African Journal of Advanced Pure and Applied Sciences (AJAPAS)
Online ISSN: 2957-644X
Volume 2, Issue 3, July-September 2023, Page No: 332-345
Website: https://aaasjournals.com/index.php/ajapas/index
||Arab Impact factor 2022: 0.87|| SJIFactor 2023: 5.689|| ISI 2022-2023: 0.557

Physicochemical Characterizations for the Evaluation of Agricultural Soils in the City of Tobruk-Libya

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Received: July 21, 2023	Accepted: September 04, 2023	Published: September 09, 2023

Abstract:
This study was conducted on agricultural soils in five sites located in the north and southwest of the city of Tobruk between latitude 12 24˚ north and longitude 17 23˚ east. This study aims to study the physical and chemical characteristics of soil evaluation. The study included a physical and chemical analysis of investigated soil samples. It was found from the mechanical analysis of the soil samples that it can be classified as sandy in texture, and saline-alkaline according to the division of the American Salinity Laboratory. The results showed that nutrients such as phosphorous in soil samples are poor, and potassium available to plants ranges from 70-113 ppm, with an average of 91.2 ppm, and this level in sandy soil is sufficient for the crops' needs of this element. The zinc concentration ranges from 0.46-0.76 ppm, with an average of 0.57 ppm, which is an insufficient amount to supply the plant with its needs of this element. It was also found that the manganese concentration ranges from 0.78-0.96 ppm, with an average of 0.86 ppm, which is a low concentration that is not sufficient to supply plants with their essential needs and also, some other elements.

Keywords: Soil, Chemical, Physical, Characterizations, Cations, Anions, Salinity, Nutrients.

Cite this article as: S. Y. M. Ragab, H. M. Arigig, "Physicochemical Characterizations for the Evaluation of Agricultural Soils in the City of Tobruk-Libya," *African Journal of Advanced Pure and Applied Sciences (AJAPAS)*, vol. 2, no. 3, pp. 332–345, July-September 2023.

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التوصيفات الفيزيائية والكيميائية لتقييم التربة الزراعية في مدينة طبرق- ليبيا

صفاء ياسين محمد [1]، هند محمد ارقيق [2*]
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الملخص
أجريت هذه الدراسة على تربة زراعية في خمسة مواقع تقع في شمال وجنوب غرب مدينة طبرق بين خطي عرض 24˚ 12 درجة شمالا وخط طول 23˚ 17 درجة شرقًا. تهدف هذه الدراسة إلى دراسة الخصائص الفيزيائية والكيميائية لتقييم التربة. تضمنت الدراسة التحليل الفيزيائي والكيميائي لعينات التربة التي تم فحصها. وتبين من التحليل الميكانيكي لعينات التربة أنه يمكن تصنيفها على أنها رملية في الملمس ومالحة - قلوية حسب تقسيم معمل الملوحة الأمريكي. وأظهرت النتائج إن العناصر الغذائية مثل الفوسفور في عينات التربة ضعيفة، وأن البوتاسيوم المتاح للنباتات يتراوح بين 70-113 جزء في المليون، بمتوسط 91.2 جزء في المليون، وهذا المستوى في التربة الرملية كافٍ لاحتياجات المحاصيل من هذا العنصر. يتراوح تركيز الزنك بين 0.46 - 0.76 جزء في المليون، بمتوسط 0.57 جزء في المليون، وهي كمية غير كافية لتزويد

المصنع باحتياجاته من هذا العنصر. كما وجد أن تركيز المنجنيز يتراوح من 0.78 - 0.96 جزء في المليون بمتوسط 0.86 جزء في المليون وهو تركيز منخفض لا يكفي لإمداد النباتات باحتياجاتها الأساسية وكذلك بعض العناصر الأخرى.

الكلمات المفتاحية: التربة، الكيميائية، الفيزيائية، الخصائص، الكاتيونات، الأنيونات، الملوحة، العناصر الغذائية.

Introduction

The natural resources of any country are the national treasure and there is a need for proper planning to make the best use of them. The most important and basic natural resource is soil. It is evident that the production of food, fodder, fuel and feed to meet the requirements of human beings and animals is primarily dependent upon agriculture and allied areas which are dependent on soil resources. Soil resources of the world are finite, easily degraded by misuse and mismanagement, nonrenewable over the human time frame, and shrinking because of degradation and conversion to nonagricultural uses [1-3]. Soil degradation is a severe global issue, and predominant degradative processes are accelerated soil erosion, depletion of soil organic matter and plant nutrients, decline of soil structure, and salinization. Most of these degradative processes are more severe in the tropics than in the temperate climate, in marginal rather than prime agricultural lands, and in resource-based and subsistence agriculture rather than science-based or commercial farming. There is need of judicious and scientific management of soil resources. Degraded soils and ecosystems must be ameliorated, and the depleted organic carbon pool restored so that soil can respond to the use of yield–enhancing input (e.g., fertilizers, improved varieties) and can meet the current and future food demand [4].

