbon Storage in Soil is Determined by Soil Type

The soil type impacts how much carbon can be stored or how much potential there is for soil to retain carbon. According to reports, soil with a high clay content has a greater capacity to store carbon. Organic matter particles can adsorb to clay surfaces, be covered with clay particles, or be stabilized inside micro-aggregates.. Because it is out of reach of soil microorganisms, all of these activities result in a net build-up of soil carbon, which would otherwise be lost via decomposition. Soil aggregation is greater in clay-rich soils, and so Carbon accumulation is greater. As a result, as soil clay content rises, the quantity of Organic Carbon stored in the soil rises as well. Light texture sandy soils with minimal aggregation, on the other hand, have a poor capacity for Carbon storage, and bacteria are able to use the Organic Carbon more rapidly, resulting in increased losses due to decomposition ,Fig (1.7) (Ramteke & Ghosh, 2020).

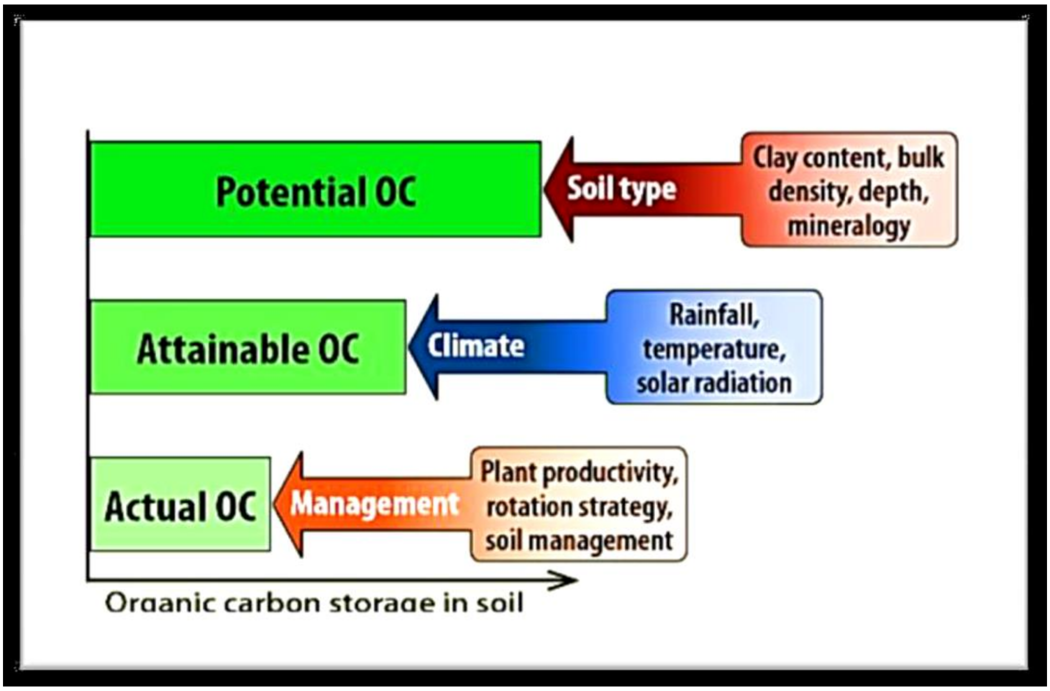

Figure1.7: The influence of soil type, climate and management factors on the storage of organic carbon (OC) that can be achieved in a given soil(Ramteke & Ghosh, 2020).

1.13.Type of the Soil of Sofia Area at Ramadi City

The soil of the area is a good fertile sandy clay soil for river basins. This soil is characterized by its texture ranging from very coarse sand to coarse sandy texture and medium coarse sandy texture, then to fine sand, to very fine sandy sand, then to a silty mixture and then to a clay texture ,This soil does not consist of one type of particles, but rather consists of a mixture of sand, silt and clay (Hamdani, 2020).

1.14.Location of Study Area

The study area is Sofia area in Ramadi city located in the west of Iraq between the longitudes of($33^{\circ}29'07''$N) and latitudes($43^{\circ}12'51''$E) as show in Fig(1.8).Sofia-Ramadi city, which is located in an open area bordered to the north by the Euphrates River and to the east by the Nazim Al-Warar Canal. As well as the five-kilo area, which has an increase in the proportion of spaces in it due to its location in the west of the city and first affected by the western desert plateau. It is directly on the side facing the winds, most important areas in which temperatures have decreased (Sharif & Hedy, 2021).

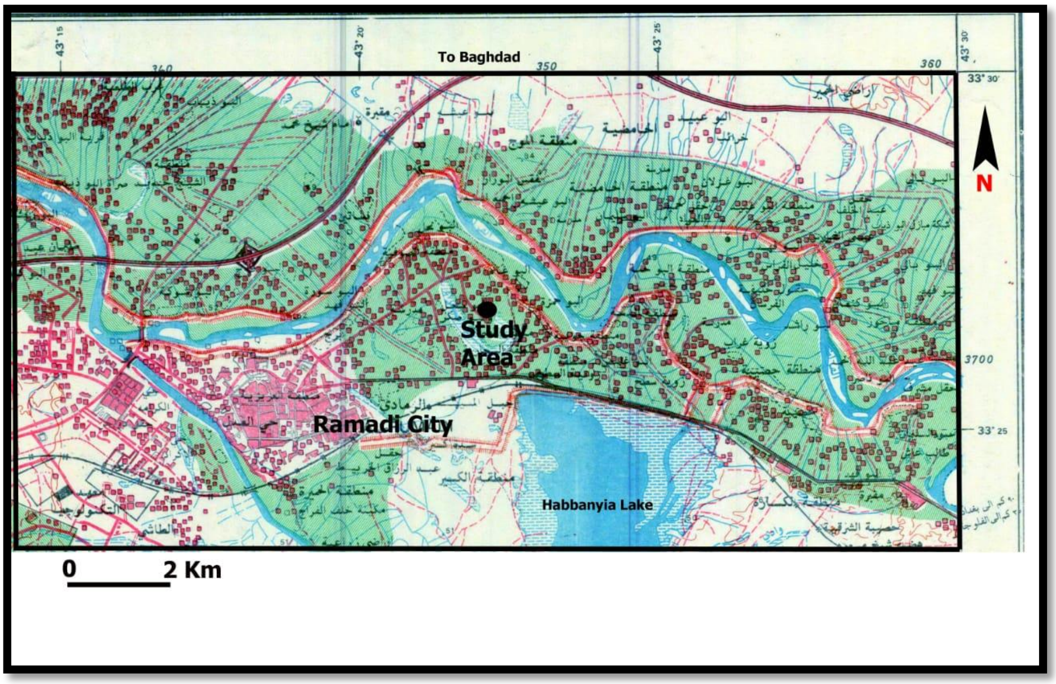

Figure1.8: location map to study area.

1.15. Tectonic and Geological Setting of Study Area

The study area is located near the western edge of the Mesopotamian zone, of the stable continental shelf area, according to Iraq's tectonic divide(Jassim & Goff, 2006), The Zubair zone, the Euphrates zone, and the Tigris zone are the three longitudinal units of the Mesopotamian zone. The Euphrates subzone, which includes the study region, is the shallowest unit in Mesopotamia, but when compared to the Tigris subzone, it is the deepest(Jassim & Goff, 2006), The Abu Jir fault zone is a major structural feature in the study region, as well as an underground fault that stretches from north to south (Sissakian and Muhamad, 1994), Except for the northwestern section of the research region, where the slope is increasingly moderate toward the north, the study area is rather level and gradually increases to the west(Yass, 2021), Groundwater levels in Ramadi's core are ranging from 10 meters. The reservoirs of the Euphrates River and Habania Lake have caused the underground water level to increase and occasionally seep onto the surface during the previous year (http//Iraqi-forum2014.com).

1.16.Climate Properties of Study Area

1-Wind Speed

The winds are northwesterly and southwesterly, with gusts of up to 21 meters per second (Hammody, 2021).

2-Temperature

The temperature increases to 52° C in the summer and drops to 9° C in the winter, the average annual minimum and maximum air temperature readings in Sofia- Ramadi, which ranged from 15 to 28.9° C. Summer temperatures in the governorate varied from 28 to 34° C, while winter temperatures ranged from 8 to 12C^{o} (Hussein, 2010).

3-Rainfall

The average annual rainfall in Sofia-Ramadi is between 50 and 150 millimeters per year, with rainfall exceeding 40 millimeters per day on rainy days. At some stations, the greatest daily rainfall recorded exceeds the total rainfall recorded for a dry year. On the other side, winter accounts for 46% of rainfall, while autumn and spring account for the remaining 6%. (Hussein, 2010).

The rainfall in the Sofia area varied over a period of time, so the measuring periods were characterized by very little rainfall, which was calculated as shown in which figures:(1.9),(1.10),(1.11),(1.12),(1.13),and it was7.336cm (http//meteoblue.com).

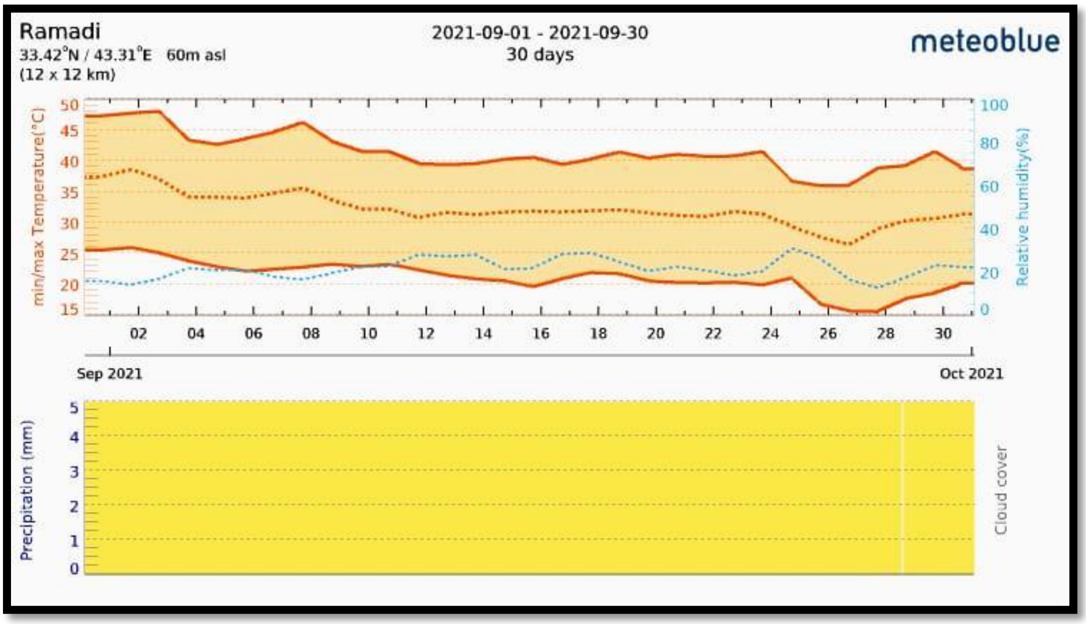

Figure1.9: Track of temperature, Relative Humidity and precipitation for the month of September (http//meteoblue.com),at 2021/09/30.

