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(RESEARCH ARTICLE)

The effect of preservative agriculture technology on some spectral and physical properties of the soil according to the years of application in the Telkif Region

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Abstract

Conservation agriculture is one of the innovative techniques that has proven to be successful in terms of decreasing effort, time, and expenses. The current study used two key criteria to prove some relevant findings for Conservation agriculture in order to test the results of its success, they are the bulk density (which measures soil compaction, de-oxidation and a lack of ventilation) as well as the percentage of soil organic matter. Four regions have been selected for different periods of adoption of conservation agriculture (2, 5, 10) years and other area is a unplowed fallow soil for comparison. The results revealed a great superiority for all conservative agriculture regions in terms of organic matter percentage and soil compaction. Also, the results also indicated that the spectral signatures of the areas that have been used for long-term the conservation agriculture are less than those of fallow soil due the effect of organic matter. This is an encouragement to use this technique of agriculture, where the soil surface appears to be unaffected by the agricultural machines.

Keywords: Conservative agriculture; Telkif; Organic matter; Bulk density; Spectral Signature

1. Introduction

The wheat crop is one of the most important agricultural crops in Iraq, which is at the top of the agricultural sector and which in turn contributes to the economic and social development of the country. The crop ranks first among other agricultural crops in the cultivated areas in most of the governorates of Iraq, (especially the northern regions), and including the current study area, which It is located within the semi-guaranteed rain areas. It is one of the main administrative units of the Tel Kayf district in Nineveh Governorate, within the southern part of the district.

As a result of its geographical location in dry and semi-dry areas. Iraq is facing the problem of desertification due to harsh climatic changes that have led to a lack of rainfall and water resources. A dangerous manifestation of desertification was the appearance of dust storms, The encroachment of sand dunes, the deterioration of vegetation cover, and the salinization of agricultural lands in many areas of Iraq, in addition to the lack of water resources and the increasing levels of erosion in agricultural soils of agricultural lands, all this has led to a decline in land productivity and the deterioration of the agricultural sector in Iraq. The accompanying economic problems were represented by the increase in fuel, labor, operating requirements and spare materials (Al-Hiti et al., 2021).

Therefore, in order to ensure the sustainability of agricultural crop cultivation such as wheat, it was necessary to confront the significant environmental challenges faced by Iraq from and use alternative methods to traditional agriculture. The most responsive technology to previous challenges was the adoption of a conservation agriculture system, which has started to be applied in many international countries as well as Arab countries, (Saudi Arabia, Sudan, Syria, Tunisia, Morocco and other countries). This system has actually begun to be implemented in Iraq, especially in Governorates of Nineveh, Kirkuk, Salah al-Din, and Anbar.

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The Food and Agriculture Organization (FAO) International (2015) defines conservation agriculture (CA) as an approach to managing agricultural ecosystems to improve and sustain productivity, increase profits and food security while preserving the environment and strengthen the ecological resource base (FAO, 2015). Conservation agriculture is characterized by three interconnected principles: continuous maintenance of minimal mechanical soil disturbance. Providing a permanent organic cover for the soil. And the diversity of crops grown that are grown in seasonal and/or locational succession (crop rotations) (Phillips and Young, 1973). The application of the conservation agriculture system leads to many benefits, all of which work in combating the manifestations of desertification, such as reducing erosion, alleviating drought waves and scarcity of water resources, increasing the efficiency of using water resources available in limited quantities, especially in arid and semi-arid areas under rain-fed agricultural systems, and also reducing the manifestations of soil degradation. It also works to increase production and economic returns. Many studies have shown that applying the conservation agriculture system in the long term leads to improving the soil's physical, chemical and biological properties and fertility compared to traditional agriculture (Manal et al., 2020), due to the significant cessation of soil erosion as well as the preservation or increase of the soil's organic matter content. By leaving the remains of the previous crop (IFA, 2018). It is worth noting that soil characteristics are linked to the biological changes that occur in plant residues, especially in terms of the formation of organic matter and the enrichment the soil with nutrients through the biological cycle of mineral elements (ACSAD, 2011). Accordingly, the presence of previous crop residues leads to an increase in the productive capacity of the soil in the system. Conservation agriculture also leads to improving soil properties, composition, and natural biodiversity, and protecting it from degradation, erosion, and erosion processes.