Soil is a dynamic natural body developed as a result of pedogenic processes through weathering of rocks, consisting of mineral and organic constituents, possessing definite chemical, physical, mineralogical and biological properties, having a variable depth over the surface of the earth, and providing a medium for plant growth [5]. Soil supports terrestrial life through five processes: (1) biomass productivity, (2) restoration and resilience of ecosystems, (3) purification of water, (4) detoxification of pollutants, and (5) cycling of C, N, P, S, and H2O.

Soil Components

Mineral soils consist of four major components: mineral materials, organic matter, water, and air [6]. Figure 1 shows the approximate proportions of these components of these components in a representative silt loam surface soil in optimum condition for plant growth. Note that this soil contains about half soils and half pore space (water and air). Of the total soil volume, about half is solid space, 45% mineral matter and 5% organic matter. At optimum moisture for plant growth, the pore space is divided roughly in half; 25% of the volume is water space and 25% is air. The proportions of air and water are subject to rapid and great fluctuations under natural conditions, depending on the weather and other factors.

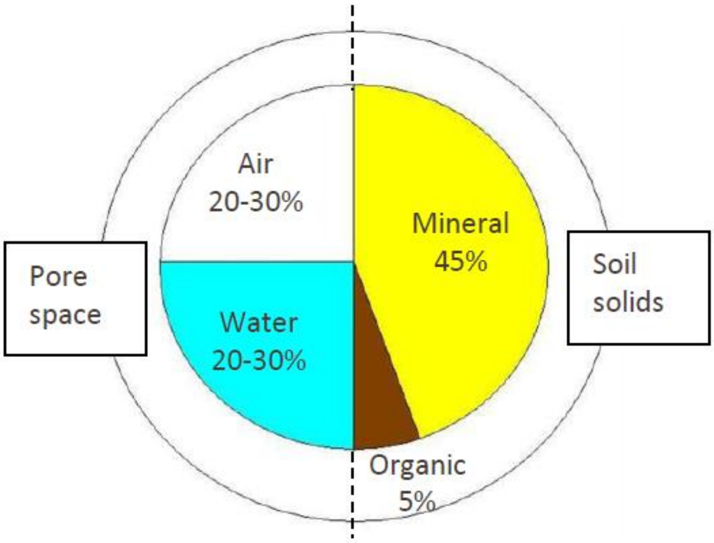

Figure 1: Composition of a loam soil when conditions are good for plant growth [6]**.**

Each soil has different types and arrangements of these components which creates unique soil properties or 'soil types. Soil properties affect [7];

1. plant growth responses
2. fertilizer requirements

3. the soils' response to management
4. land use capability (i.e. suitability for different land uses such as grazing versus cultivation)
5. drainage and water runoff
6. nutrient loss and leaching
7. soil erosion

A soil's properties are largely determined by its parent material and weathering during its formation. Topography, age and agricultural practices can also affect a soil's properties. Three groups of soil properties influence plant growth:

1. Physical, or the texture and structure of the soil.
2. Chemical, which affects both the fertility of the soil and its physical properties.
3. Biological or the organisms in the soil, such as bacteria, fungi, insects and earthworms

It is the combination of these properties that determine soil health and the ability of the soil to provide ecosystem services.

Soil properties influence plant growth and guide fertiliser decision making. Information relating to soil properties can be used to help guide investment decisions on-farm to maximise the benefit, for minimal investment [8].

Physical Properties

Physical properties of a soil that affect a plant's ability to grow include:

1. Soil texture, which affects the soil's ability to hold onto nutrients (cation exchange capacity) and water. Texture refers to the relative distribution of the different sized particles in the soil. It is a stable property of soils and, hence, is used in soil classification and description.
2. Soil structure, which affects aeration, water-holding capacity, drainage, and penetration by roots and seedlings. Soil structure refers to the arrangement of soil particles into aggregates (or peds) and the distribution of pores in between. It is not a stable property and is greatly influenced by soil management practices [9].

Soil Texture

Soil texture, or the 'feel' of soil, is determined by the proportions of sand, silt, and clay in the soil. When they are wet, sandy soils feel gritty, silty soils feel smooth and silky, and clayey soils feel sticky and plastic, or capable of being moulded. Soils with a high proportion of sand are referred to as 'light', and those with a high proportion of clay are referred to as 'heavy' as seen in Figure 2 [10].

