Ahmed Majeed Heeshan[*]
Ammar S. Ismaeal

Abdulla Azawi Rashid

Department of Soil Science and Resource Water, College of Agriculture, Tikrit University, Iraq

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Optical, morphological and Physico-chemical Properties For some soils in central and northern Iraq, using a digital camera

ABSTRACT

The study was conducted in three selected sites representing the soils of three governorates of central and northern Iraq (Salah al-Din, Kirkuk, and Erbil), to determine the effect of morphological, physical and chemical characteristics of some soil genetic horizons on their spectral reflectivity using digital camera as well as Knowing the degree of soil development and classification according to the Quantitative (American) system for classifying soils, Three pedons representing these soils were excavated, the horizons were morphologically diagnosed and samples were obtained from each horizon of each pedon from the soils of the study sites to conduct some laboratory tests for the physical and chemical properties. Pictures were taken that combine dry and wet samples; In order to calculate the spectral reflectivity and RGB values using ERDAS software. The results revealed a heterogeneity in the morphological characteristics represented by the dominant color class of each pedon, with the diagnosis of the morphological features of each of the surface diagnostic horizon Ochric with the subsurface diagnostic horizons Gypsic, Calcic and Argillic. The results also found that the spectral reflectivity values of RGB were high in dry soil and decreased in the wet condition, and the lowest value of the spectral reflectivity was for the surface horizons, as it reached 44.87% on the surface horizon of the second pedon, and the highest value of the reflectivity was on the horizon Cky1 of the pedon 1, where its ratio is 72.15% ,and the reflectivity values of the red color at the red band were high in pedon Erbil as a result of the effect of iron oxides. Show the spectral and hematological differences represented by the index of brightness (value), hue and index of iron oxides The results also found that the most influential traits in these spectral indices are the dominant soil color as well as the texture of the soil represented by the content of silt and clay with moisture content, as well as the effect of the content of organic matter, iron oxides, gypsum and lime content on the surface and subsurface diagnostic horizons.

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INTRODUCTION

Knowing and studying the spectral reflective properties of soil has become important and effective in identifying and interpreting many of the soil characteristics that depend on it in the processes of surveying and classifying soils and drawing digital soil maps. on the surface of the earth depending on the wavelength used. That is, some soil materials give a high reflection when photographed by one of the spectral channels, and their reflectivity varies relatively through other channels, and the totality of these differences is what is known as the spectral behavior (reflection or emissivity) of soil materials or components of any other system.)) The spectral reflectivity is defined as the ratio between the amount of The total rays incident from any environmental component to the rays reflected from it as a function related to the wavelength (Daghestani, 2003.(

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[*] *Corresponding author: E-mail*: **ahmedmajeed@st.tu.edu.iq**

The spectral reflectivity of soil and soil color are important indicators in the application of modern technologies and as a good and effective tool in identifying and distinguishing differences between soils. The results of recent studies and research confirmed the importance of knowing and determining the spectral reflective properties of soils because of their effective role, and a close link with different soil properties, which were recently called the optical properties of soil (Al-Dulaimi, 2012) and (Atiya, 2017).

Al-Jawadi, (2006) indicated the possibility of relying on calculating the results of the values of the red, green and blue beams from the digital camera as an approximate measuring device for the reflectivity values, in the event that the spectra radiometer is not available in the field, taking into account the discrepancy that occurs In the reading, it was found that the values of the digital camera readings gave higher values than the calculations obtained using the spectra radiometer, and this is due to the specificity of the digital camera and the specificity of the calculations in which the reflectivity was estimated. Al-Dulaimi (2007) reached the possibility of using the ERDAS program in studying soil color and calculating the spectral reflectivity of the soil by calculating the values of the basic colors (R G B), and found that There is a strong relationship between soil color and spectral reflectivity with some physical properties of soil such as texture and moisture content, as well as some chemical properties such as organic matter, iron oxides, gypsum and lime content.

The process of linking the morphological, physical and chemical properties of soils with the spectral properties of the important matters that help in predicting a number of factors that affect the components and conditions of the soil. The spectral reflectivity of the soil is affected by the morphological, physical and chemical properties of the soil, especially iron oxides, tissues, organic matter, minerals and dissolved salts, as well as About the factors of surface roughness and moisture content, which play an important role in influencing the spectral reflectivity (Al Salem, 2018).

Al-Askari (2019) concluded the possibility of using a digital camera and relying on calculating the results of the basic color values RGB (Red, Green, Blue) in order to find the spectral reflectivity values of the soil by relying on the ERDAS program, and it was also shown that it is possible to rely on the values of Primary colors in the absence of a field or laboratory device (Spectra radiometer). The study of Al-Kiki et al. (2020) in the Al-Faisaliah area, northeast of Mosul, aimed at calculating the basic color values of RGB soils by making use of the digital camera, as well as making use of a color book.

The results of the study carried out by Hamad et al. (2021) in Erbil governorate indicated that there is a case of differences in soil color and spectral reflectivity between the surface and subsurface layers, and the reason for this difference is due to the discrepancy in organic matter between soil horizons, especially the surface horizons.

The current study aims to assess the morphological, physical and chemical properties of the soil, as well as to determine the optical properties based on color evidence using a digital camera, and to determine the most capable spectral channels in showing the variations in the soil characteristics of the surface and subsurface diagnostic horizons in selected sites from the soils of central and northern Iraq.

MATERIALS AND WORKING METHODS

Study area

Depending on the reference data represented by Google maps, topographical maps and a review of previous studies, the study area was chosen in central and northern Iraq, representing the nature of the variability in the source material of the selected soils under dry and semi-arid climatic conditions (Figure 1). Three pedons of soils of two different origin materials were selected. Pedon 1 is of gypsum-calcareous origin, west of Tikrit, in the Ayyubid region, located within coordinates latitude 34º37′55.53″ N, and longitude 43º36′36.63″E. The average annual temperature and the average annual precipitation are more than 22 and 150 mm with slightly flat terrain. Pedon 2 is made of limestone in the north tof Kirkuk governorate in the Altun Kupri region. It is located within the coordinates, latitude 35º36′45.15″N, and longitude 44º20′49.31″E. The average annual temperature and the average annual precipitation are more than 22 Degree and 375-400 mm with a slope of 1 %. Pedon 3 consists of limestone material west of Erbil Governorate in the Karak region.