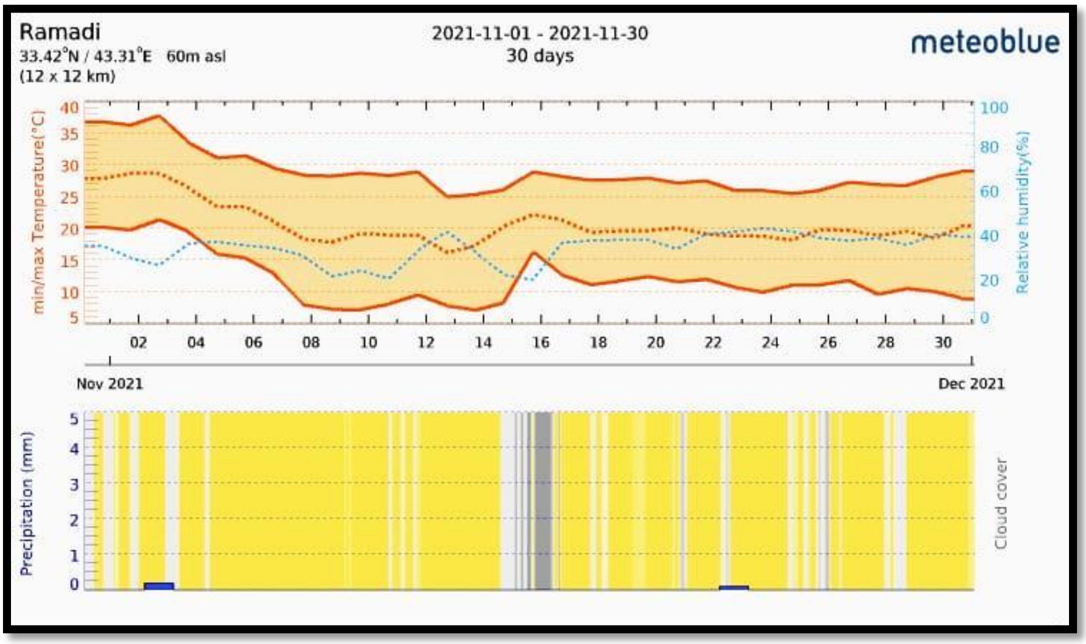

Figure1.10: Track of temperature, Relative Humidity and precipitation for the month of November (http//meteoblue.com),at 2021/11/30.

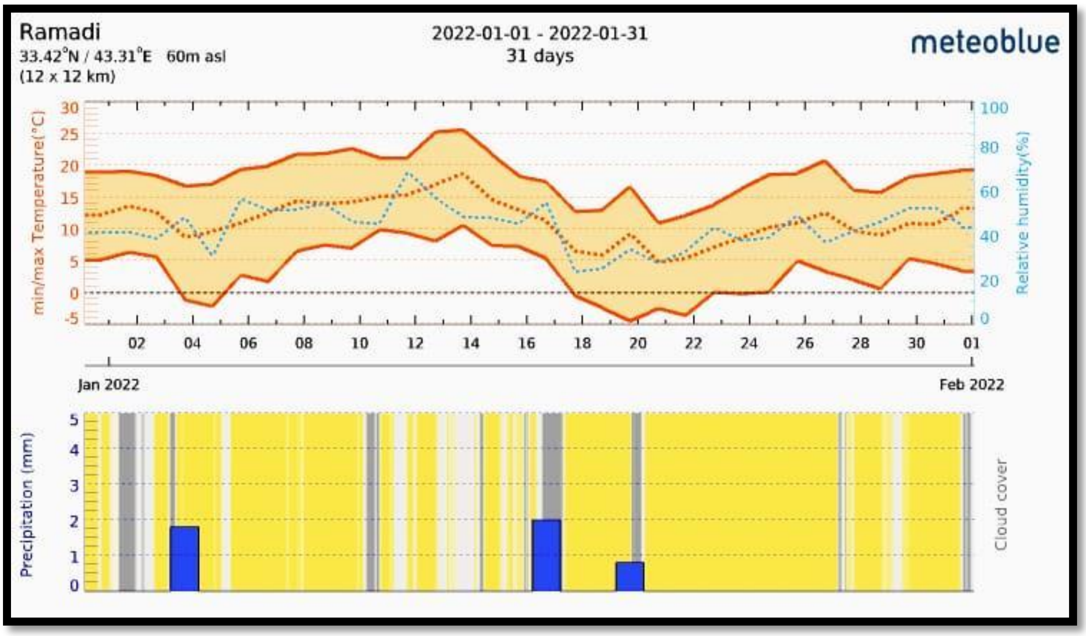

Figure1.11: Track of temperature, Relative Humidity and precipitation for the month of January (http//meteoblue.com),at 2022/01/31.

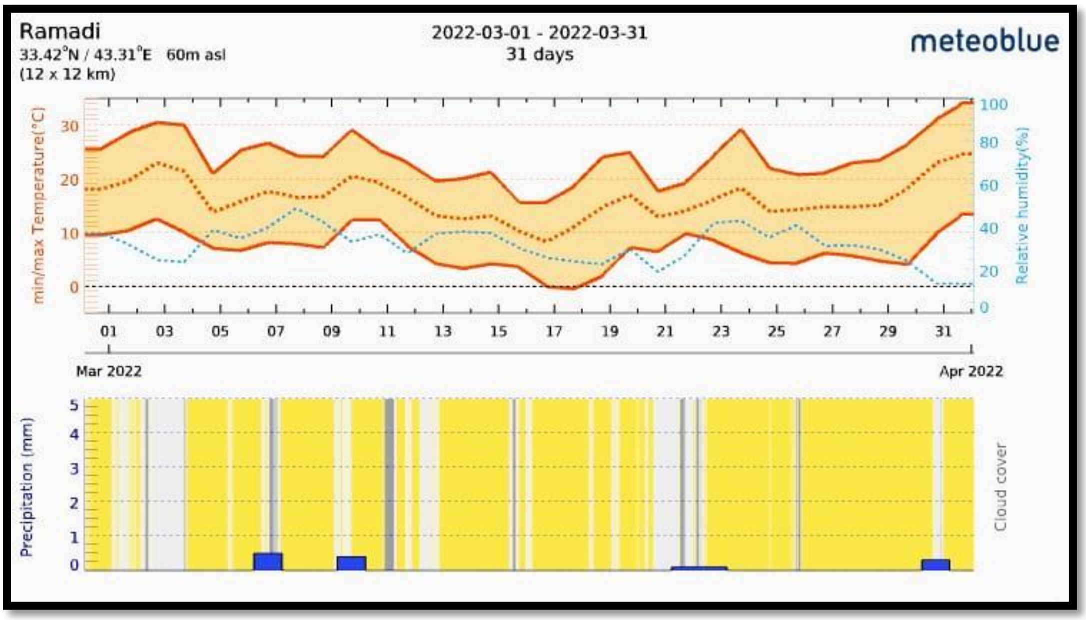

Figure1.12: Track of temperature, Relative Humidity and precipitation for the month of March (http//meteoblue.com),at 2022/03/31.

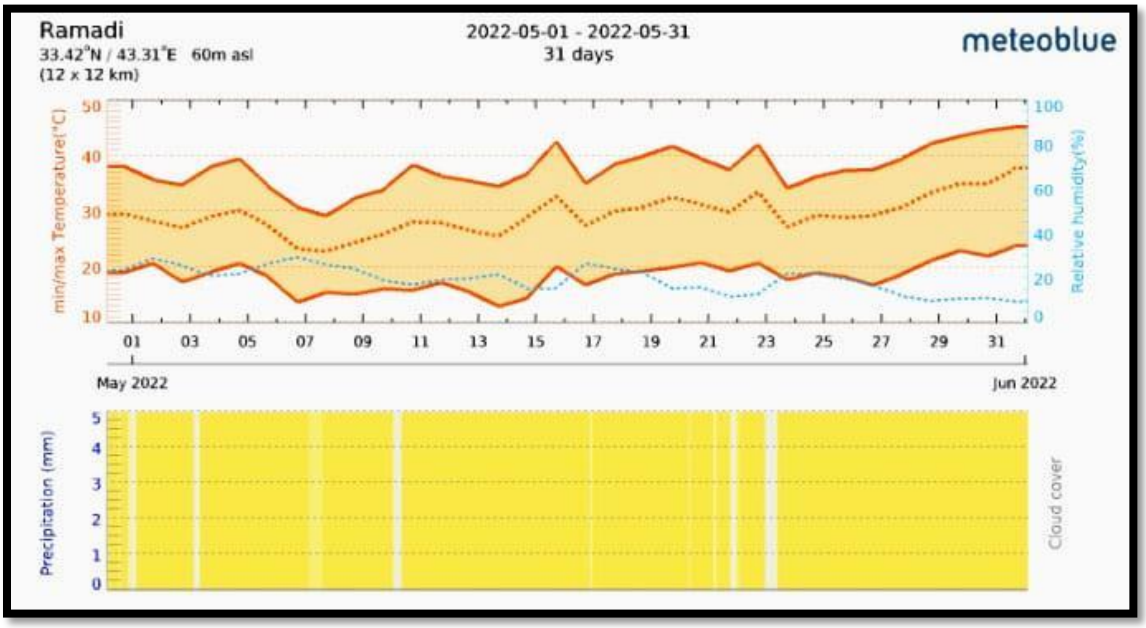

Figure1.13: Track of temperature, Relative Humidity and precipitation for the month of May (http//meteoblue.com) , at 2022/05/31.