Soil Structure

Soil structure refers to the arrangement of soil particles (sand, silt and clay) and pores in the soil and to the ability of the particles to form aggregates.

A well-structured soil forms stable aggregates (aggregates that don't fall apart easily) and has many pores of varying sizes – See Figure 3a. A well-structured soil is friable, easily worked and allows germinating seedlings to emerge and quickly establish a strong root system.

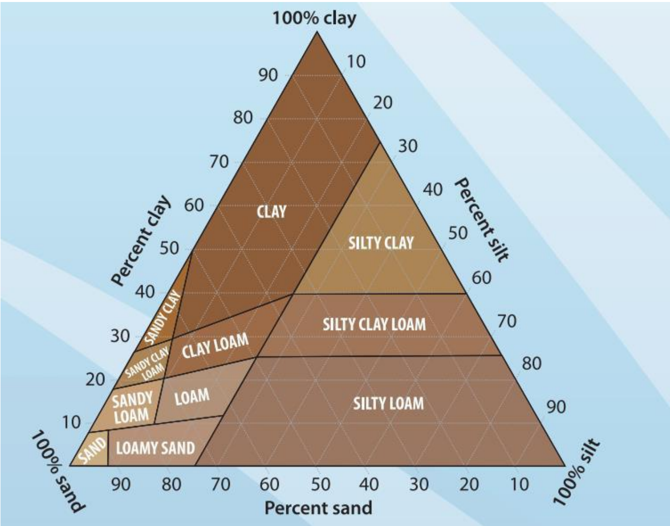

Figure 2 Soil Texture Triangle. Source: Image adapted from Hunt and Gilkes (1992).

poorly structured soil has either few or unstable (readily broken apart) aggregates and few pore spaces – See Figure 3b. A poorly structured soil can result in unproductive, compacted or waterlogged soils that have poor drainage and aeration. Poorly structured soil is also more likely to slake and to become eroded [10].

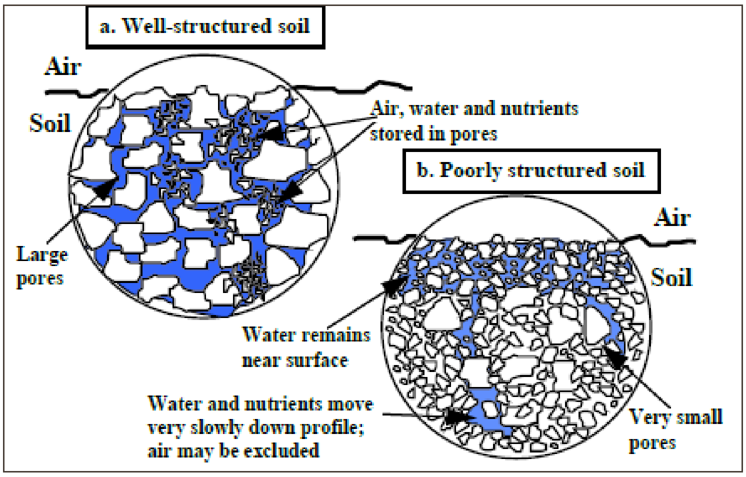

Figure 3 Soil structure [10].

Chemical Properties

The chemical properties of soils that are important to plant growth are [11,12]:

1. Nutrient availability and cation exchange capacity, which affect the soil's inherent fertility and its ability to hold nutrient cations such as calcium, potassium and magnesium.
2. The chemical characteristics of the soil solution, which affect pH and salinity.
3. The sodality of the soil, which affects soil stability and nutrient cation supply.

Problem Statement

The problem of this study revolves around finding out the extent to which agricultural soils are affected by irrigation water with a high content of dissolved salts, as irrigation operations using groundwater led to soil salinization.

Materials and Methods

Study location

The city of Tobruk is located in the northeastern part of Libya within the Al-Batnan Plateau, which ranges between 150-250 meters above sea level.

The study area is represented geographically, starting from the Kroom Al-Khail region located in the west of the city of Tobruk to the city center in the east and from the Mediterranean Sea in the north until the memorial of the martyrs of the Battle of Nadura in the south. A large part of this city is located in the form of a peninsula within the sea waters to form the Gulf of Tobruk as shown in Figure 4.

As for the astronomical location, the study area is located at the point of intersection of longitude 27' 58" 23º east and latitude 46' 05" 32º north. This identification shows that this area is located about 8 degrees north of the Tropic of Cancer.

On the other hand, the map shown in Figure 4 shows the study area, which includes five selected sites: the site of the Kroom Al-Khail (1), the site of the Kroom Al-Khail (2), the site of Tasleeh (1), the site of Tasleh (2) and the site of the Sagifa.