The current study will focus on various chemical and physical soil characteristics that demonstrate the features of conservation agricultural technology in increasing the good attributes of the soil in the study region, particularly organic matter. In addition to researching the spectral characteristics of soil samples collected from various sites over the years of conservation agriculture application, and the link between spectral reflectivity and the level of organic matter in the soil.

1.1. Study area

1.1.1. Location and Topography

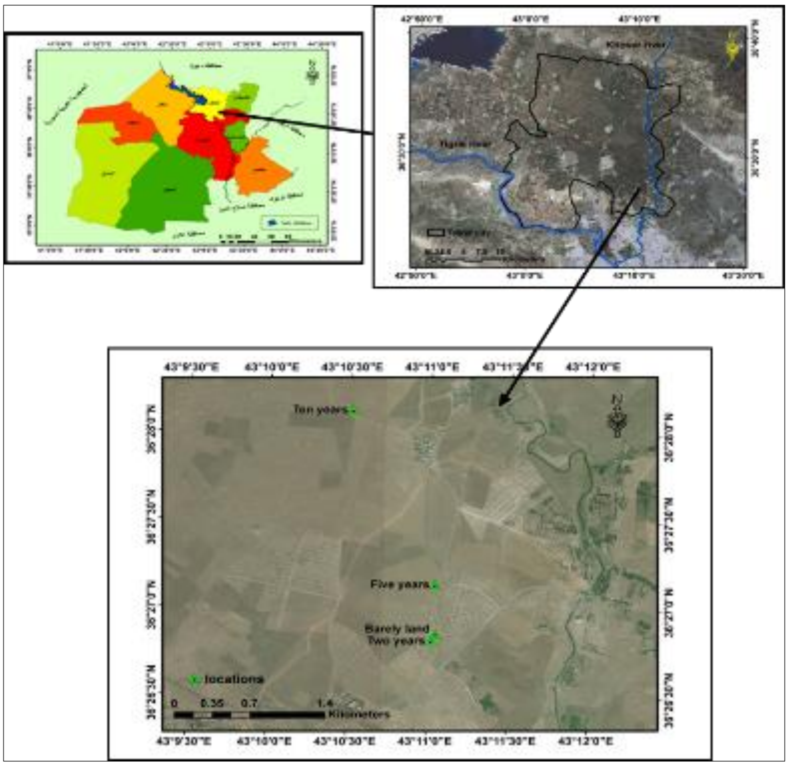

Figure 1 Location of the study area

The study area is located in Nineveh Governorate, within the southern part of TelKayf district, 18.53 km away from the city center of Mosul, and within two latitudes (36^0:26':19.85" and 36^0:28':16.27") north, and two longitudes

(43^0:09':20.12" and 43^0:12':26.84") east, Fig.1. The region's topography is characterized by a clear variation in elevations and undulations, as the region's elevations range from (230-280 m), which led to the emergence of valleys and surface drainage patterns with river levels, part of which flows into the Al-Khosar River and the other part into the Tigris River (Manoukh and Ali, 2021). The presence of these surface drainages makes the area have good water storage, which contributes to increasing groundwater storage, which can be used in the process of watering field crops (wheat and barley) as well as summer crops with sprinklers, noting that the majority of agriculture in the study area depends on rain (dim agriculture). The soil of the study area falls within the class (Entisols), and the source material contains limestone rocks and clays. The topography of the area is undulating, slightly sloping, and well-drained. In general, the study area is exploited for growing field crops such as wheat and barley, and vegetable crops are also grown there (Al-Sayegh, 2020).