4-Relative Humidity:

The mean monthly relative humidity readings for the varied from 22% to 76%, with an average yearly relative humidity of less than 50% (Hussein, 2010).

1.17. The leaf

Because of the leaves are the main part of plant can give spectral reflectance so we need to know general characteristic, Leaf morphology differs significantly across species, and a deeper examination, such as using an optical microscope, reveals finer-scale variations in cell and tissue structure between species and plants growing in various conditions. An epidermis, mesophyll, and a vascular system make up a majority of leaves. Small green organelles known as chloroplasts are seen in many mesophyll cells. These chloroplasts are essential to the photosynthesis process, which is responsible for practically all life on the plane(Oguchi et al., 2018).

1.17.1. Anatomy of the Leaf

Leaf anatomy includes epidermis with stomata, mesophyll (a kind of parenchyma), and vascular bundles, or veins. Palisade and spongy forms exist in the mesophyll. Palisade mesophyll is found in the top layer and functions to reduce the intensity of sunlight for the spongy mesophyll while also catching slanted solar rays. Palisade mesophyll is made up of long, thin, closely packed cells with chloroplasts mostly along the sidewalls. The mesophyll cells are spongy, spherical, and feature numerous chloroplasts, Cells in some or all layers of the mesophyll can develop into elongated, evenly dispersed cells in many species(Oguchi et al., 2018).

Intracuticular waxes serve as the primary transport barrier, preventing the loss of water and small molecules like ions from within the cell as well as the absorption of liquids and molecules from the outside(Barthlott et al., 2017).

The pear leaf differs from the orange leaf in terms of its internal structure in terms of leaf thickness, the thickness of the mesophyll tissue, as well as the presence of nozzles in the leaf and the size of cells in the pear leaf as showing in which figures:(1.14),(1.15). The plant that can be a major reason for the rapid decomposition of the leaf inside the soil by the influence of environmental factors, and this means that the pear leaf is less resistant to decomposition compared to the orange leaf(Kārkliņa et al., 2021).

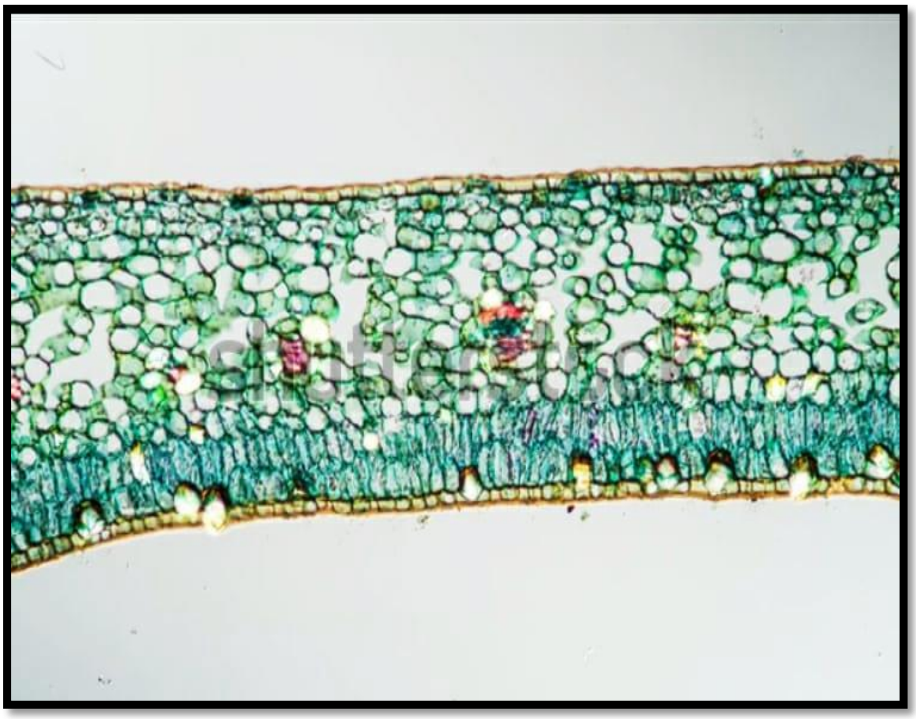

Figure1.14: Cross-section to orange leaf ×100 (Lange,2022).

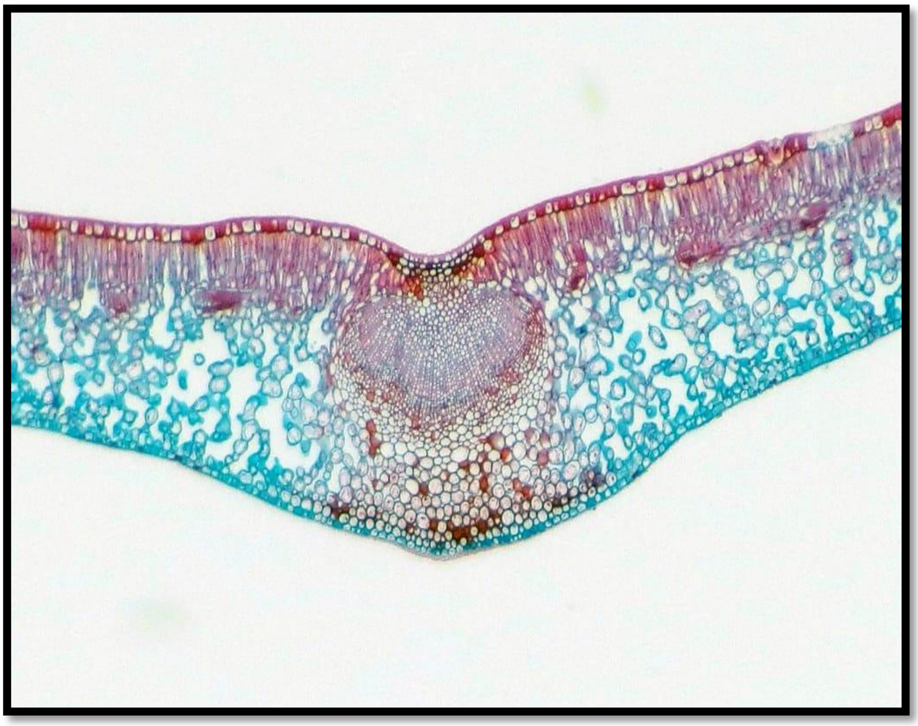

Figure1.15 : Cross section to pear leaf×100 (Blogger,2014).

Choosing two types of plants to show the difference in reflectivity between them, and therefore the different effects of organic matter.

1.18.Aim of Study:

1- Finding the direct relationship between soil reflectivity and its organic content according to measurements for specific time periods based on the continuous organic decomposition of plant leaves buried and reflectivity measurements.

2- Finding the relationship between the rate of organic decomposition and the prevailing climatic changes in the measurement area and the effect of that due to moisture or heat of the soil and the accompanying change of general reflectivity.

3- Measuring the probability of difference in the rate of changing of reflectivity depending on two types of different leaves of a plants buried in the same place.

4- Determining the effect of the depth of leaf burial on the amount of decomposition and thus changing the amount of reflectivity of the model.

Chapter Two
Materials And Methods

2.1.Preface

This chapter deals with the explanation of the method used in the field work and how to collect information from the study area, the tools used, and the methods used in office work, in order to reaching the aim of the study.

2.2. Materials and Methods

Many steps were done to prepare the samples for spectral reflectivity measurements and determine type of soil in pits area to study the effect of organic decomposition of the leaves of selected plants.

2.3. Preparing the Area for Burial of Samples

After choosing the appropriate site to bury the samples ,it was at an open area(a backyard of a house) free of plants and any other factors of moisture , which is Sofia –Ramadi city. our pits were dug at different depths, two of them at a depth of 40 cm and two at a depth of 100 cm. A number of orange and pear plant leaves were placed with soil from the same pit inside small net case(nylon) and buried at these depths, As shown in which figures: (2.1),(2.2),(2.3),(2.4),(2.5),(2.6).

Figure2.1: pit at a depth of 40 cm

Figure2.2: pit at a depth of 100 cm.

Figure2.3: Leaves of orange

Figure2.4: Leaves of pear

Figure2.5: Plant leaves with soil inside the net case(nylon) before burial.

Figure2.6: Place the samples inside the hole.

We buried the leaves in the soil to accelerate the decomposition of the leaves much more than if they were on the surface. The depth of 40 was chosen and within the high specifications that emphasize taking soil samples, it should be more than 30 cm to avoid direct surface soil, which is often affected by weathering, erosion and life waste or any unknown soil moisture source. The depth is 100 cm to avoid the deeper depths that are often affected by groundwater ,then all area of burial rounded by net fence to avoid any out effector walking there. As showing in Fig(2.7).

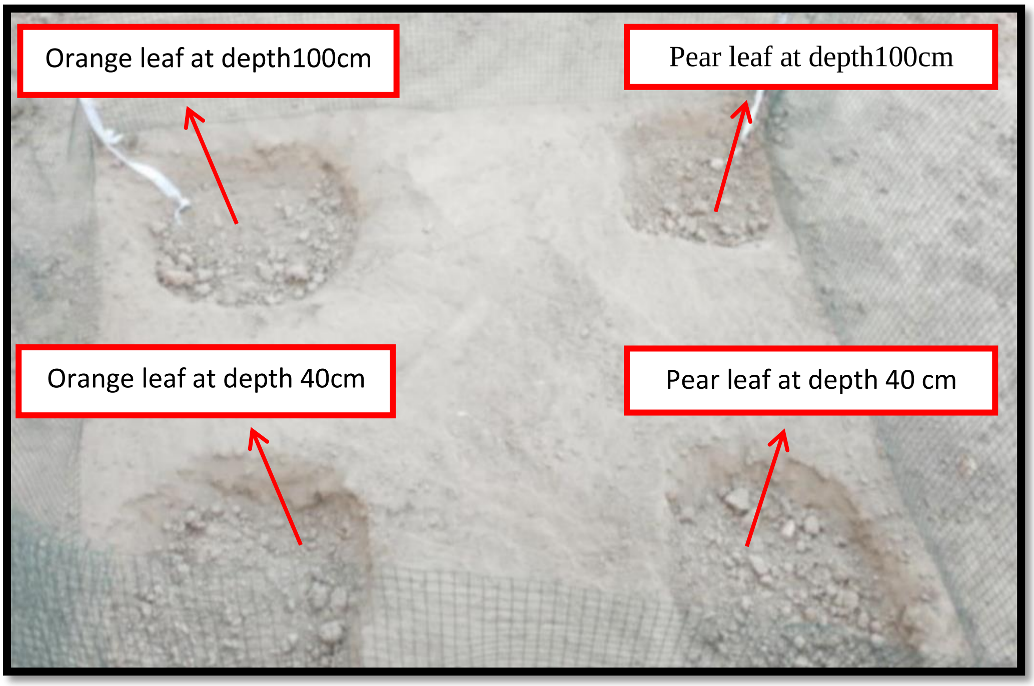

Figure2.7: Place of burial of the samples.