It is located within the coordinates, latitude 36º16′07.19″ N, and Longitude 44º01′47.80″ E. The average annual temperature and average annual precipitation are more than 20° and 500mm With a slight slope level 2-3%.
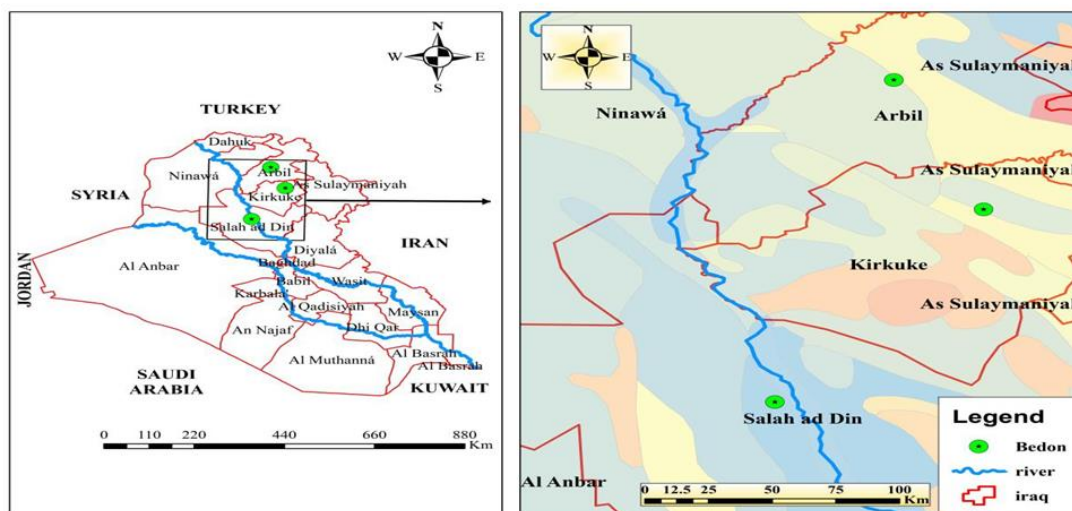

Figure 1: The soil locations of the study areas

Field Procedures

Three pedons representing these sites were excavated and morphologically described according to the principles mentioned in the Soil Survey Staff.(2017) and based on the morphological documentation form to study the morphological characteristics (soil color, soil composition, soil nationality, root distribution, horizons boundaries, and aggregate forms of lime and gypsum).), then soil samples were taken from the genetic horizons representing each pedon and placed in nylon bags and transported to the laboratory to study the physical and chemical properties. Then the soil samples were dried pneumatically, and then ground with a wooden mallet and sieved with a sieve diameter (holes of 2 mm), collected, and placed in cans A plastic sheet with the number, name, horizon and depth of the pedon shown on it; thus, it was ready for laboratory analysis.

laboratory work

Soil separations (sand, silt, and clay) were estimated using the international pipette method described by (Kimer and Alexander, 1949). The bulk density was estimated according to the method (Black, 1965). The total porosity of the soil was calculated through the relationship between the bulk density and the real density mentioned in ((Black, 1965).

Porosity = [1- (Bulk Density/ Partical Density)]x 100

$$f = \left(1 - \frac{pb}{ps}\right) * 100$$

The soil pH was also estimated and the electrical conductivity of the soil was measured by making an extract (1:1), and using the (Ec Meter) and according to Richards (1954). The cation exchange capacity(CEC) was estimated using ammonium acetate and sodium acetate, according to (Rhoades, 1982) method mentioned in (ICARDA, 2003). Calcium carbonate (calcium) was determined by titration with sodium hydroxide (NaOH) (N1) and in the presence of phenolphthalein evidence, and as mentioned in Page et al., (1982). Calcium sulfate (gypsum) was determined by the acetone method, as stated in (Richards, 1954). The organic matter was estimated by wet digestion method, according to the method mentioned in (Black and Walkely) and mentioned in (Jackson, 1958).The iron was extracted in the form of free oxides by the Citrate-Bicarbonate-Dithionite (CBD) method, according to the Jackson Mehra and (1960) method. Iron with an Atomic Absorption Spectrophotometer with a wavelength of (882 nanometers).

The digital camera and the spectral Evidence of the soil peduncles of the study area were used to find out the variation in the morphological characteristics (soil color) and optical properties, by placing the crushed samples on a sieve (2) mm in Petri dishes. Two boxes of Petri dishes are

used for each sample, then we settle the soil surface By means of a ruler to make the surface smooth and flat, then the wetting process is carried out using a humidification machine (sprayer) for one Petri dish (the amount of water added (10) mm), then the dishes were placed in a sequential manner, as well as the identification card to indicate the sample number and sequence, and the pictures were taken which combines dry and wet samples as in Figure (3); In order to calculate the (RGB) values, then the spectral reflectivity values and the color indices of the soil sites represented for the study were measured by applying the color result equation (reflectivity) proposed by George et al. (1981) using the ERDAS program, which expresses (Earth Resources Data Analysis) .

$$………………………………………….. (1) P = \sqrt{X^2 + Y^2 + G^2}$$

When applying the equation to the colors, it will become in the following form:

$$P = \sqrt{R^2 + G^2 + B^2} …………………………………….. (2)$$

whereas :

R = X , G = Y , B = GE

P = represents the sum of the chromatic values of the selected spectral bands reflected from the pedon site.

R = the value of the reflectivity at visible red rays with a wavelength of (0.6-0.73) µm.

G = the value of the reflectivity and the visible green rays and their wavelength (0.5-0.6) µm.

B = the value of the reflectivity at the visible blue rays with a wavelength of (0.4-0.5) µm.

The result of the reflectivity is found by dividing the value of the resultant color of the soil by the value of the standard material used, multiplied by (100).

It is expressed in the following form:

$$………………………………….. (3) \qquad RF(\%) = Ps/Pw \times 100$$
$$…………………………………. (4) \qquad Ps = \sqrt{Rs^2 + Gs^2 + Bs^2}$$
$$……………………………………. (5) Pw = \sqrt{Rw^2 + Gw^2 + Bw^2}$$

- Brightness Index-BI, which expresses the reflectivity rate

$$BI = \sqrt{\frac{R^2 + G^2 + B^2}{3}}$$

- Wavelength Index (Hue Index-HI), which expresses the sum of the primary colors

$$HI = (2XR - G - B)/(G - B)$$

- Saturation Index -SI, which expresses the spectrum (Spectra Slope) and the extent of color saturation (such as light red and dark red.

$$SI = (R - B)/(R + B)$$

- Color Index -CI, which expresses the color of the soil (Soil Color).

$$CI = (R - G)/(R + G)$$
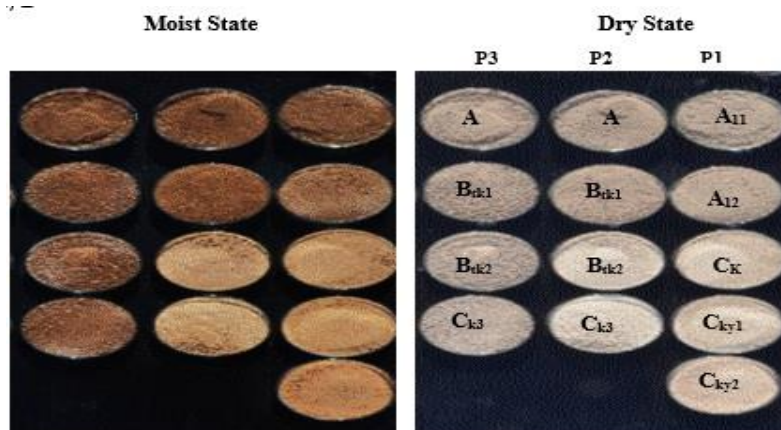
- Iron Oxide Ration-IOR Index

$$IOR = R/B$$

Figure (2): Method for laboratory imaging and measurement of soil color for dry and wet conditions