1.1.2. Climate

Data from the Mosul Meteorological Directorate for the years (1988-2018), found that the monthly average minimum temperature is (13.4 degrees Celsius) and the monthly average maximum temperature is (28.40C), while the average temperature is (20.60C). (Manal et al., 2020). Table (1) shows the monthly average temperatures for each month. In a way, these values are considered appropriate for growing wheat and barley crops in the study area, depending on the growth stages.

Table 1 Average monthly temperatures in the Mosul Meteorological station (1988-2018)

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	annual rate
Min. temperature	2.4	3.7	7.4	11.5	16.6	21.7	25.6	24.8	19.9	14.7	7.9	4.0	13.4
Max. temperature	12.9	15.5	19.9	26	33.4	39.8	43.3	43.2	38.5	31.6	21.4	15.5	28.4
Average temperature	7.0	9.2	13.3	18.5	24.9	31.3	35	34.3	28.9	22.2	13.6	8.9	20.6

For precipitation, the study area is located in an area where rain is almost semi-guaranteed, as it is characterized by fluctuating and irregular timing of its fall. The average monthly precipitation according to the data of the Mosul Meteorological Directorate was (339.7 mm) for the period of (1988-2018), which encouraged farmers to implement the conservation agriculture system. Table (2) lists the monthly averages of precipitation for each month.

Table 2 Average monthly precipitation in the Mosul Meteorological station (1988-2018)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	sum
Prec.mm	58.4	56.1	55.6	38.7	16.6	1.7	0.2	0.0	0.2	11.6	41.8	58.8	339.7

2. Methodology

To evaluate the effect of conservation agriculture on the soil, a typical agricultural area has been chosen specifically located east of the city of Mosul within the Telkif district, near the village of Tal-Yabes, as this agricultural area is considered one of the areas that pioneer conservation agriculture.

Table 3 Geographic coordinates of soil samples locations and duration of conservation agriculture

Site No.	Latitude	Longitude	Period / Year
1	36.447000	43.183730	2 years
2	36.447680	43.184200	barely soil
3	36.452360	43.184070	5 years
4	36.468850	43.175250	10 years

Accordingly, four places have been chosen to evaluate soil conservation agriculture according to the geographical coordinates shown in Table (3). Surface samples had been taken from each site for the purpose of laboratory analyzes in a manner consistent with the purpose of the study, in addition to taking non-excited soil samples (because any pressure on the soil changes its porosity and therefore its bulk density), using the metal cylinder method (balls) to estimate the amount of compaction to which the soil was exposed, as well as recording field observations that can be recorded in the field, as shown in Figure (2).

Figure 2 Soil sample collection sites

The samples were taken using plastic bags, taking into account that the samples collected using the balls were transferred quantitatively very accurately to avoid any loss in weight. After the samples were transported to the laboratory, they were dealt with using two axes. The first axis was to estimate the bulk density by placing Soil samples as they are in metal cans to be weighed while they are air-dry for each sample. They are then placed in an oven at a temperature of (105°) to dry them completely. Their weight is measured a second time, to find the percentage of moisture to dry weight, and by knowing the mass of the soil and its volume, which is the volume The ball used was to find the bulk density of the samples, as the bulk density is used in porosity calculations and determining the weight of the soil and the materials present in it. It is also used in irrigation calculations and extracting the volumetric moisture percentage of the soil. It is also considered evidence of the composition and structure of the soil and its porosity (Sabah et al, 2019).

The second axis was by air-drying the soil for one day and purifying it from roots and plankton, then grinding it with a wooden hammer, and then sifting it with a sieve with a diameter of (2 mm), so that it would be ready for other soil analyzes to measure soil salinity, organic matter, and soil texture. An extract was also made in a ratio of 1:1 to measure the electrical conductivity (EC) of the soil extract. Secondly, the texture was estimated using the hydrometer method in the soil laboratory of the Remote Sensing Center. The organic matter was also estimated using the digestion method with concentrated sulfuric acid. The color of the soil had been estimated for each sample in its dry and wet states. (Electronic Color Atlas, Al-Jawadi and Daoud,2011),(Al-Hamdani, 2012), in addition to measuring the spectral reflectivity of the soil using a digital camera in its dry and wet states, and finally the spectral fingerprint of the soil was found using a device (Analytical Spectral Devices: ASD) in the Spectral Analysis Laboratory of the Remote Sensing Center.