2.4. Instruments

2.4.1.Sieving Process to Determination the Soil Texture

1-In determining the burial area for the samples, a soil sample was taken to determine the type of soil because this has a significant impact on plant decomposition.

2-The sample was dried by placing it in a thermal oven at a temperature (105C°) and then weighing 1 kg of it for the purpose of sieving.

3-The sieving process was performed using a vibrating sieve device(sieve shaker, model: SI 90) located in the laboratories of the Department of Applied Geology as shown in Fig(2.8).

Figure2.8: Sieving process.

3-The sieving operation lasted for (30 minute), using sieves the sizes of which correspond to the world tables (US Deparment of Agriculture soil textural triangle) and was as follows: (Clay < 0.002mm,Silt 0.002-0.075mm,Fine sand 0.075-0.42mm,Medium sand 0.42- 2mm,Course sand 2-4.75mm.

5-At each sieve, the sediments were weighted and the results were listed in Table(2.1).

Table(2.1) sieving results

N0	**Type sediment**	**Weight(g)**	**Percentage**
1	Sand	430.39g	%43
2	Silt	110.19g	%11
3	Clay	440.54g	%44

6- Table(2.1), shows that the soil type of the burial area is sandy clay, as showing in Fig(2.9).

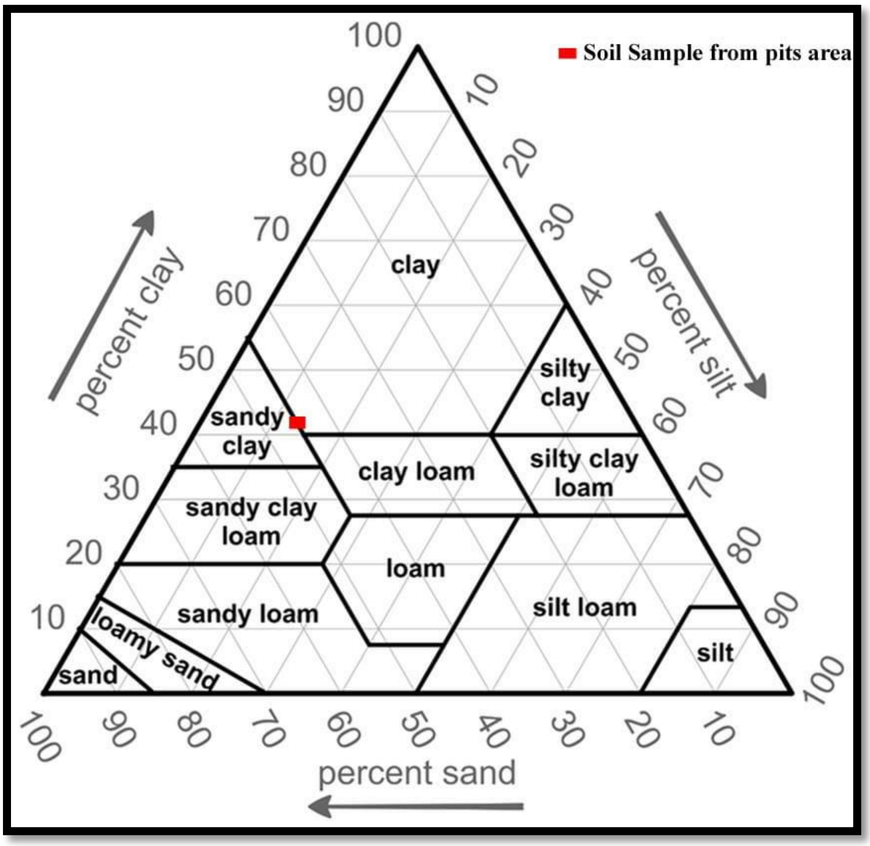

Figure 2.9: Type of soil with the stander triangular of soil textural(US Department of Agriculture soil textural triangle,2022).

2.4.2. Measurements of the Temperature and Humidity for Pits

The soil temperature and humidity inside the pits were measured at the same depth of burial (40cm-100cm) at each pit and the samples were extracted for measurement times at the required intervals.

The measurement was made using the device (Temp.&Humidity Meter.HTC-2) which consisted of a sensor buried in the pit wall and waiting one minute for the readings to stabilize as shown in Fig(2.10).

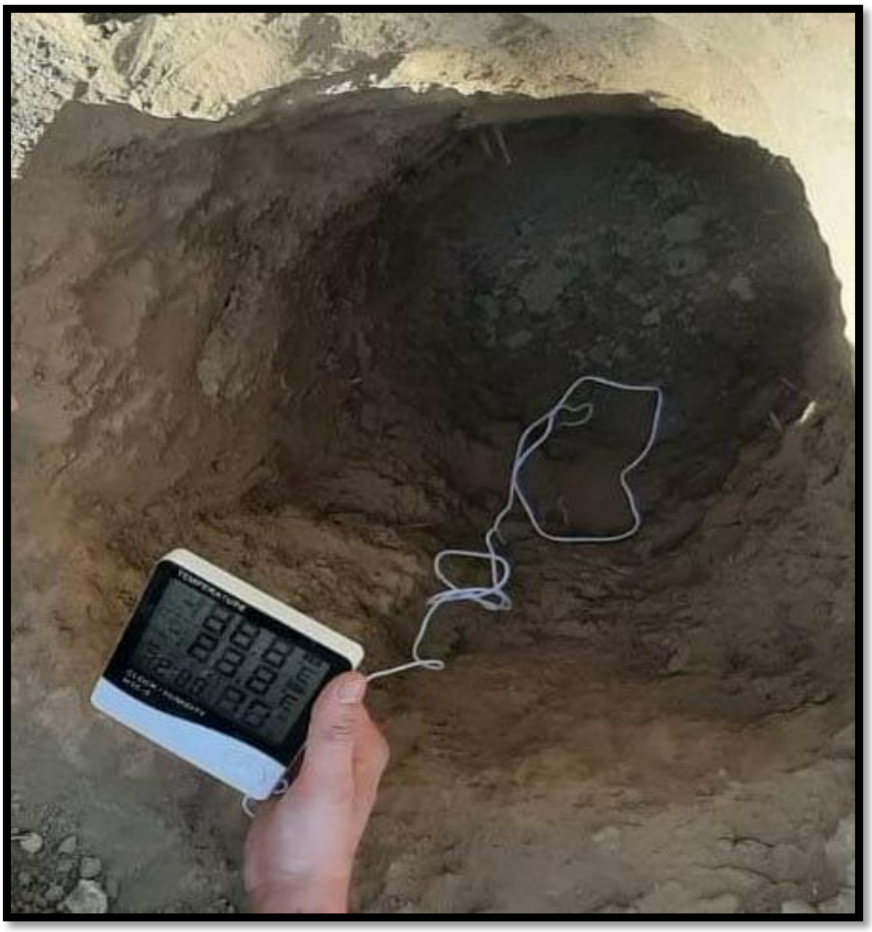

Figure 2.10: Measuring the temperature and humidity to all pits.

This device has the following specifications:

1-Temperature Measuring Range: -50C°~+70C°(-58F°~+158F°).

2-Temperature Resolution:0.1C°(0.2F°).

3-Humidity Measuring Range:10%RH-99%RH.

4-Humidity Resolution:1%.

It turned out that the temperature in the pit varied depending on the season, the temperature difference between 40 cm and 100 cm is as high(1-5C°),The values are obtained as shown in the table(2.2).

Table(2.2) The temperature and humidity for all pits with all Dates of measurements.

NO	Date	Temperature(C°)		Humidity%		Notes
1	20/09/2021	40cm	28C°	40cm	22%	Day of burial
		100cm	25C°	100cm	22%	
2	29/11/2021	40cm	23C°	40cm	31%	After(70)day
		100cm	22C°	100cm	29%	
3	20/01/2022	40cm	13C°	40cm	34%	After(122)day
		100cm	18C°	100cm	35%	
4	29/03/2022	40cm	21C°	40cm	18%	After(190)day
		100cm	23C°	100cm	19%	
5	18/05/2022	40cm	30C°	40cm	27%	After(247)day
		100cm	29C°	100cm	31%	

2.4.3. Measuring of Spectral Reflectivity

1-The reflectivity of buried samples was measured each two months to provide an opportunity to demonstrate bio decomposition activities and the effect of organic matter on surrounding soil.

2- Two types of leaves were selected, for the orange and pear trees, because they are located in the study area and because of the obvious differences in leaf shape and thickness, as show in which figures(2.3),(2.4), and because of the internal structure of the leaves, as show in which figures(1.20),(1.21), which may give the possibility that the amount of organic matter produced by decomposition and thus the soil reflectivity were different, an objective of the study, as mentioned in paragraph(1.18). It was measured on Monday 20/ 9/2021, using (spectroradiometer-fieldspec®3) reflecting device as showing in Fig(2.11).

Figure 2.11: Measuring the spectral reflectivity of plant before burial(20/9/2021).

3- The spectral reflectivity was measured by using a reflectivity measuring device (spectroradiometer-fieldspec®3).

The truly field-portable spectroradiometer designed to perform solar spectral reflectance, radiance and irradiance measurements.

The fieldspec®3 portable spectroradiometer offers the modular Goetz spectrometer engine with a spectral range from 350nm to 2500nm.

4-Measurements were made at each given interval for two variables ,the leaf or its remains and the surrounding soil.

5-Before any measurement ,the device was calibrated on a special standard chip to remove interference from the readings ,Fig(2.12).

Figure 2.12: Calibration the device.