RESULTS AND AND DISCUSSION
Morphological characteristics of the study sites of pedons soils

Through the morphological description of the soil peduncles of the study sites Table (1) and Figure (3), it was found that the values of the dominant wavelength (Hue) For all soil pedons of the study sites were from page 10YR of the color atlas, as most of the soils of dry and semi-arid areas located inside this page, as the soil colors of the surface and subsurface diagnostic genetic horizons for the Tikrit soils ranged from light yellowish brown to very pale brown, As for the pedon2 of the soils of the Kirkuk site, it ranged from light yellowish brown to very pale brown. As for the pedon3 of the soils of the Erbil site, yellowish-brown predominated. As for the degree of chromatic intensity (Value), which reflects the spectral reflectivity value of the soil components whose values generally range between zero, as in the case of black soils. to 10, as in the case of white-colored soils. The difference soil color between this range is due to the heterogeneity of the internal soil characteristics that reflect the manifestations of the activity of some pedogenic processes affecting the formation of these soils and the mineral and organic nature of the soil as well as the water content in it within the surface and subsurface diagnostic genetic horizons. It ranged between (5-8), and the degree of color purity or saturation (Chroma) ranged between (3-6), and this discrepancy in the degree of intensity (Value) and the degree of color purity or saturation (Chroma) may be attributed to the nature of the prevailing morphological characteristics in the soil Which reflects the formative nature of these soils and their influence on the factors and processes of their formation, as we note in pedon Tikrit that the chromatic intensity values of the surface and subsurface genetic diagnostic horizons were affected by the roughness of the Soil Particles Size Distribution type represented by the high content of sand as these soils are poor in their content of organic matter and iron oxides and because of the inability of these soils to retain moisture, This is reflected in the nature of the dominant soil color type, as well as the diagnosis of the surface horizons represented
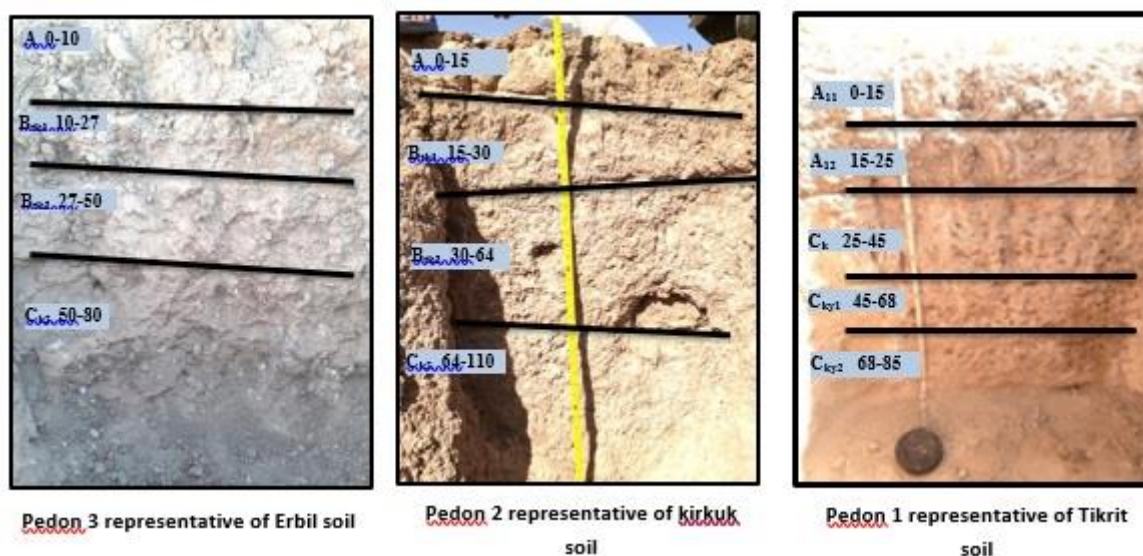

Figure 3: Pictures of the study sites' soil

by the oak horizon and the sub-surface genetic horizons represented by the gypsum and calcic horizons, which are characterized by light colors as a result of their high content of these components, as the presence of gypsum and carbonate with a high content increases the values of soil color in order to acquire a characteristic The color is white and due to the absence of the effect of moisture content, and this is consistent with (Al-Ani, 1980), (Al-Dulaimi, 2007) and (Lulu, 1998). Accordingly, the pedon 1 ranged in the dry state between (4 10YR6/ and 10YR8/3), and in the wet state it ranged between 10YR4/4) and 10YR6/4).). As for the pedon of Kirkuk, it ranged between (10YR6/4 and 10YR7/4) in the dry state, while in the wet state, it ranged between 10YR4/4 and 410YR6/), as for the pedon soils of the Erbil site, it ranged in the dry state between (10YR 5/4) and 10YR 5/6), and in the wet condition, dark yellowish brown (10YR 4/4) prevailed From the foregoing, we note that the chromatic intensity and purity values of the surface and subsurface diagnostic horizons are affected by the physical characteristics represented by the high