Field Study

The study was carried out on five sites in the city, which represent vital sites in terms of its natural resources, which are the horse groves (1) and (2) located west of the city of Tobruk, and the weaponization sites (1) and (2) in the southwest of the city, and the Sagifa site in the south of it.

These sites were studied through field visits according to the study research plan and the collection of soil samples for these sites. The physical and chemical analyzes of the soil samples were carried out at the central laboratory of the Libyan National Cement Company in Al-Fataeh. Figure 5 shows a photographs of sample collection sites.

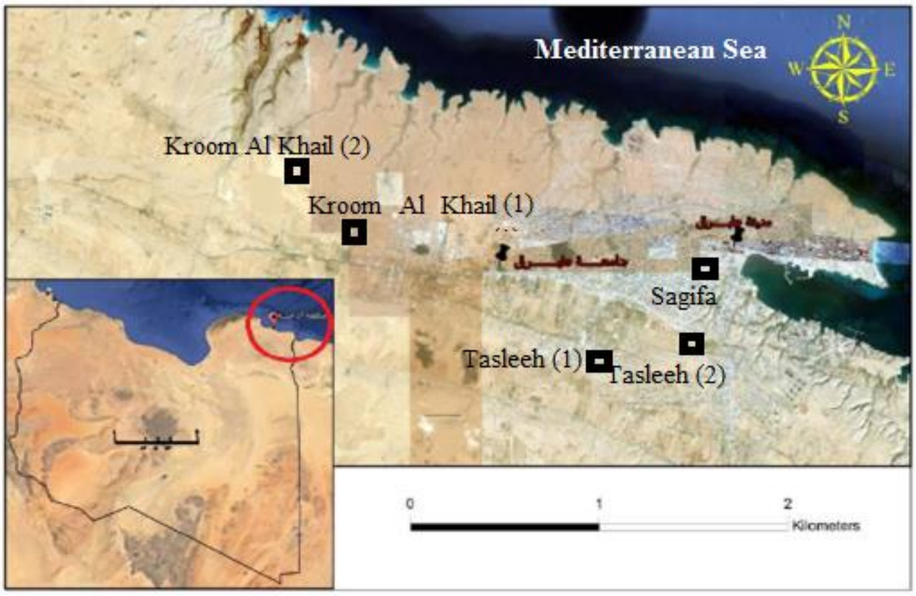

Figure 4 Samples location map (Source: Google)**.**


Figure 5 Locations of soil samples

Results and Discussion
Soil Characteristics
To study the physical and chemical properties of the soil in the study area, soil samples representing the five study sites were collected at depths ranging from 0-30 cm from the soil surface, which is the area in which most of the surface roots of plants are spread (Table 1). From the mechanical analysis of the soil samples (Table 1), it was found that:

1. The percentage of gravel ranges from 4.09-12.80%, with an average of (7.46%).
2. The percentage of very coarse sand ranges from 2.09-4.13%, with an average of (3.25%).
3. The proportion of coarse sand ranges from 4.09-20.74%, with an average of (13.39%).
4. The percentage of medium sand ranges from 13.70-23.87%, with an average of (19.83%).
5. The percentage of fine sand ranges from 18.07-45.30%, with an average of (34.42%).

6. The percentage of very fine sand ranges from 5.88-12.28%, with an average of (8.97%).
7. The proportion of silt and clay ranged from 10.01-15.80%, with an average of (12.67%).

Soil physical properties

The study of the physical properties of the soil is important in characterizing the nature of the soil and studying its strength, so the soil samples were mechanically analyzed to know the granular distribution of them as shown in Table 1.

Table 1 Soil particle size distribution

Parameters / Locations	Gravels %	Very coarse sand %	Coarse sand %	Medium sand %	Fine sand %	Very fine sand %	Silty clay %
Kroom Al Khail (1)	12.80	3.86	20.74	21.70	18.07	10.09	12.55
Kroom Al Khail (2)	8.20	4.09	4.09	13.70	44.04	10.14	15.80
Tasleeh (1)	7.06	4.13	16.75	19.17	30.70	12.28	10.01
Tasleeh (2)	4.09	2.10	17.77	23.87	34.00	6.48	11.70
Sagifa	5.16	2.09	7.60	20.72	45.30	5.88	13.30
Range	4.09-12.80	2.09-4.13	4.09-20.74	13.70-23.87	18.07-45.30	5.88-12.28	10.01-15.80
Average	7.46	3.25	13.39	19.83	34.42	8.97	12.67

Volumetric analysis of soil samples at the study sites revealed a large variation in the distribution of volumetric ratios among the different components. This matter may be attributed to the sedimentary conditions and geological factors from which these soils were formed from different weathering factors sedimentation factors and environment. Figure 6 illustrates this difference between study sites.