6-Measurements were done for two leaf plants and with two depths (40 cm and 100 cm), for the two variables (leaf and surrounding soil) .Each measurement done 3 times to avoid any mistakes can happen with moment of measurement and then we do average of these 3 readings (but in general no changes noticed between the 3 readings), and we took one reading from them.

After the samples (leaves) were buried in the soil ,after two months, high humidity and low temperatures were occurred due to the light rainfall between 2/11/2021 and 20/11/2021. This led to high humidity and low temperatures, which led to the decomposition of the leaves and the formation of organic matter in the soil.

At 29/11.2021, the samples were removed and placed in a plastic box for each external noninteraction , and the reflectivity of both plant and soil was measured using the same device. As showing in fig(2.13).

Figure 2.13: Measurement of soil and plant reflectivity ,first set at(29/11/2021).

Then data was obtained that was processed in the software(Microsoft Excel 2010).

After first set of results, the samples, buried again, to preparing for second period of measurement, there was light rain to heavy rain between 16/12/2021 and 16/1/2021, this can increased the decomposition of organic matter in the soil.

At 24/1/ 2022, the samples were removed and placed in a plastic box to prevent them from being affected by external conditions. The soil and plant reflections were measured using the same device as previously mentioned, then data processed with the same program as previously was obtained .

After six months on the burial of samples ,at 29/3/2022, the samples were removed and placed in a plastic box to prevent them from being affected by external conditions. The soil and plant reflections were measured using the same device as previously mentioned, then data processed with the same program as previously was obtained

The samples were removed and placed in a plastic box to protect them from external conditions after eight months of burial on 18/5/ 2022. their soil and plant reflections were measured using the same device as previously mentioned, then data was processed with the same program as previously mentioned.

2.4.4. Measurements Of Organic Matter Chemically

The aim of this method is to find the reflective change related to the percentage of organic matter. The samples were analyzed on the same day as the measurement of reflectivity in the chemistry department laboratories. And the analysis was done total organic content based on (The hydrogen peroxide (H_2O_2) method .The method was carried out in the Department of Chemistry, college of Science, University of Anbar.

Total Organic Content method of chemical analysis was used to determine the total ratios of organic matter for the four pits at each measurement date, determining Toc in the sample is based on the method(The hydrogen peroxide (H_2O_2). This was done by oxidizing organic matter in the soil using the digestive method of adding 30% or 50% solution of concentrated hydrogen peroxide to the known weight of the soil or sediment, added to the sample on a regular basis until the sample froths up. To increase the speed and completeness of the peroxide digestion, the samples can be heated to 90°C during peroxide addition. The sample was dried at 105°C, cooled in a desiccator, and weighed after the digestion process is completed. The difference between the initial and final sample weights divided by the initial sample weight multiplied by 100 percent was used to calculate the organic matter(Schumacher, 2002).

The soil samples were taken at different depths, 40cm and 100cm, and calculated the organic matter at both depths using the above method, the results shown in table(2.3).

Table(2.3): The values of total organic carbon in soil for depths 40cm and 100cm.

NO	Type measure	Depths	20/9/2021	29/11/2021	20/1/2022	29/3/2022	18/5/2022
1	Soil(before burial)	40cm	3.36%	——	——	——	——
		100cm	3.33%				
2	Soil(Orange)	40cm	___	4.33%	4.65%	4.91%	5.3%
3	Soil(Orange)	100cm	___	3.38%	4.45%	4.73 %	4.92%
4	Soil(Pear)	40cm	___	3.43%	3.9%	4.5%	5.1%
5	Soil(pear)	100cm	___	3.32%	3.88%	4.34 %	4.81%

Chapter Three

Results And Discussions

3.1.Measurement of the Spectral Reflectivity of the Soil before the Burial for Both Depths

Soil samples were taken at both depths 40cm,100cm ,to show natural reflectivity before the entry of organic matter which result from the decomposition of leave. As showing in Fig(3.1)

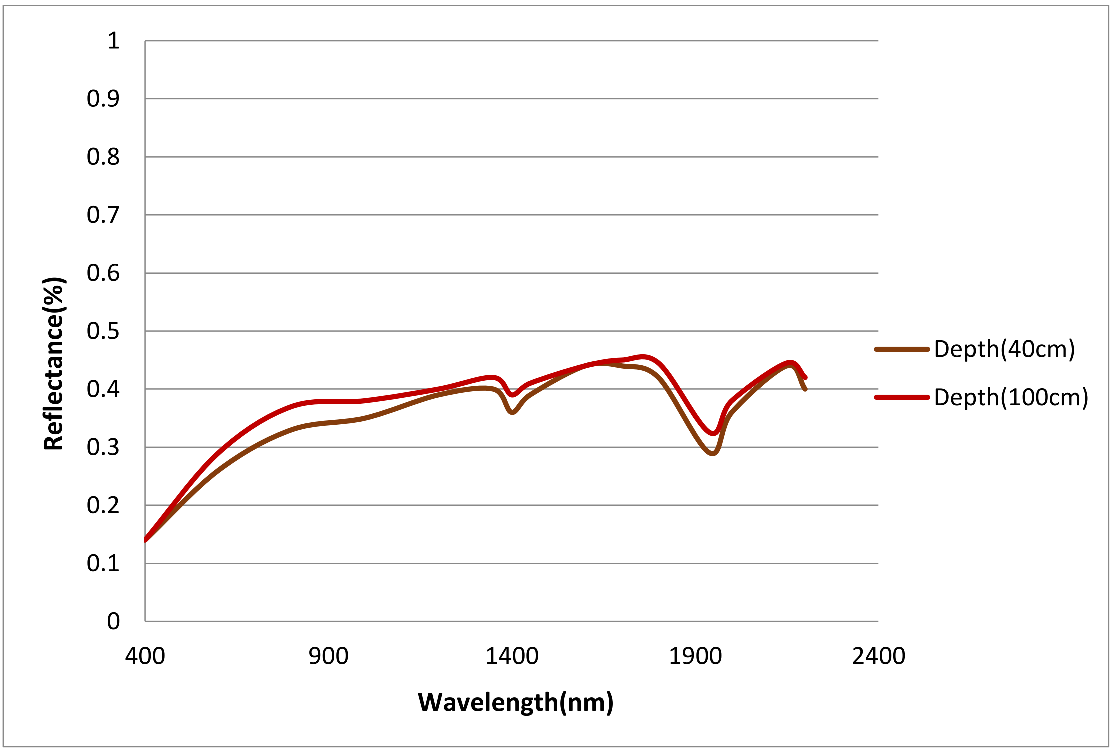

Figure3.1: Matching between the Spectral Reflectivity of the Soil before the burial, for both depths 40cm,100cm , at 20/9.2021.

From the above figure can be seen that the reflectivity of the two soil samples is generally identical to the standard reflectivity of the soil as shown in the Fig(1.4). The reflectivity of the soil increases with wavelength, and measurements show no significant difference between the reflectivity of the samples at these two depths. This is because there is little difference in burial depth and also because the area is dry and devoid of decaying vegetation.

3.2. Measurement of the Spectral Reflectivity for Two Type of Plant before the Burial, at 20/09/2021

Both leaves show a clear match with standard reflectivity curves in terms of regions of reflection and absorption, but there is little difference between the reflectivity of the two leaves. This is because of the varies amount of organic matter and chlorophyll which involved in the internal structure of the leaves, as show in which Figures (1.14),(1.15). The reflectivity of the pear leaf was relatively more than the orange leaf, due to the presence of mesochlorophyll cells with Spaces filled by air. Orange leaf has a large inner cell size and few mesochlorophyll cells, which cause an increase in the amount of organic matter and chlorophyll, which reduces the reflectivity of the orange leaf ,as show in Fig(3.2).

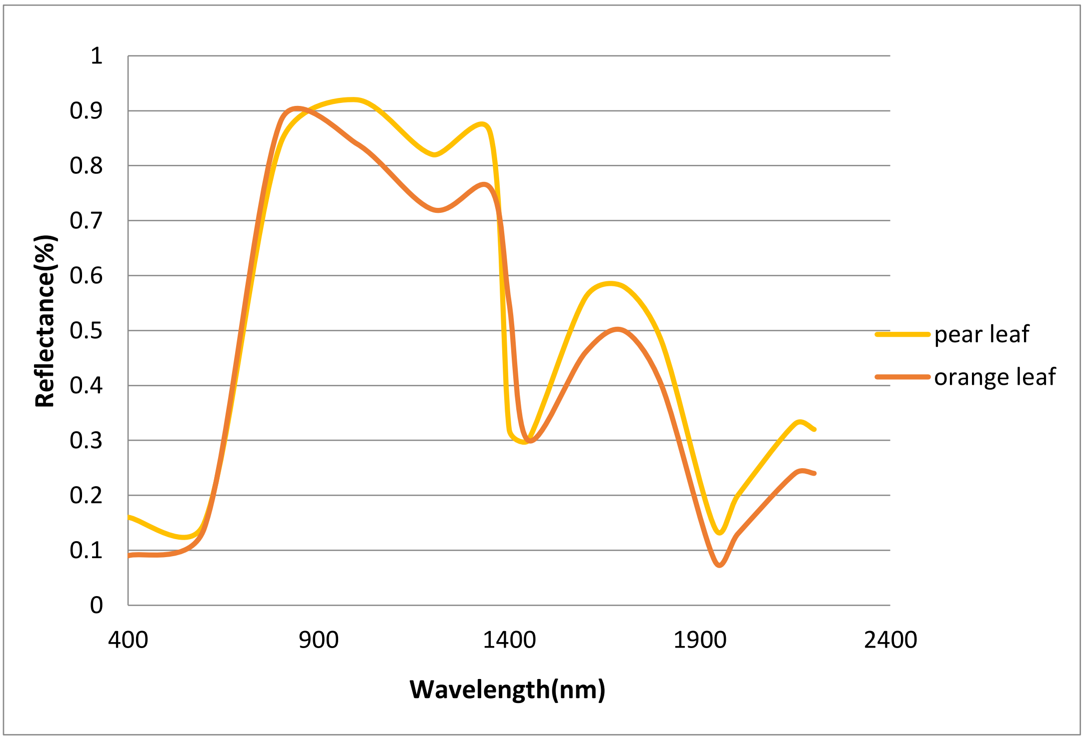

Figure3.2: Matching between the spectral Reflectivity of the leaves(Orange-Pear) before the burial, at 20/09/2021.