Table (1): Morphological characteristics of the study sites

Horizon	Depth(cm)	Color Dry	Color Moist	Texture Classe*	Structure**	Consistence*** Dry	Consistence*** Moist	Root distribution	Boundary	Notes
Tikrit Pedon / P1										
A_{11}	0-15	10YR 6/4	10YR4/4	SCL	2msbk	s.h	Fri	Many v.fine fibrous	Abrupt smooth boundary	Accumulation of Lime and gypsum in the soil matrix as vertical gypsic threads and beards
A_{12}	15-25	10YR 6/4	10YR 4/4	L	2msbk	s.h	Fri	Many v.fine fibrous	Abrupt smooth boundary	
C_k	25-45	10YR 8/3	10YR 6/4	L	2msbk	H	Fi	v.few.v.fine roots	Clear smooth boundary	
C_{ky1}	45-68	10YR 8/3	10YR 6/4	L	1msbk	v.h	Fi	-	Clear smooth boundary	Accumulation of lime and gypsum as vertical gypsic threads and beards
C_{ky2}	68-85	10YR 8/3	10YR 6/4	L	1msbk	v.h	Fi	-		Accumulation of gypsum as beards
Kirkuk Pedon / P2										
A	0-15	10YR 6/4	10YR 4/4	CL	2mg	Sh	Fri	v.few.v.fine fibrous roots	Clear smooth boundary	accumulation of powdery spots of lime
Btk1	15-30	10YR 6/4	10YR 4/4	C	2mg	Sh	Fri	v.few.v.fine fibrous roots	Clear wavy boundary	accumulation of powdery spots of lime
Btk2	30-64	10YR 6/4	10YR 4/4	C	2msbk	Sh	Fri	-	Clear wavy boundary	accumulation of powdery spots of lime
Ck1	64-110	10YR 7/4	10YR 6/4	CL	2csbk	Vh	Fi	-		
Erbil Pedon /P3										
A	0-10	10YR 5/4	10YR 4/4	CL	2msbk	Sh	Fri	v.few.v.fine fibrous roots	Clear wavy boundary	
Btk1	10-27	10YR 5/4	10YR 4/4	SiC	2msbk	Sh	Fri	v.few.v.fine fibrous roots	Clear wavy boundary	accumulation of powdery spots of lime
Btk2	27-50	10YR 5/6	10YR 4/4	SiC	2csbk	Sh	Fi	-	Clear wavy boundary	accumulation of powdery spots of lime
Ck1	50-80	10YR 5/6	10YR 4/4	SiC	2csbk	H	Fi	-		accumulation of powdery spots of lime

* L= Loam, SCL= Sandy Clay Loam, CL= Clay Loam, C= Clay, SiCL = Silty Clay Loam

** 1 = Weak   2 = Moderate   sbk = Sub angular block   m = medium   g = Granular   c = coarse

*** s = Slight   h = Hard   fi = Friable   fii = Firm   v.fr = very friable , v.h= very hard

content of silt separated as the high content of silt reduces the values of soil color, because the silt is one of the effective components of the soil and has the ability to link with iron compounds and organic matter as well as the high content of silt. Clay separated, which has the ability to bind with other soil components of iron compounds and organic materials, in addition to its ability to retain moisture to a large degree, and thus increase the darkening of the soil and this is consistent with (2002) and Al-Dulaimi, (2007). The dominance of the soft Soil Particles Size Distribution class with the predominance of the effect of the moisture content had the effect of decreasing the values of soil color, as well as the effect of some chemical properties such as organic matter and iron oxides, which increase the darkening of the soil. The reason for the difference in the color of the horizons is also due to the nature of the material of the original lime and gypsum, as well as the organic matter, and this is consistent with (Al-Qaisi, 2020), (Yahya, 2017) and (Al-Husseini, 2010.(As for the Soil particle size distribution class prevalent in the surface and subsurface genetic diagnostic horizons for pedons of soils of the study sites, it ranged from the medium coarse texture class represented by mixture to the soft tissue class represented by clay tissue, lipids in the soils of Tikrit, Kirkuk and Erbil, respectively. The coarse-texture class predominated in the pedon1, representing the Tikrit soil, while the soils of the Kirkuk and Erbil sites were characterized by the predominance of the medium-to-soft tissue class in the surface and sub-surface genetic diagnostic horizons.

As for the structure prevailing in most of the soils, it was lumpy, not sharply angled, in the subsurface horizons, while some of the surface horizons were of the granular type. As for the degree of construction, it was moderate for most of the surface and subsurface horizons, As for the building volumes, it was prevalent for medium construction in the surface horizons. As for the subsurface horizons, it was between medium to coarse.

The reason for this discrepancy in the nature of the soil structure between the soil pedons of the study sites may be attributed to the nature of the deposition of the parent material and the nature of the environmental conditions and the pedogenic processes affecting the stages of soil formation and development, in addition to the presence of carminative and binding materials such as decomposing organic matter, iron oxides, carbonate minerals and sulfates, which affect the regularity of soil particles The primary and consequently in the shape of the soil aggregates, its size and the degree of its development to form the shape of the building units prevalent in these soils.

As for the texture of the soil, we find that all study sites for the surface horizons in the dry condition were lightly hard, while in the wet condition, the texture of the soil for the surface horizons was between very fragile and fragile). As for the subsurface horizons, they ranged between lightly hard, hard and very hard in the dry state, while in the wet state they ranged between friable and firm. It is also noted through the morphological description that the boundaries separating the surface horizons ranged from abrupt to clear in their degree of clarity and smooth and wavy in their topography.

As for the subsurface horizons, the boundaries separating them were clear, flat, and wavy in their topography. This is due to the nature of sedimentation when forming these soils, in addition to the fact that the topographical characteristic reflects the intensity of the activity of some pedogenic processes and biological activity that the soil has undergone during the period. The morphological description refers to the lack of natural vegetation cover in the soils of the study sites, and its absence in general in most of the soils of the study sites, except for the surface horizon of the second pedon, where the fine roots were observed in abundance, but in the subsurface horizons and for all study sites, they were few and no. The important morphology that was diagnosed and documented morphologically forms the gypsum and lime aggregates in the pedon of the study soil. The carbonate clusters were documented in the form of white knots of different sizes in most of the study sites, especially in the subsurface horizons and for most of the sites of Kirkuk and Erbil. Likewise, gypsum aggregates in the form of small single grains with small and clear gypsum threads were found in the soils of Tikrit sites, in some of the subsurface diagnostic horizons, some of which were in the form of small columns and washing lines (dissolving) and sometimes palpation aggregates concentrated and fused under stone pieces within parts of gypsum horizons. In

addition to the presence of gypsum stone pieces of varying sizes that were diagnosed overlapping within the body of the soil in these horizons, which explains the nature of sedimentation and the effect of the origin material as well as the environmental conditions prevailing in the soil of the study site.

Physical and chemical properties

The results of the laboratory analysis of the physical and chemical properties table (2) showed that the texture of the soil differed in its content of soil particles and the nature of its distribution with depth within each peduncle and among all the studied peduncles. In general, the sand content in Pedon 1 ranges from (456-545) g. kg -1. While its weight ranges from (256-325) g. kg -1 and from (120-211) g. kg-1 in without 2, 3, respectively, while the silt value ranged between (410-448) g. Kilo-1 without 3, while it ranges from (303 - 361) g. kg -1 of (310-360) g. kg -1 in Pedon 2, 1 respectively, while the clay content ranged between (379-462) g. Kilo-1 and from (372-435) g. kg -1 from (170-240) g. kg -1 without 3, 2, 1 respectively, and this is consistent with what was found (Saleem and Mahmed, 2002) and (Jaata, 2014) (Rashid, and Kamal, 2020), (Rashid, 2017) and (Al-Taghabi, 2018). As for the bulk density of the soil, its values ranged between (1.21-1.71 Mg.m3). As for the porosity, it ranged between (35.36-54.48)%. The study pedons showed that they had a low salinity ranging between (0.31-2.52) decisamines.m-1, and this is in agreement with (Al-Ra'i et al., 1991) and (Al-Hussaini, 2010), and (Al-Dawzlani, 2011), with a neutral pH of It , which is slightly more basic due to the state of calcium carbonate, and this is consistent with (Al-Zubaidi, 1989) and (Ahmed, 1982), (Yahya, 1982), (Al-Taghabi, 2018) .