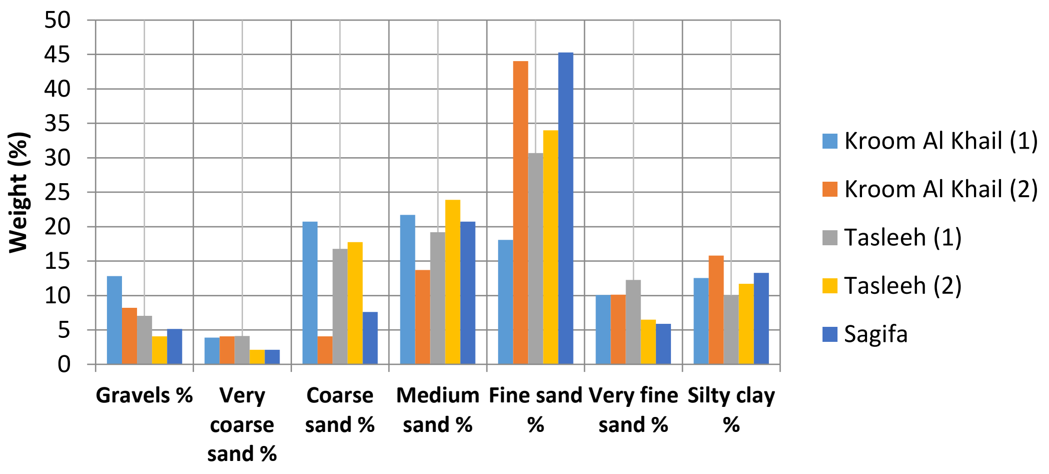

Figure 6 Percentages of the size distribution of soil particles**.**

Soil Texture

Consistency means determining the percentage of the mineral components of the soil according to its diameters, as gravel is greater than (2 mm), sand is (2 - 0.05 mm), silt is (0.05 - 0.002 mm), and clay is less than (0.002 mm). Soil texture after estimating its volumetric ratios, where the texture ranges from sandy to clayey, and the texture of the soil is important in ironing the ability of the soil to retain water and nutrients as well as the speed of water movement and the degree of ventilation. Sandy soil is well ventilated and its ability to retain water and nutrients is low unlike clay lands It is poorly ventilated, the movement of water is slow, and it has a high ability to keep water and nutrients.

From Figure 6, which represents the mechanical analysis of soil samples, it was found that fine sand represents the highest percentage, followed by medium and coarse sand. Based on these components, the soil can be classified as sandy in texture.

Saturation Percentage with Water

It is the amount of water needed to saturate (100 grams) of the soil. In this case, all soil pores are filled with water, and it is close to the state of the soil after rain or irrigation, and it is almost twice the amount of moisture at the field capacity.

In general, water is essential in the productive soil, where water occupies part of the pores, and the percentage of water in the soil depends on the texture, construction, and density, and the soil texture can be inferred from the ability to saturate with water as follows:

Less than 20% sandy soil, from (20-35%) sandy loam, from (35-50%) silt loam, from (50-65%) clay loam) and greater than (65%) clay. From the analysis of the samples taken (Table 1), it was found that the ability to saturate with water ranges from (17-23%), with an average of (20%).

From the analysis of soil samples (Table 1), it was found that the ability to saturate with water ranges from (18-26%), with an average of (22.2%).

Figure 7 shows the water saturation percentages of the soil samples in the study sites, where the percentage was higher in the sites of Saqifah and Krom Al-Khail (2) than the rest of the sites, and this is due to the formation of the soil from a high percentage of sand with high porosity.

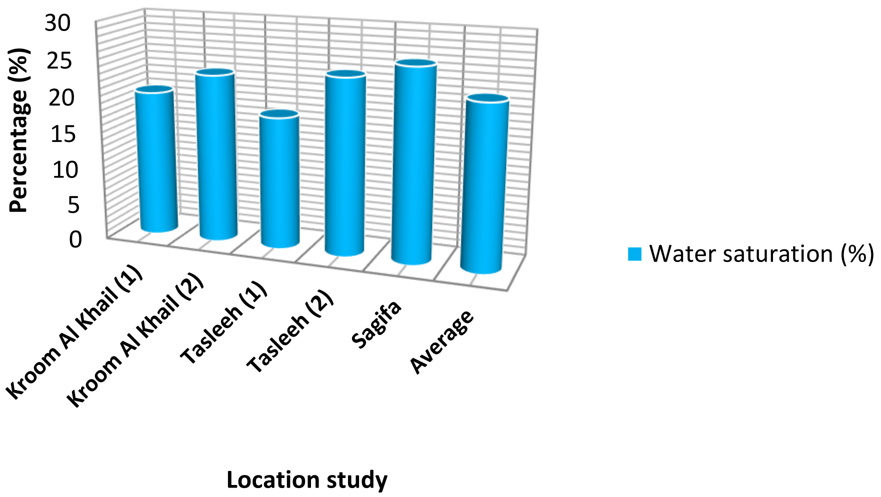

Figure 7 Water saturation percentage for soil samples

Chemical Properties

It is necessary to specify some chemical properties of the soil due to its importance in evaluating the quality of the soil and determining its characteristics. In this study, both pH (acidity number) and electrical conductivity were determined (Table 2).