3.3.Measurements of the Spectral Reflectivity for the Soil which the leaves Buried in it, for Both Depths 40cm,100cm, and for the First Step at 29/11/2021

Measurements of the reflectivity of the soil in which the orange leaf is buried show a difference in reflectivity values between the two depths, as shown in the Fig(3.3). This figure shows that at depth 40cm the environment is natural, and suitable for living the simple organisms which responsible on the decomposition of organic matter. There may be a minor effect of surface humidity , after the samples (leaves) were buried in the soil ,after two months, high humidity and low temperatures were occurred due to the light rainfall between 2/11/2021 and 20/11/2021. This led to high humidity and low temperatures, which led to the decomposition of the leaves and the formation of organic matter in the soil.

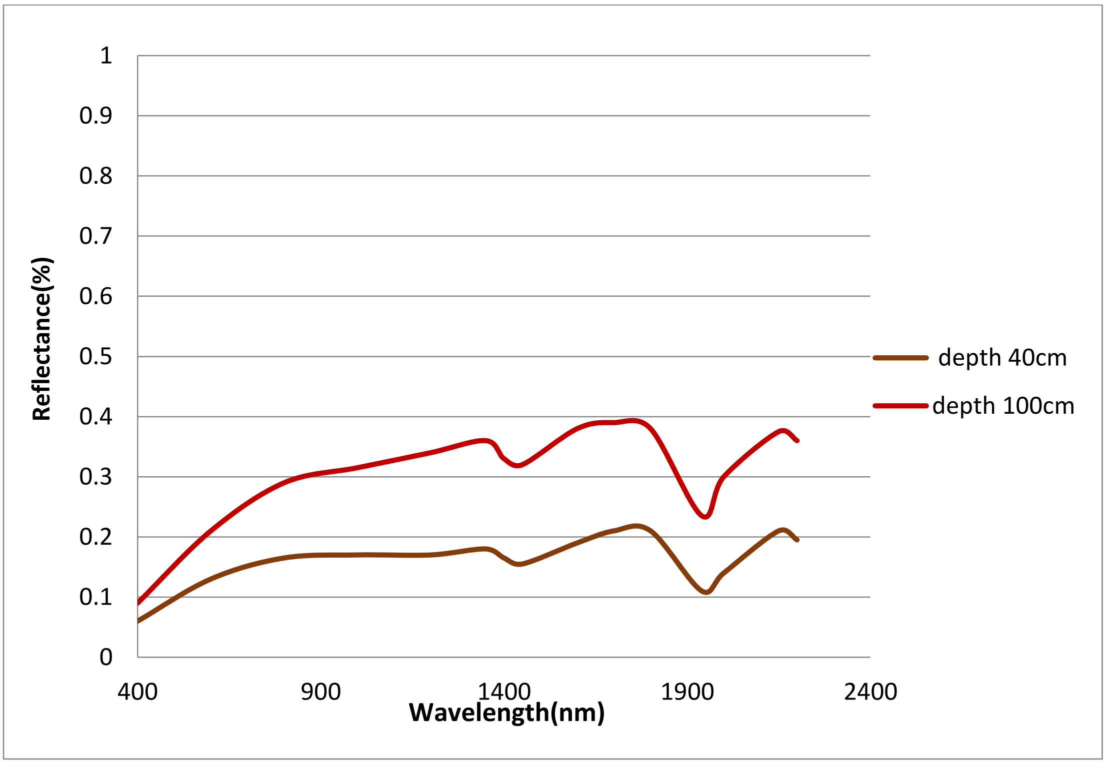

Figure3.3: Matching between the spectral reflectivity of orange leaf for two depths 40cm,100cm, at 29/11/2021.

In the pear leaf, the measurements showed little variation in the reflectivity values between the two depths This was due to decreases of organic matter which result from decomposition of pear leaves and the same reason that mentioned in the paragraph (3.2), where the primary measurements were still recorded with little downward change in values .As show in Fig(3.4).

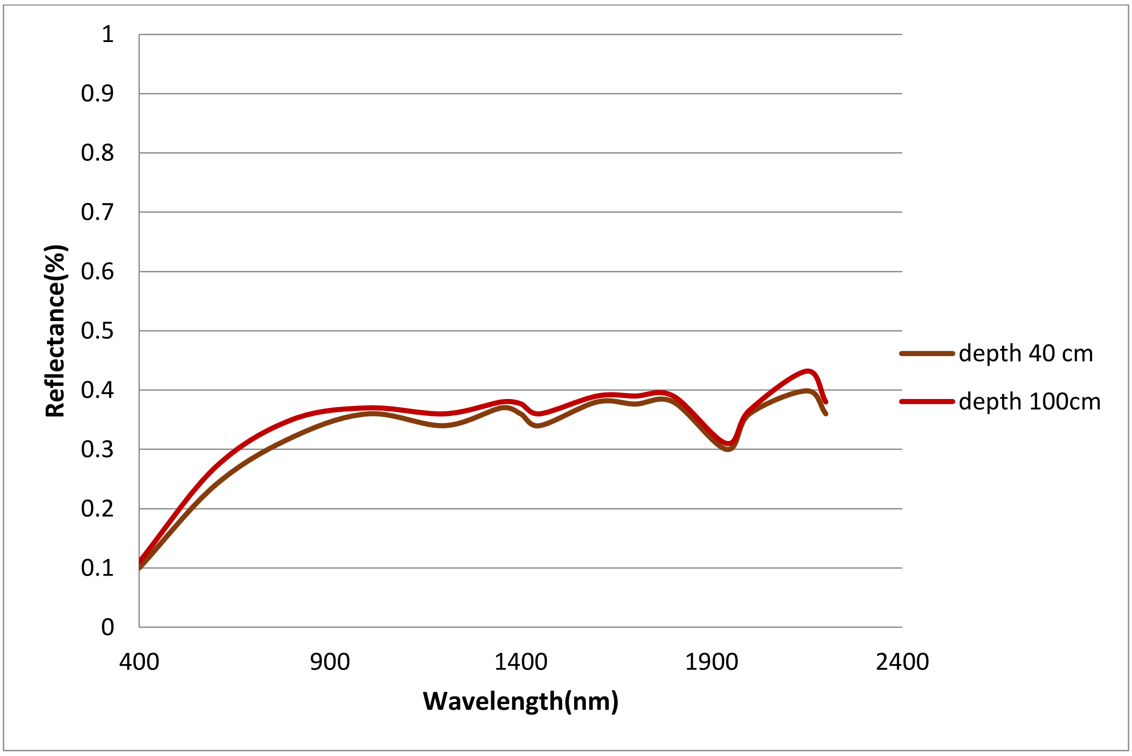

Figure3.4: Matching between the spectral reflectivity of pear leaf for two depths 40cm,100cm, at 29/11/2021.

3.4.Measurements of the Spectral Reflectivity for the Soil which the Leaves Buried in it, for Both Depths 40cm,100cm, at 18/5/2021

The reflectivity of soil samples in which both leaf types were buried was measured, and this was the last measurement period 247 days after the samples were buried. As show in which figures(3.5),(3.6). Both figures show that the reflectivity of 40 cm is less than the depth of 100 cm, and for the same reason that mentioned in the paragraph (3.3), which states on the effect of greater decomposition of organic matter at this depth. The burial period had a significant effect in increasing the amount of organic matter that produced compared to the first measurement period after the samples were buried.

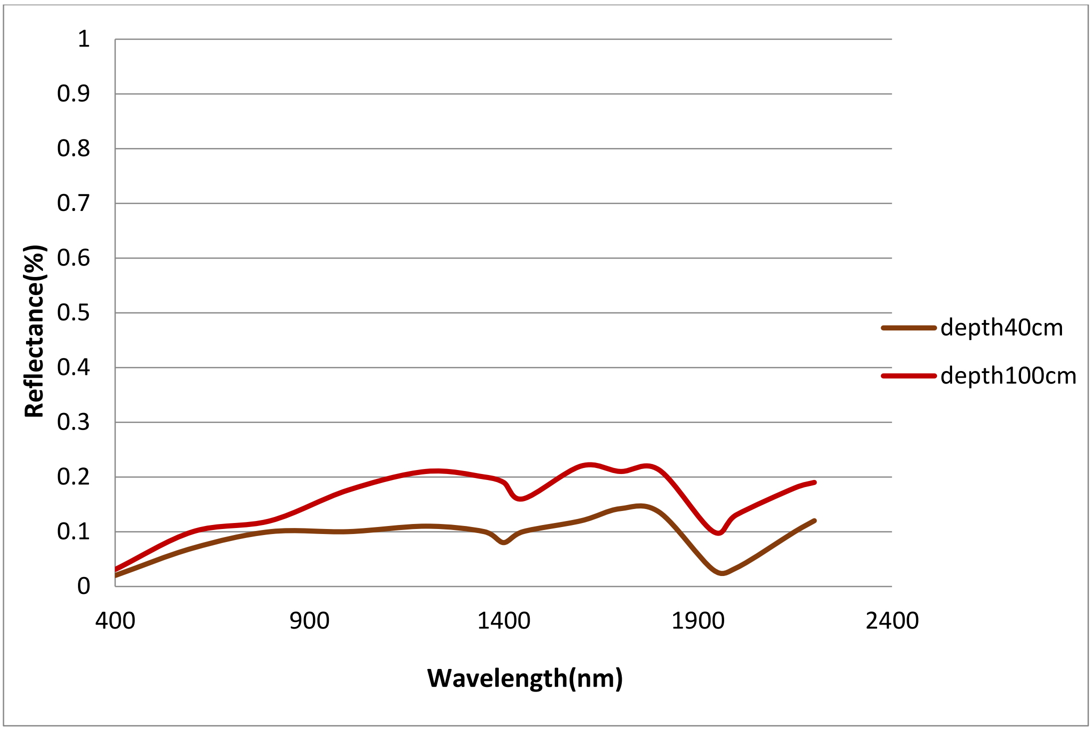

Figure3.5: Matching between the spectral reflectivity of orange leaf for two depths 40cm,100cm, at 18/5/2021.