The study's pedons showed The results showed that the content of the organic matter in Tikrit Table (1): that they had low salinity, ranging between (0.31-2.52) decisamines.m-1, and this is consistent with (Rahi, et al., 1991) and (Al-Husseini, 2010), and (Al-Dawzlani, 2011), with a pH neutral to It is slightly more basic due to its calcium carbonate condition, and this is consistent with (Al-Zubaidi, 1989) and (Ahmed, 1982), (Yahya, 1982), (Al-Taghabi, 2018) .

Morphological characteristics of the study sites. ranged between (Nil-13) g.kg-1, as it showed a clear decrease in Tikrit Table (1): Morphological characteristics of the study sites. and with depth, and this is consistent with what was reached (Al-Amri, 2011), (Jaata, 2014). , and (Al-Bayati, 2010) and (Al-Qaisi, 2020). The results also showed in pedon Kirkuk and Erbil that the organic matter content was relatively high, ranging between (16-42.6) g.kg-1 .

This discrepancy in the organic matter content of some sub-surface diagnostic horizons of the soils of Kirkuk and Erbil may be due to the washing and transfer of the organic colloids to Gain horizons and their association with clay, and these results are consistent with what was indicated by (Webster et al., 2000), as they showed that a large amount of organic matter content can be washed from surface horizons to subsurface horizons. This is also consistent with (Lahsini, 2010) (Al-Ramli, 2016). The values of the cation exchange capacity ranged between (13.22- 25.18) centimole charge.kg-1 as these values were related to the soil content of organic matter and clay. The results showed an increase in the gypsum content, which showed a clear behavior in the distribution in pedon Tikrit, as the gypsum increased with depth, as its value ranged between (52.38-487.39 g.kg-1), and this is in agreement with many researchers, including (Yahya, 2017), and (Al-Bayati, 2010), (Al-Salem, 2018), (Al-Qaisi, 2020), and (Ismail and others, 2017). The results showed a relative increase in iron oxides, especially in pedon, Erbil region, and the surface horizons and subsurface horizons, especially the gain horizon. This may be attributed to the nature of the origin material originally rich in oxides, and this is consistent with (Abdullatif, 2020) (Ismail et al., 2017). The results showed a relative increase in iron oxides, especially in pedon, Erbil region, and the surface horizons and subsurface horizons, especially the gain horizon. This may be attributed to the nature of the origin material originally rich in oxides, and this is consistent with (Abdullatif, 2020) (Ismail et al., 2017). The results also showed that the study soils were calcareous gypsum in the pedon soils of the Tikrit site, while they were calcareous in the pedon of the Kirkuk and Erbil sites, with varying content of carbonate minerals in line with the prevailing site conditions in each site

Table (2): Some physical and chemical properties of the soils of the study site

Horizon	Depth (cm)	sand	silt	Clay	Texture classes	Bulk density gr.cm^{-3}	Porosity %	pH (1:1)	EC dS m^{-1}	Organic matter gkg^{-1}	Gypsum gkg^{-1}	Total carbonate gkg^{-1}	Active carbonate gkg^{-1}	CEC	Total iron oxides gkg^{-1}	Ca^{++}	Mg^{++}	Na^+	K^+	SO_4^{--}	Cl^-	HCO_3^-
			Practical size distribution gr.kg^{-1}																			
Tikrit Pedon / P1																						
A11	0-15	505	275	220	SCL	1.52	42.65	7.3	1.91	13	52.38	333.75	24.23	16	1.67	5.08	3.68	1.93	0.26	6.76	2.05	0.25
A12	15-25	410	350	240	L	1.66	37.51	7.6	2.36	10	95.23	256.75	47.86	17	7.45	4.13	4.28	10.3	0.08	9.40	3.90	0.1
Ck	25-45	490	330	180	L	1.21	54.20	7.6	2.52	4.2	271.18	262	32.26	13	5.32	5.05	3.25	9.91	0.07	7.48	8.00	0.3
Cky1	45-68	463	345	192	L	1.24	53.06	7.5	2.39	2	448.47	239.25	29.14	13	Nil	5.83	2.6	6.69	0.09	6.63	7.50	0.2
Cky2	68-85	520	310	170	L	1.21	54.48	7.5	2.39	Nil	487.39	235.75	33.12	14	Nil	6.25	2.03	6.08	0.10	6.21	8.00	0.2
Kirkuk Pedon / P2																						
A	0-15	325	303	372	CL	1.58	40.48	7.6	0.46	16.2	---	332	57.91	18	8.14	0.93	0.78	0.50	0.11	0.5	1.9	0.25
Btk1	15-30	278	310	412	C	1.56	41.12	7.9	0.41	26.1	---	365.25	35.68	19	2.34	0.55	0.28	0.73	0.04	---	2.0	0.4
Btk2	30-64	256	309	435	C	1.56	40.96	7.8	0.48	21.4	---	386.25	43.66	20	9.40	0.68	0.18	1.08	0.03	0.0	2.1	0.5
Ckl1	64-110	263	361	376	CL	1.71	35.36	8	0.63	19.3	---	402	24.28	20	11.13	0.88	0.08	1.39	0.02	0.2	2.5	0.2
Erbil Pedon /P3																						
A	0-10	211	410	379	CL	1.55	41.32	8.1	0.53	42.6	---	251.5	81.86	25	17.16	1.33	0.18	0.82	0.10	0.6	2.0	0.4
Btk1	10-27	148	440	412	SiC	1.45	45.34	8.1	0.36	39.8	---	375.75	43.47	18	2.11	0.53	0.55	0.66	0.03	---	2.3	0.7
Btk2	27-50	120	418	462	SiC	1.37	48.30	7.9	0.32	31	---	293.5	72.60	23	23.45	0.45	0.40	0.61	0.06	---	2.0	0.6
Ckl1	50-80	142	448	410	SiC	1.65	37.78	8.0	0.31	32.5	---	330.25	57.08	23	19.10	0.48	2.05	0.70	0.06	0.2	2.5	0.7

and ranged between (235.6-402) g.kg-1 There is an increase with depth as a result of the activity of decalcification and calcification processes, and the results showed an increase in active carbonate with depth in most of the pedon of the study areas as a result of the increase in precipitation and ranged between (24.23-72.60) g.kg-1.

Optical properties and colorimetric evidence of surface and subsurface diagnostic horizons computed with a digital camera

The results in Table (3) show that the optical characteristics, color indices, and spectral reflectivity values computed by the digital camera at the visible spectrum represented by the red, green and blue bands were high for all surface and subsurface genetic diagnostic horizons for the whole of the soil pedons of the study sites with the diagnosis of some relative differences in their values at some horizons As a result of the effect of morphological characteristics represented by soil color, high and low value values, as well as the effect of soil texture, salt content, organic matter content and iron oxides.