3. Results and discussion

Table (4) shows some physical characteristics of the soil of the study area. The samples were taken when the soil was dry, although the samples were taken in January, but the percentage of rain was low, and its appeared on the surface of the soil. This year's planting season was suffering from an almost complete drought, and this is what was shown in the humidity percentage in the table. The bulk density, which is a good indicator of soil compaction, which is the main goal of comparison in this research, as the higher bulk density, is an indicator of the increase in soil compaction processes due to the decrease in the apparent volume (Al-Hamdani, 2012). From here it becomes clear to us that sample no. (2) Soils left for a long period were relatively higher in bulk density and reached (1.45 g/cm3), compared to agricultural soils based on conservation agriculture depending on the number of years that were used as a criterion for the research. This indicates that although the use of agricultural machinery, even if it was in a regulated manner and simple excavator plows, did not affect soil compaction, the results were even better than abandoned soil, which encourages the adoption of conservation agriculture by not affecting the soil and increasing its aeration, in addition to the texture of The soil was almost similar, most of the soil was a clayey alluvial mixture. This supports the method of comparison and impartiality.

Table 4 Some physical properties of soil

Soil sample	Clay %	Silt %	sand %	Bulk density average	Humidity to wet weight %	Moisture to dry weight %	Description of soil texture
1	34.85	52.95	12.2	1.27	3.87	4.06	Silty Clay Loam
2	37.65	49.4	12.95	1.45	3.62	3.76	Silty Clay Loam
3	40.08	47.73	12.2	1.31	2.92	3.00	Silty Clay
4	37.8	47.28	14.93	1.35	4.18	4.36	Silty Clay Loam

Table (5) shows the percentage of organic matter and electrical conductivity of soil samples according to laboratory testing. The percentage of organic matter appears in the second sample, which is the sample of abandoned soil (1.41%). It is considered relatively lower than the rest of the samples, although the difference is small. This is a second indicator that the soils dependent on conservation agriculture have retained a percentage of organic matter because the residues of previous crops remain in the soil without being turned over, as happens in traditional plows such as the rotary plow and the disc plow, which work to turn the soil upside down, which exposes the soil to sunlight and loss of moisture. Soil biological and organic materials (Shadha, 2015). This is considered a good indicator and supports the adoption of this type of simple tillage, noting that the electrical conductivity is close and homogeneous for all soil samples, and this indicates that the percentage of salinity and drainage were in good condition and had no effect on the speed of decomposition of organic matter, or that all soils experienced the same conditions. In this respect at least. The slight decrease in reflectivity of the soil left behind may be an indication of the type of organic matter and residues present on the surface of the soil and not the percentage of organic matter. From here, it is clear that the two best indicators that were adopted in evaluating the extent of the impact of the methods adopted in conservation agriculture were successful, which are soil compaction and the percentage of organic matter, each of which is implicit in the other.

Table 5 Some chemical properties with reflectivity and color of soil

Soil sample	Dry Reading - Munsel	Wet Reading Mansell	Reflectivity of wet soil %	Reflectivity of dry soils %	Electrical conductivity us	Organic matter %
1	10 YR 5/4	10 YR 3/4	26.61	43.42	627	1.58
2	10 YR 6/4	10 YR 3/4	30.37	51.97	515	1.41
3	10 YR 5/4	10 YR 3/4	28.84	44.65	426	1.86
4	10 YR 5/4	10 YR 3/4	30.30	50.76	420	1.51