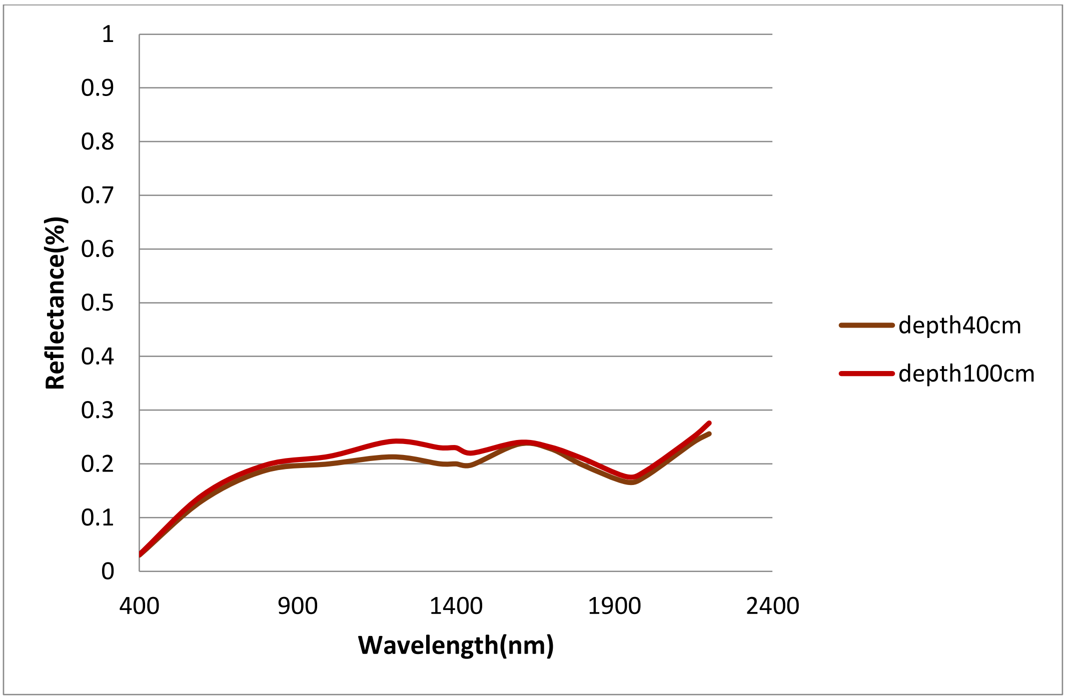

Figure3.6: Matching between the spectral reflectivity of pear leaf for two depths 40cm,100cm, at 18/5/2021.

3.5. Follow General Changes in Soil Reflectivity During all Measurement Periods and for Depth of 40 cm

The soil reflectivity values were continuously recorded and for all measurement periods which lasted to 247 days. It shows that the reflectivity of the soil has been progressively reduced , in the last measurement, on 18/5/2021, has turned into a shape that is somewhat identical to the standard soil reflectivity, as show in Fig(3.7). And that was by removal the chlorophyll effect, it was clearly in the early measurement periods. But the chlorophyll effect is still reflective in this shape. The ratio of organic matter at the first measurement was 3.36%, and it increased to 5.1% at the last measurement, this was the cause in the spectral reflectivity of soil samples decreased.

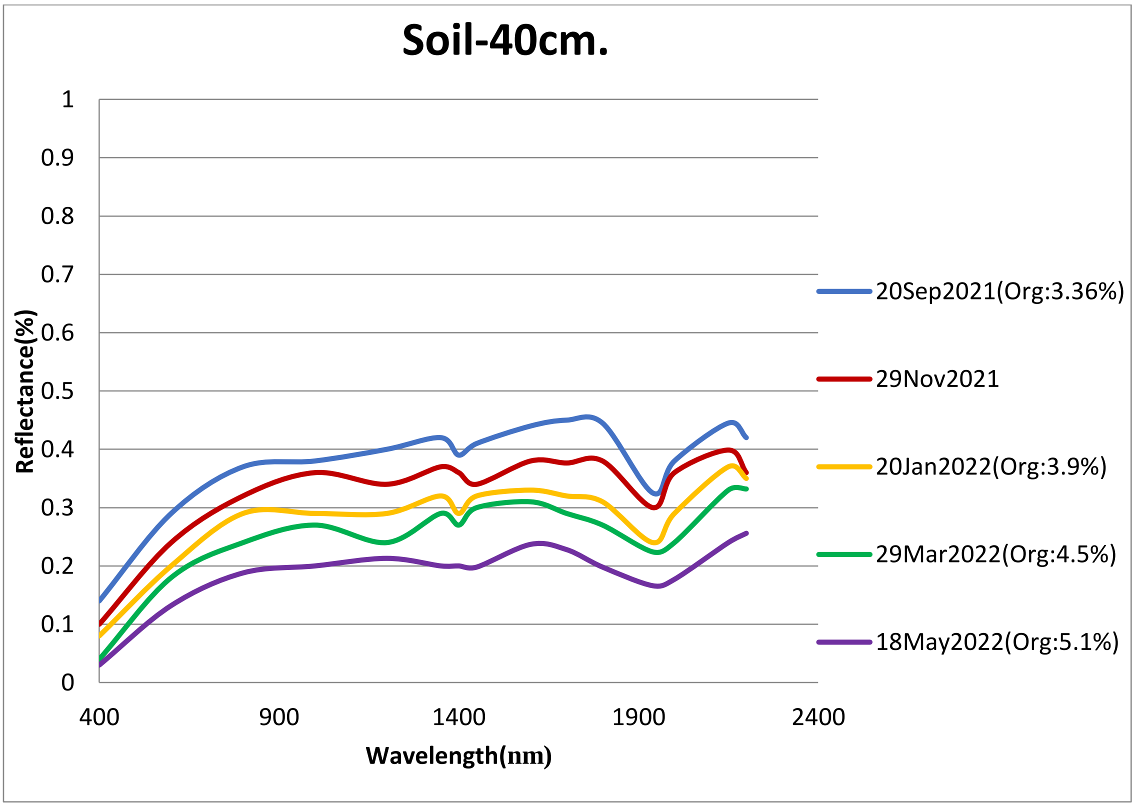

Figure3.7: The spectral reflectivity of the soil on a depth of 40cm,for all measurement periods.

3.6. Follow General Changes in Soil Reflectivity During all Measurement Periods and for Depth of 100 cm

All measurements showed variations in soil reflectivity values along measurement periods. In Figure (3.8) it is show that the reflectivity of the soil still predominates on the organic matter which mixed with it. The reason for this was that the rate of decomposition of organic matter at this depth was relatively low compared to 40 cm depth. The ratio of organic matter at the first measurement was 3.33%, and it increased to 4.81% at the last measurement.

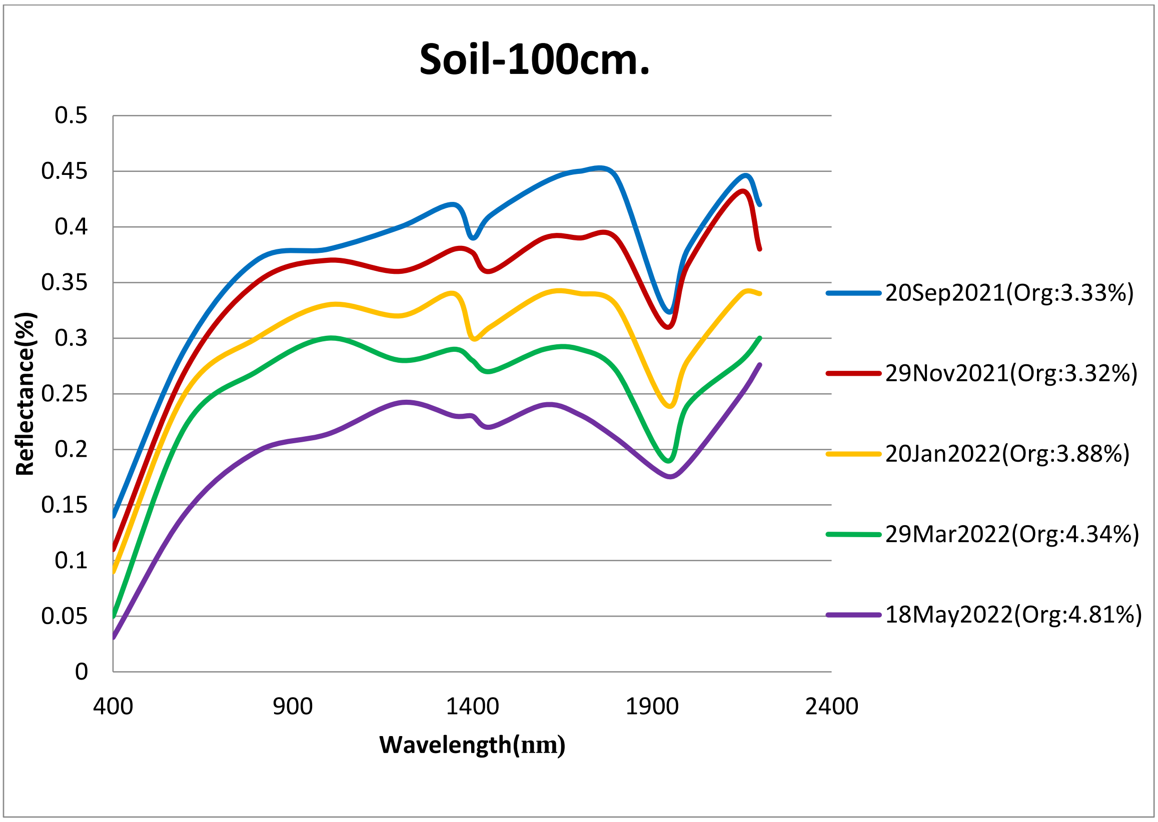

Figure3.8: The spectral reflectivity of the soil on a depth of 100cm,for all measurement periods.

3.7. The Relationship between the Spectral Reflectance of the Soil and It's Organic Content.

Measurements during their five periods showed a clear inverse relationship between increased soil organic matter (resulting from leaf decomposition in the measurement regions) and the reflectivity value. The organic matter at the beginning of measurements was in a normal limit without entering organic material that produced from the decay of leaves. Re-measured reflectivity showed a decrease in the reflective value of the soil with an increase in organic content, as show in which figures (3.9), (3.10) an increase in organic matter in very small amounts caused a clear decrease in reflectivity, this is because the ideal and natural condition of the soil has changed. The measurements gave values influenced by the reflectivity of organic matter away from the natural condition of soil.