As these characteristics had the most impact on the variation in the ratios of the color indices and the values of the total spectral reflectivity. The highest value of the spectral reflectivity of the surface horizons at the horizon A1 in the pedon3 and this may be due to the high content of iron oxides, as the presence of iron oxides in the soil increases its reflectivity in the beam The visible red color (Al-Mashhadani and Al-Kubaisi, 2014), in addition to the high content of silt and clay, which affects the increase in the total spectral reflectivity, in contrast to the high content of sand, which affects the scattering of the spectral radiation and thus lowering the spectral reflectivity values at the visible wavelength, specifically at the 0.40 band, and this agrees with (Buamgardner et al., 1985) .

As for the subsurface genetic diagnostic horizons, specifically the gypsum and calcic horizon at the first pedon, the spectral reflectivity ratio was high, represented by the high values of the reflectivity of the red, green and blue bands at the Cky1 and Cky2 horizons of the Tikrit soil pedon, and this is due to the dominance of the influence of morphological characteristics represented by the distinctive light and whitish color of the soil of the sub-surface horizons, which shows its dominant effect on the visible spectrum, which in fact reflects the compositional nature of these horizons, as well as the high sand content, which increases the spectral reflectivity values and the effect of the nature of the factors and processes that led to the dominance of the influence of some chemical characteristics represented by the high content of gypsum, lime and salt content, and this is consistent With Al Dulaimi 2007,Compared to the diagnostic subsurface horizons of the soil peduncles of the Kirkuk and Erbil sites, in which the gypsum horizon was not diagnosed due to the absence of the requirements for the existence of this horizon, which appear in dark colors, as well as the dominance of the effect of the moisture content with the effect of the content of the organic matter, which works to reduce the spectral reflectivity, especially if it is higher than 2%, and this is consistent With Baumgardner and others (1970), who mentioned that organic matter plays a major role and has dominance over the rest of the factors affecting the spectral properties of soil when its percentage exceeds 2%,%, as it can be seen that the primary colors, spectral reflectivity values, and colorimetric indices in the dry state are higher in all soil samples than they are in wet conditions because soil moisture has an effect in increasing the soil darkness, decreasing the values of valeo and chroma and decreasing the reflectivity values of the basic colors and thus reducing the values of the total reflectivity In addition, it is affected by surface roughness and smoothness, organic matter, soil salts and minerals. The results are indicated in Table (3) and Figure (5). The spectral reflectivity values were different for the study sites, as the lowest value of the spectral reflectivity was for the dry state in pedon Kirkuk for horizon A, its value ranged 44.87%, and the highest value of the reflectivity was on the last horizon Cky1 from pedon Tikrit, where its value ranged 72.15%. Soils, calcium carbonate, soil salts, and low organic matter content. As for the wet condition, all the values of the reflectivity of the basic colors of the surface and subsurface diagnostic horizons of the pedons of the study sites were characterized by a decrease due to the predominance of the influence of the moisture content, which increases the darkening of the color and consequently the absorption values of the incident rays increase, which made the reflectivity values lower than in the dry state and it was the lowest value The reflectivity value of pedon Kirkuk for horizon A ranged 34.76%,

and the highest value of reflectivity was on the last horizon 1Cky from pedon Tikrit with a value of 63.08%. It was found that the values of the optical properties of the basic color elements, which include This is because the moisture content of the soil increases, the darker the color, as person (2005) and Karavanova et al. (2000) show that moisture makes the color of the soil darker, and the spectral reflectivity values at the red band in the dry state range from 144 to 196. In the case of moisture between 72 and 125, and the spectral reflectivity values for the green bands in the dry state ranged between 119 to 172, and in the humid conditions about 40 to 64, while the blue bands ranged from 93 to 147 for the dry state, and for the wet condition it was between 19 and 41, (Red, Green, and Blue) in the wet state (Moist State, were less than in the dry state; These values are related to organic content, texture, minerals and soil salts, as shown in Table (3). The results showed the luminosity index BI, its values ranged between (183-294), as the highest value on the horizon was Cky1 as is the case for the reflectivity. Perhaps this is due to the variation in the physical and chemical properties of the soil affecting the color of the soil.
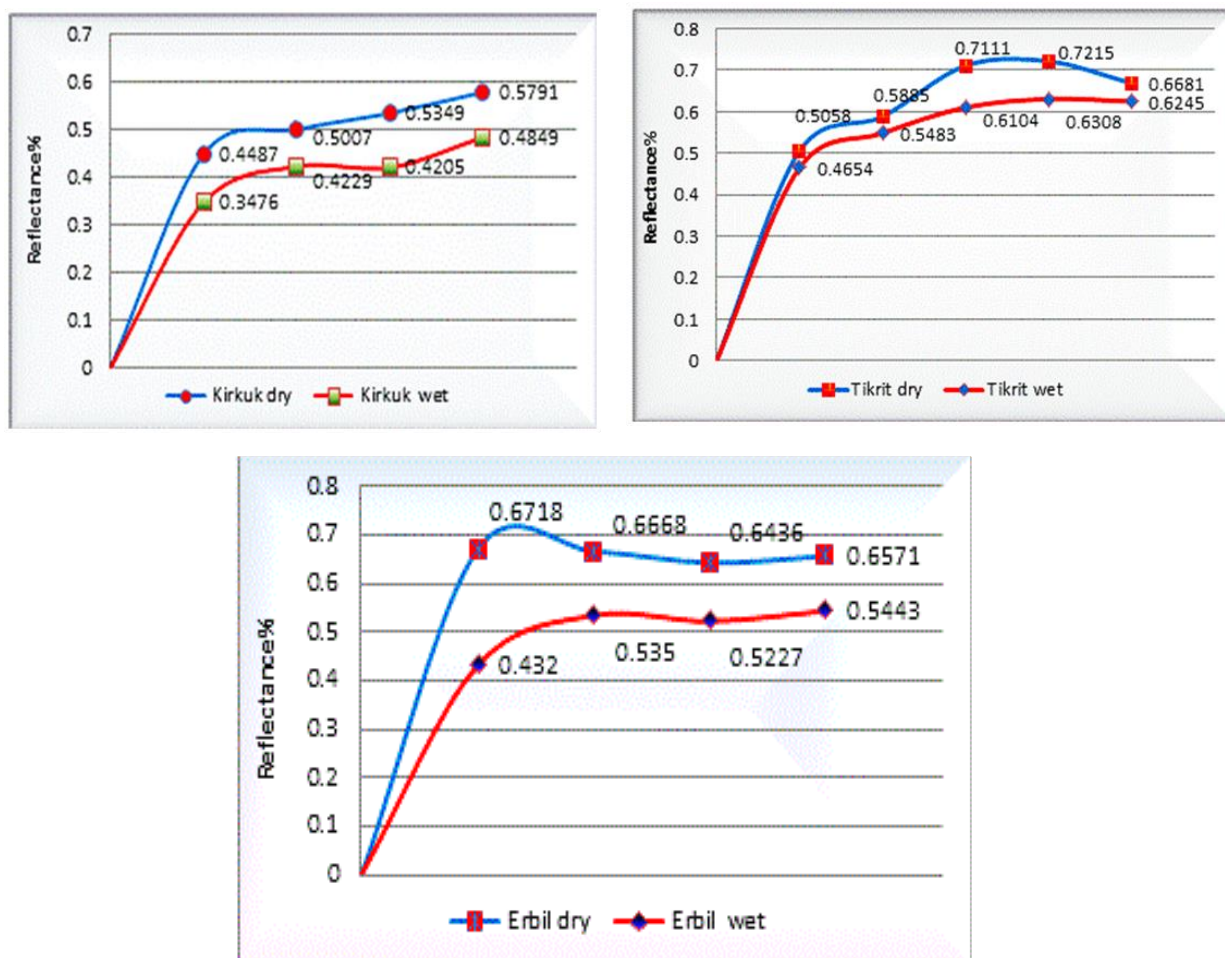