The spectral signatures of the adopted soil samples were measured by Spectroradiometer device (ASD-Field Spec 3) at the wavelength range of (350-2500 nm), which covers the visible, near-infrared and mid-infrared spectrum bands. Figure (4) shows the similar spectral signatures for all soil samples, an inverse relationship can be observed between reflectivity with organic matter, where the more organic matter, the lower the spectral reflectance. The abandoned soil of sample no. (2) showed the highest level of reflectivity compared to other samples, then comes a low reflectivity for soil sample (1) with a period of (2 years) and the spectral reflectivity curve is close to that of sample (3) with a period of (5 years) and sample (4) has a period of (10 years) relatively. The increase in organic matter in the soil leads to an increase in the absorption of electromagnetic wavelength and thus a lower spectral reflectivity. The highest reflectivity was for the abandoned soil (0.64), while the lowest reflectivity was for the soil model (10 years) alive. It reached (0.54). The spectral curves of the models in Figure (4) confirm that the soil adopted for conservation agriculture has retained a percentage of organic matter due to the remaining residues of previous crops in the soil and the preservation of moisture, which has increased the process of absorption of electromagnetic rays, and this also appears clearly in the water absorption bands at wavelengths (1.4, 1.9) micrometer.

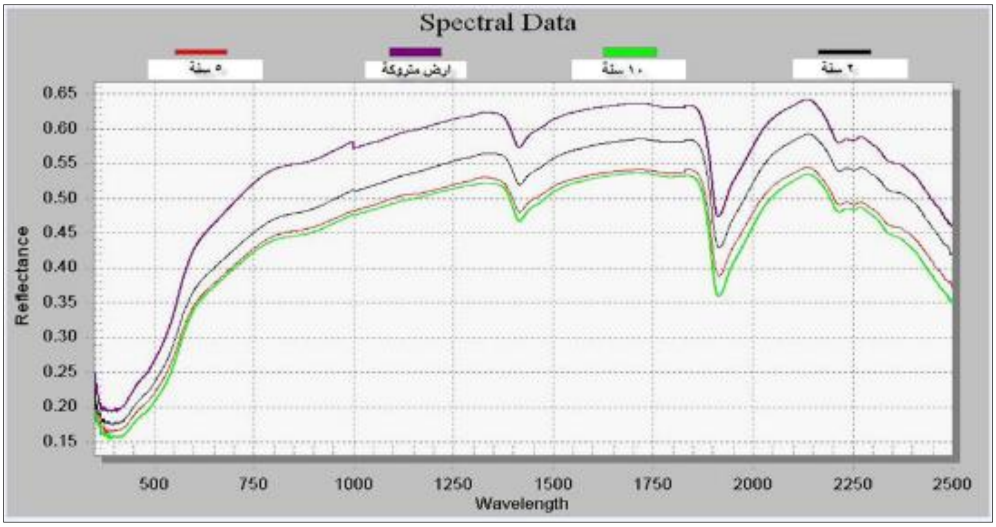

Figure 3 Spectral reflectivity of soil samples

4. Conclusion

Conservation agriculture aims to reduce production costs (tillage, fuel, labor...), increase productivity per unit area, preserve soil moisture, reduce the effects of climate change, and mitigate the phenomenon of global warming by increasing the soil's efficiency in sequestering carbon and reducing its emission into the atmosphere. By reducing repetitive tillage operations, the following conclusions have been reached through research:

- Conservation agriculture leads to less depletion of organic matter and its retention in the field for a long period. Thus, the physical properties of the soil are raised in terms of a large number of soil aggregates, moisture retention, and increased soil aeration, in addition to the nutrients that the organic matter contains that are beneficial to plants.
- Conservation agriculture, through the lack of frequent running of agricultural wheels in the field, had a clear and positive effect in reducing soil compaction, good water drainage, and the absence of hard layers, lead to good ventilation and lack of reducing conditions. This is in addition to what was mentioned above in terms of economics and the reduction of time and manpower.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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