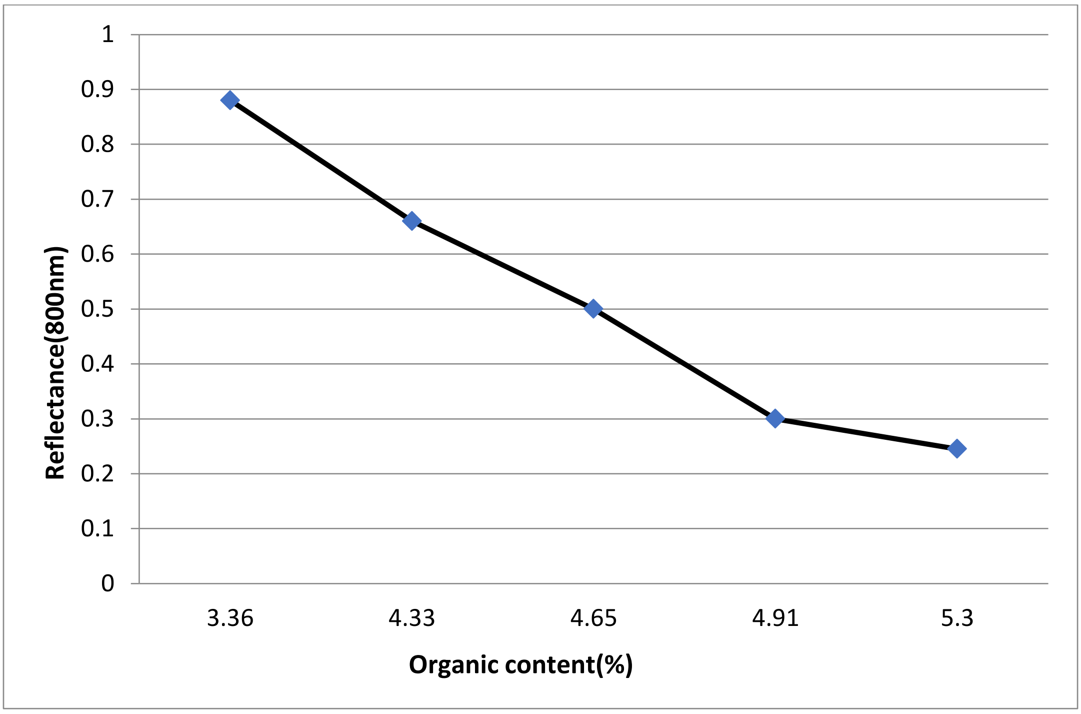

Figure3.9: The Relationship between the Reflectivity of the Soil which orange leaves are buried and it's Organic Content.

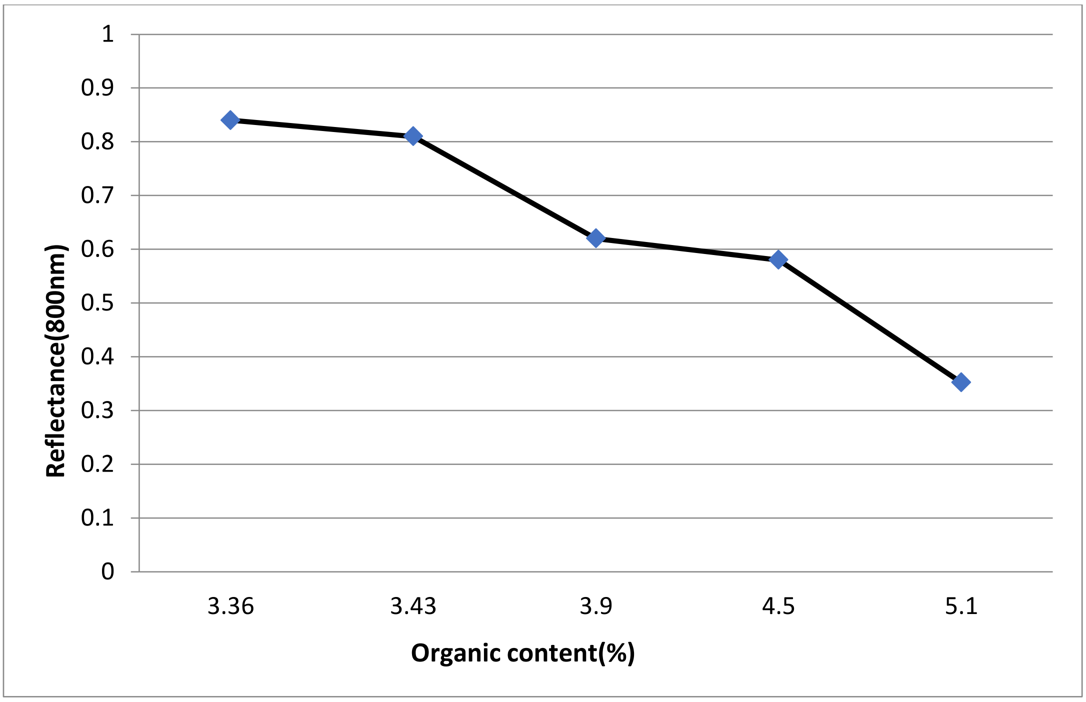

Figure3.10: The Relationship between the Reflectivity of the Soil which pear leaves are buried and it's Organic Content.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1.Conclusions

1- There was a clear inverse relationship between the value of the reflectivity of the soil and the amount of its organic content. This relationship changed magnitudes during the measurement periods, but was generally inverse between them.

2- There was little effect of climatic conditions on soil reflectivity readings because the measurement period was dry in terms of rainfall. The total rainfall for the measurement period was 7.336 cm. If it were rainy, there would be a significant effect on the difference in reflectivity due to humidity. In terms of heat, we didn't notice a clear effect, and it's consistent with theories of universal reflectivity.

3- Measuring the reflectivity of two different leaf types shows that the shape of the leaf and its internal structure have a significant effect on the reflectivity value of both leaves. The different internal structure, cell size, and amount of chlorophyll gave different reflective curves between the two type of leaves. If a further measurement of another leaf were introduced, the results would show another variation, which would give a reflective classification by type of plant**.**

4- The difference in burial depth showed a significant effect on the strength and amount of decay of the leaves, and thus showed clear differences in reflectivity between the depths, and to the same type of leaf . So the burial depths were chosen as far away as possible from surface moisture or groundwater influence.

5- There is no fixed standard curves to all regions and for all times; it can change from one region to another as climatic, environmental and geological conditions change, or it can change in the same region as those elements change.

4.2.Recommendations

There are two main recommendations that can be proposed for any future research in reflectivity remote sensing and designing standard curves

1- Conducting a similar research to the current one, but by burying the leaves in a two different soil and environment, the first in Ramadi and the other in one of the northern governorates of Sulaymaniyah, for example, To study the impact of the difference in the environment, soil type and climate on the results of organic decomposition and the expected a large difference in the results of the measurements with one condition is the burial and measurement take place at the two sites on the same day to ensure the same measurement periods .

2- Repeating the measurements in the same way as the current one if there is a rainy season with good precipitation to determine the effect of the moisture on the samples and reflectivity, because that factor had no so clear effect in our present study with that dry rainy season .

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المستخلص

تهدف هذه الدراسة الى قياس تأثير المادة العضوية على انعكاسية التربة في منطقة الصوفية –مدينة الرمادي وخاصة عند عدم وجود أي منحنيات انعكاسية قياسية للمنطقة. حيث يتغير انعكاس التربة مع بعض العوامل وتفقد خصائصها الرئيسية ، مما قد يؤدي إلى أخطاء في عمليات التفسير لانعكاسية التربة للعديد من الدراسات .يمكن أن تكون النتائج الخطوة الأولى في تصميم هذه المنحنيات للمنطقة و كمرجع لغيرها . ولإنتاج مادة عضوية متحللة داخل التربة بصورة سريعة ، تم اختيار أوراق أشجار البرتقال والكمثرى (تختلف من حيث الخصائص) و وضعت داخل أكياس شبكية و دفنت على عمق 40 سم و 100 سم لضمان أن النماذج لا تتأثر بالرطوبة السطحية أو الجوفية . تم قياس المدى الكلي للانعكاسية (المرئي و وصولا لتحت الحمراء) لكلا نوعي اوراق النبات وللتربة المحيطة قبل الدفن وباستخدام جهاز قياس الانعكاسية الطيفية(spectroradiometer-fieldspec®3). وكذلك تم قياس حرارة ورطوبة النماذج والتربة المحيطة بها قبل وبعد عملية الدفن. وفي مختبرات قسم الكيمياء تم قياس اجمالي المادة العضوية في التربة باستخدام طريقة (بيروكسيد الهيدروجين H_2O_2) . حيث تكررت عملية القياس كل شهرين تقريبًا حتى كانت الفترة الإجمالية للقياسات 247 يومًا. أظهرت القراءات النهائية انخفاضًا في انعكاسية التربة بمعدل(15%) و زيادة المادة العضوية بمعدل (5.3%). وقد أعطت نماذج كلا النوعين من الأوراق المتحللة قراءات مختلفة تعتمد على نوع وشكل الأوراق وصلت نسبة الاختلاف الى (20%) ، ولم تكن للانعكاسية منحنيات ثابتة على طول فترة القياس. كذلك لم يكن هنالك تأثيرًا واضحًا للتغيرات المناخية على القراءات وخاصة الرطوبة بسبب كون فترة القياس كانت فترة جافة وقليلة الامطار في المنطقة حيث كان إجمالي كمية هطول الأمطار (7.336سم) خلال فترة القياسات . لذلك لا يوجد تأثير للرطوبة على الانعكاسية في نفس الموقع للنماذج المدفونة. أعطت العينات قراءات مختلفة وذلك بسبب ان في العمق 40 سم تكون بيئة مناسبة لمعيشة الفطريات المسؤولة عن التحلل العضوي تكون أكثر نشاطًا على عكس العمق الاخر ذو النشاط التحليلي الاقل . بشكل عام اشارت الدراسة الحالية بأنه لا توجد منحنيات انعكاسية قياسية يمكن استخدامها لجميع المناطق والأوقات أو لجميع أنواع النباتات ، ولكن مع حالة التربة المماثلة ، يمكن أن تكون قراءاتنا الأخيرة هي المرجع لدراسات انعكاس التربة الجديدة لتجنب أي خطأ يمكن أن يحدث في التفسيرات.

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الجيولوجيا

قدمت من قبل
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