pH acidity number

Estimation of pH is a measurement of the degree of acidity and alkalinity of the soil, and the units of acidity and alkalinity are measured from (0-14) and at the neutral number (7) the concentration of hydrogen (H+) and hydroxyl (OH-) is equal, while from the degree (0-7) the concentration of hydrogen ion increases and on conversely, (7-14) the concentration of the hydroxyl ion (OH-) increases.

Table 2 Chemical analysis of soil

Parameter / Locations	Ec.× 10^6 at 25°C	pH	Cations & anions (mg/l) K	Na	Mg	Ca	SO_4	Cl	Water saturation ratio (%)
Kroom Al Khail (1)	14.05	7.60	3.90	89.60	5.90	25.00	31.15	85.00	20
Kroom Al Khail (2)	35.55	7.76	6.94	160.55	30.00	65.00	80.7	45.00	23
Tasleeh (1)	5.55	8.44	4.64	39.04	22.05	12.50	21.24	35.00	18
Tasleeh (2)	15.46	7.90	5.99	87.65	15.40	35.50	60.45	62.00	24
Sagifa	5.05	8.70	3.97	28.08	10.00	25.0	40.65	22.00	26
Range	5.05-35.55	7.60-8.70	3.90-6.94	28.08-160.55	5.90-30.00	12.50-65.00	21.24-60.45	22.00-85.00	18-26
Average	15.13	8.08	5.09	80.98	16.67	32.6	46.84	49.80	22.2

The pH was estimated in the soil paste, for samples taken from the soil (Table 2), and it ranged from (7.60-8.70), with an average of (8.08), and this means that this soil is alkaline. To lower the pH, acidic fertilizers and tri-calcium phosphate fertilizer must be used before planting, in addition to adding organic fertilizers. Figure 8 shows the distribution of each of the pH values and electrical conductivity in different soil sites, which showed a clear variation from one site to another, where the Al-Khail Chrome site (2) recorded the highest percentage in electrical conductivity values, which in turn reflects the total dissolved salts compared to the rest of the sites, which decreased significantly.

The soil type can be determined based on the division of the American Salinity Laboratory as follows:
A- saline soil:
The total dissolved salts are more than (4 mmol/cm) at (25 °C), and the pH number is less than (8.5).
B- saline-alkaline soils:
The total dissolved salts are more than (4 mmol/cm) at (25 C) degrees Celsius, and the (pH) is higher than (8.5).
C- Alkaline soil:
The total dissolved salts are less than (4 mmol/cm) at (25 °C) and the acidity number (pH) is higher than (8.5).

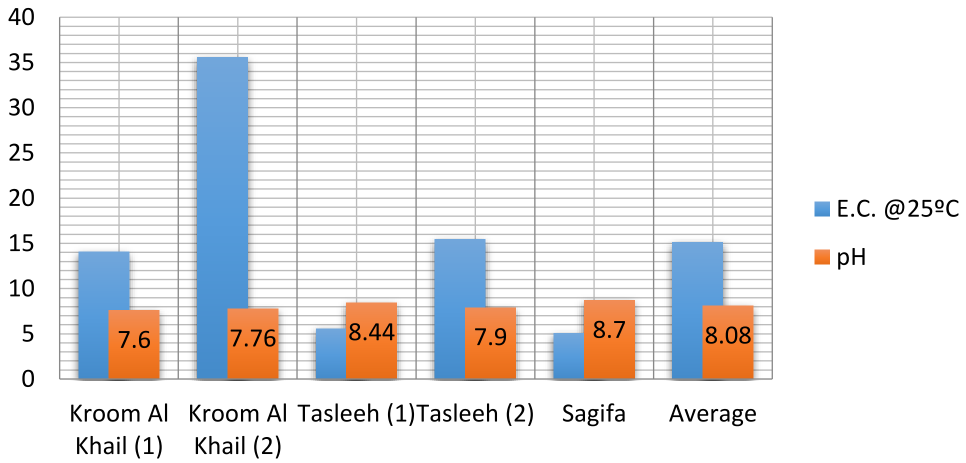

Figure 8 pH and electrical conductivity values for soil samples**.**

And from the results of the analysis of the samples, it was found that the total dissolved salts in the soil ranged from (5.05-35.55 mmol/cm), at (25 m), with an average of (15.13 mmol/cm) at (25 m). Therefore, this is an alkaline saline soil according to the division of the American Salinity Laboratory.