Figure (4): Spectral reflectivity curves of the surface and subsurface diagnostic horizons of the study sites

As for the brightness index, which shows its effect as a result of the high values of the value, it was high in the subsurface genetic diagnostic horizons, especially in the pedonates of soils in the Tikrit site, compared to the diagnostic genetic horizons in the peds of soils in northern Iraq, Kirkuk and Erbil. The light and whitish color mostly indicates an increase in the content of carbonate and gypsum. Or quartz minerals, the main component of the sandy part, which reflects its effect on increasing the values of the value and increasing the brightness index, and this is what Al-Mashhadani (2018) indicated.) When the color value is 10YR 8/3, the color is very pale brown and the effect of gypsum mineral appears, which affects the raising of the color value and its reflectivity as a result of its nature of composition and the size of its crystals. The results showed that the SI saturation index values for the dry condition ranged between (0.12-0.22), and there is a relative

Table (3) Spectral reflective properties and some camera color parameters of the study sites soil for dry and wet condition

Dry Samples

Horizon	Depth(cm)	Essential Colors				Color clues				
		Red	Green	Blue	Reflectency%	BI	HI	SI	CI	IOR
Tikrit Pedon / P1										
A11	0-15	155.1	124.8	101.4	50.58	146.7	3.58	0.20	0.89	1.52
A12	15-25	177.5	146.3	121.1	58.85	169.9	3.47	0.18	0.90	1.46
Ck	25-45	210.7	179	149.1	71.11	204.7	3.12	0.17	0.91	1.41
Cky1	45-68	216	181.4	148.3	72.15	208.4	3.09	0.18	0.91	1.45
Cky2	68-85	203.8	166.2	133.9	66.81	193.8	3.32	0.20	0.89	1.52
Kirkuk Pedon / P2										
A	0-15	136.6	109.7	92.7	44.87	129.5	4.16	0.19	0.89	1.47
Bk1	15-30	156.5	121.4	98.4	50.07	145.7	4.05	0.22	0.87	1.59
Bk2	30-64	165.7	130.2	106.8	53.49	155.2	4.03	0.21	0.88	1.55
Ck1	64-110	179.3	141.9	114.7	57.91	168.3	3.75	0.21	0.88	1.56
Erbil Pedon /P3										
A	0-10	190.8	170.9	149.8	67.18	191.1	2.88	0.12	0.94	1.27
Bk1	10-27	193.9	168.7	143.8	66.68	190.9	3.02	0.14	0.93	1.34
Bk2	27-50	188	161.1	139.7	64.36	184.1	3.51	0.14	0.92	1.34
Ck1	50-80	189.3	165.3	145.2	65.71	187.3	3.38	0.13	0.93	1.30

Wet Samples

Horizon	Depth(cm)	Essential Colors				Color clues				
		Red	Green	Blue	Reflectency%	BI	HI	SI	CI	IOR
Tikrit Pedon / P1										
A11	0-15	142.3	116.5	91.9	46.54	135.3	3.09	0.21	0.90	1.54
A12	15-25	160.2	138.4	117.6	54.83	157.2	3.09	0.15	0.92	1.36
Ck	25-45	180	155.3	127.3	61.05	175.9	2.76	0.17	0.92	1.41
Cky1	45-68	187.8	160.2	129.2	63.08	182.3	2.78	0.18	0.92	1.45
Cky2	68-85	188.4	157.2	126	62.45	180.9	3	0.19	0.90	1.49
Kirkuk Pedon / P2										
A	0-15	107.9	84.9	68.7	34.76	101	3.83	0.22	0.88	1.57
Bk1	15-30	131.4	102.9	83.9	42.29	122.8	4	0.22	0.87	1.56
Bk2	30-64	132	102.4	81.2	42.05	122.6	3.79	0.23	0.87	1.62
Ck1	64-110	151.4	119.1	93.6	48.49	141.4	3.53	0.23	0.88	1.61
Erbil Pedon /P3										
A	0-10	138.2	103.3	81.5	43.20	126.4	4.20	0.25	0.85	1.69
Bk1	10-27	171.1	128.1	100.8	53.50	156.6	4.15	0.25	0.85	1.69
Bk2	27-50	170.3	123.9	94.6	52.27	153.8	4.16	0.28	0.85	1.80
Ck1	50-80	172.7	130.5	104.6	54.43	158.9	4.25	0.24	0.86	1.65

discrepancy in the horizons for all study sites. As for the dominant wavelength index HI, its values for the dry state ranged between (2.88-4.16), and the other horizons were between that. As for the CI color index, its values were similar, ranging between (0.87-0.94); The rest of the prospects were in between. As for the index of the percentage of oxides IOR, its value ranged between (1.27-1.59), as the other horizons were between that and this is consistent with (Atezberger, 2002) (Yahya, 2011), Al-Dulaimi and others (2015), (Atiya, 2017), and (Al-Salem , 2018), and (Al-Askari, 2019) (Atiya et al. 2019), Al-Kiki et al. 2020) et al., 1985 and Persson, 2005).