On the other hand, the concentrations of cations and anions in the soil were represented graphically. Figure 9 shows the distribution of both chloride and sulfate in soil samples at the sites under study. It was found that there was a variation in the content of these cations, where the chloride concentration was higher in horse vineyards (1) than its counterparts in other sites by a large difference in the average values to record 85.00 mg/l. On the other hand, the sulphate concentration was less valuable at the reinforcement site (2), with an average of 21.24 mg/L. It is reported that this element is one of the most important nutrients for plants in the soil.

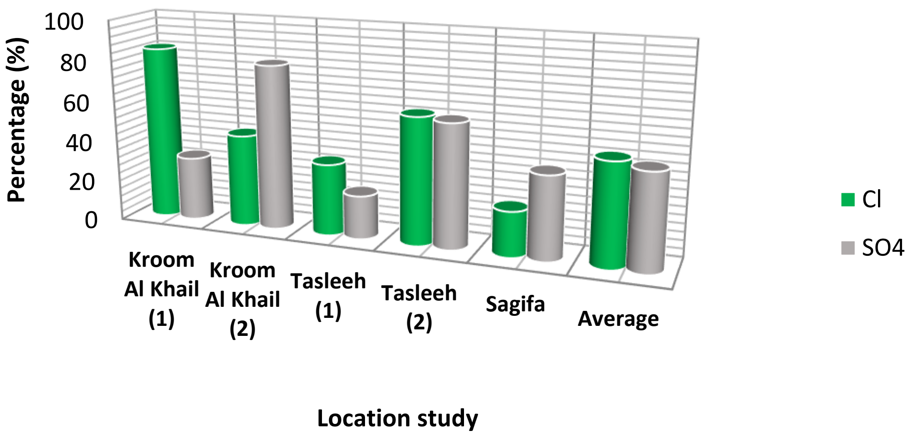

Figure 9 The content of anions in the soil**.**

The concentration of these elements reflects the general properties of the soil, which can be evaluated at the level of distribution of these elements. It also showed a clear variation in concentration, and in confirmation of what was mentioned above, we find that the horse groves site (1) and (2) are followed by the armament sites, as they have a high percentage of concentrations overall concentrations compared to the rest of the sites. Sodium values were the highest values, while these coefficients were of low concentration in other sites as in Figure 10. Also, this shows through the figure that the calcium concentration is the highest. This may be attributed to the nature of the source rock formation from which this soil descended, which may be rich in minerals that are formed from these elements.

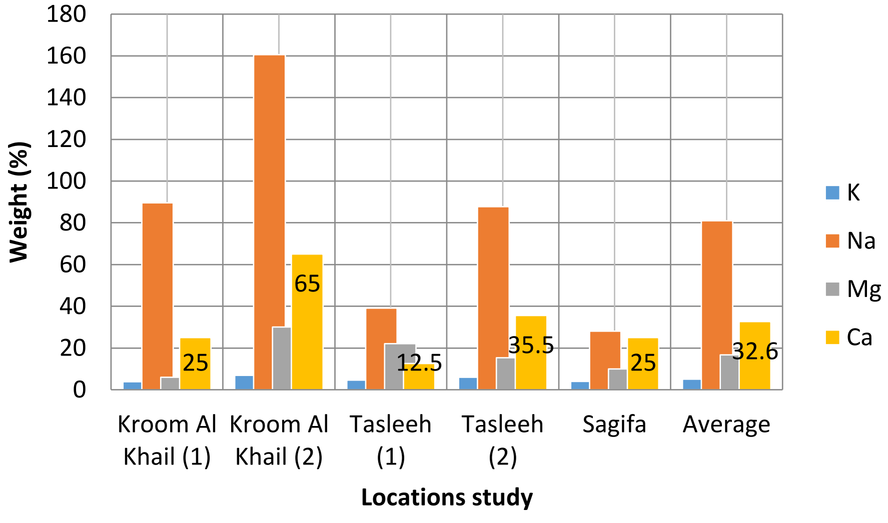

Figure 10 Soil cation content**.**

It has been shown from the study of the soil content of cations and anions that there is an increase in the content of both chlorine and sodium, which increases the salinity of the soil. On its atmosphere and thus affects plant growth rates and lower agricultural yield. Accordingly, it is imperative to reduce the content of these ions in the irrigation water and soil treatment and modification by adding improved materials such as gypsum in certain proportions to treat salinity.