As for the wet state, the reflectivity of some color indices was low compared to what is in the dry state, while others were high, according to the effect of the moisture content on the morphological, physical and chemical properties of the soil, as the variation in the color of the soil in the dry and wet conditions will lead to the variation in radiation reflection and absorption, as the reflection increases in The dry condition of light-colored soils, while the absorption increases from dark-colored soils. Therefore, a discrepancy occurs in the soil moisture content, which will lead to a discrepancy in the reflection and absorption for each horizon of the soil and for each pedon of the soils of the study sites, as the values of the saturation index rose slightly from what they are In the dry state of some horizons and some pedones, as in the third pedon, and this is due to the predominance of the influence of moisture content in increasing the darkening of the color And its saturation, in addition to its effect on the content of organic matter, iron oxides, and clay content, which works by retaining moisture and darkening the color. The same applies to the hue index, which increased slightly in the third pedon for the same reasons. As for the color correlation index, it differed slightly, affected by the nature of soil characteristics and the heterogeneity of the reflectivity of its basic colors. As for the brightness index, it was the most variable and low color index compared to the rest of the evidence. This is due to the effect of moisture content in reducing the reflectivity of color values. Basically an increase in the darkening of the color and thus a decrease in the values of the reflected rays and an increase in the values of the absorbed rays. . As for the index of iron oxides, the reflectivity was higher in the wet condition compared to the dry condition, and this is also due to the dominance of the influence of the moisture content of the soil, which affected the decrease in the reflectivity values of the visible spectrum beams, specifically the reflectivity of the blue beam, as the absorbed rays were more than the reflected, which led to an increase in the value of the index that represents The ratio between the value of the reflectivity at the red beam to the value of the reflectivity at the blue beam.

Classification of study soils

The results of the morphological description of the study sites' pedons indicate that there is a state of discrepancy in the morphological characteristics that represent the study soils in the type and thickness of the soil horizons, which was reflected on the presence of some surface diagnostic horizons, including the surface diagnostic horizon (Ochric Epipedon) and the subsurface diagnostic horizon (Gypsic Endopedon) and the subsurface diagnostic horizon Calcic Endopedon and Argillic Subsurface Diagnostic Horizon are poorly developed. The study area is located within the Aridic and Hyperthermic system, which represent the dry soil represented by the order Aridisols.

CONCLUSIONS

The results confirmed that there is a difference in the color characteristic measured by the Atlas of colors and RGB values, as well as the values of spectral reflectivity and color indices calculated by the ERDAS program. In addition to the possibility of using the camera and relying on it to measure RGB primary colors and spectral reflectivity values by relying on the ERDAS program as an alternative means for the Spectroradiometer to measure the spectral reflectivity of the soil if it is not available. And show the color and visual differences of these soils . The results also found that there was a discrepancy in the physical and chemical properties of the studied soils, as there was an increase in the content of clay, calcium carbonate and organic matter in the northern regions represented by the Kirkuk and Erbil sites, while an increase in the proportion of sand, gypsum content and a lack of clay content in the central areas represented by the Tikrit site. The results also confirmed that the highest value of reflectivity was in the soils of the Tikrit site at the subsurface genetic diagnostic horizons represented by the gypsum and calcic horizons, which amounted to

72.15% due to the high content of calcium sulfate and carbonate, as well as the increase in the percentage of salts in these soils. and the low content of organic matter. As for the brightness index, it was one of the most capable colorimetric indices in showing the spectral differences of the surface diagnostic genetic horizons represented by the ochric horizon and the subsurface diagnostic genetic horizons such as the classic horizon and gypsum through the high values of the values and approaching white or light color. Diagnostic genetics of surface and subsurface of pedons for the soils of Kirkuk and Erbil sites compared to the soils of the Tikrit site, which represents the extent to which the color approaches red as a result of the high content of iron oxides.

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الخواص البصرية والمورفولوجية والفيزوكيميائية لبعض ترب وسط وشمالي العراق باستخدام آلة التصوير الرقمية

أحمد مجيد هيشان   عمار سعدي إسماعيل   عبد الله عزاوي رشيد

قسم علوم التربة والموارد المائية / كلية الزراعة / جامعة تكريت

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الكلمات المفتاحية:
الادلة اللونية, الانعكاسية الطيفية, الكاميرا الرقمية، الآفاق الوراثية، تطور التربة.

أجريت الدراسة في ثلاث مواقع منتخبة ممثلة لترب ثلاث محافظات من وسط وشمال العراق (صلاح الدين, وكركوك, وأربيل), لتحديد تأثير الصفات المورفولوجية والفيزيائية والكيميائية لبعض آفاق التربة الوراثية في انعكاسيتها الطيفية باستعمال بعض الأدلة اللونية للحالتين الجافة والرطبة واعتمادًا على آلة التصوير الرقمي فضلاً عن معرفة درجة تطور الترب وتصنيفها وفقاً للنظام الكمي (الامريكي) لتصنيف الترب, إذ تم حفر ثلاثة بيدونات ممثلة لهذه الترب, وشخصت ووصفت الآفاق مورفولوجياً وتم استحصال العينات من كل أفق لكل بيدون من بيدونات ترب مواقع الدراسة لإجراء بعض الفحوصات المختبرية للصفات الفيزيائية والكيميائية, وتم اخذ الصور التي تجمع ما بين العينات الجافة والرطبة؛ من أجل حساب قيم الانعكاسية الطيفية وقيم (RGB) باستخدام برنامج ERDAS. توصلت النتائج الى وجود تغاير في الصفات المورفولوجية ممثلة بصنف اللون السائد لكل بيدون مع تشخيص المظاهر المورفولوجية الخاصة بكل من الأفق التشخيصي السطحي اوكريك مع الآفاق التشخيصية تحت السطحية الجبسية والكلسية والطينية، كما توصلت النتائج أن قيم الانعكاسية الطيفية لـ RGB كانت عالية في التربة الجافة وانخفضت في الحالة الرطبة, وكانت أقل قيمة للانعكاسية الطيفية للآفاق السطحية إذ بلغت في الأُفق السطحي للبيدون الثاني 44.87% وأعلى قيمة للانعكاسية كانت في الافق Cky1 من البيدون الأول حيث قيمته 72.15% وهذا يعزى لارتفاع نسبة الجبس والكاربونات في هذه الترب مع قلة محتوى المادة العضوية, وكانت قيم الانعكاسية للون الأحمر عند الحزمة الحمراء مرتفعة في بيدون أربيل نتيجة تأثير اكاسيد الحديد، وتوصلت الدراسة أنَّ استخدام التقنيات الحديثة في حساب قيم الانعكاسية الطيفية للتربة ممثلةً بالأدلة الطيفية تساهم بشكل كبير في إظهار الاختلافات الطيفية والبدولوجية ممثلةً بدليل السطوع (شدة اللون) والطول الموجي ودليل اكاسيد الحديد كما توصلت النتائج ان اكثر الصفات تأثيراً في هذه الادلة اللونية هي لون التربة السائد فضلاً عن نسجة التربة ممثلةً بمحتوى الغرين والطين مع المحتوى الرطوبي فضلاً عن تأثير محتوى المادة العضوية وأكاسيد الحديد ومحتوى الجبس والكلس في الآفاق التشخيصية السطحية وتحت السطحية.