Cation Exchange Capacity

The mineral soil colloids are characterized by the presence of negative charges on them, and with these negative charges, positive cations can be exchanged from the soil solution.

Cation exchange capacity expressed by the exchange capacity in bases and calculated on the basis of milliequivalents per 100 grams of soil. When sodium cations prevail over colloids, the natural and chemical properties of the soil deteriorate and the pH rises, which necessitates the replacement of calcium in place of sodium, and this is what happens in alkaline soil to improve its properties.

From the estimation of the exchange capacity by bases of the samples taken (Table 3), it was found that the cationic exchange capacity of these samples ranged from (2.20 - 3.60) mmequiv / 100 grams, with an average of (3.05) mmequiv / 100 grams of soil. It is a low capacity that needs to be increased by adding organic matter to the soil. As for the mutual cations that were estimated (Table 3), their levels were as follows:

Table 3 Cation exchange capacity and exchangeable cations

Parameters / Locations	C.E.C mg/100g soil	Ca	Mg	Na	K
Kroom Al Khail (1)	3.60	2.30	0.50	0.74	0.02
Kroom Al Khail (2)	3.46	2.30	0.50	0.64	0.02
Tasleeh (1)	3.54	2.20	0.50	0.80	0.04
Tasleeh (2)	2.20	1.31	0.31	0.49	0.02
Sagifa	2.43	1.00	0.75	0.61	0.07
Average	3.05	1.82	0.51	0.66	0.03

1. **Calcium**: The exchangeable calcium on soil colloids ranges from (1.0 - 2.3) mmeq / 100 grams of soil, with an average of (1.82) mmeq / 100 grams of soil, and it constitutes (60.26%) of the cationic exchange capacity of this soil.
2. **Magnesium**: The exchangeable magnesium on the surface of colloids ranges from (0.31 - 0.75) mmeq /100 grams of soil, with an average of (0.51) mmeq /100 grams of soil, and it constitutes (16.75%) of the cationic exchange capacity of this soil.
3. **Sodium**: The exchangeable sodium on soil colloids ranges from (0.49 - 0.80) mmeq /100 grams of soil, with an average of (0.66) mmeq /100 grams of soil. It constitutes (0.22%) of the cation exchange capacity of this soil.
4. **Potassium**: The exchange potassium on soil colloids ranged from (0.02 - 0.07) mmeq /100g of soil, with an average of (0.03) mmeq/100g of soil. It constitutes (0.99%) of the cation exchange capacity of this soil.

Figure 11 reflects the extent of the change in the ionic exchange capacity of the ions of the different elements in the study sites, where calcium cations showed the highest exchange capacity compared to the rest of the cations, which recorded the highest values in the horse chrome site (1) and then gradually decreased towards the other sites.

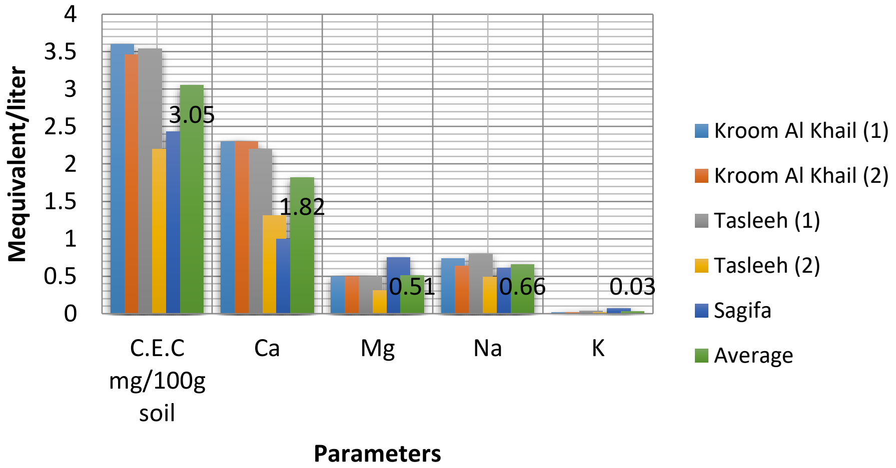

Figure 11 The ion exchange capacity of cations and anions in the soil.

Nutrients

1. Phosphorus: From the estimation of phosphorus in soil samples (Table 4), it was noted that there is very little phosphorous. This calls for the addition of phosphate fertilizers in the form of tri-calcium phosphate before planting and di-ammonium phosphate after planting.

2. Potassium: From the analysis of soil samples, it is clear that the available potassium for plants ranges from (70-113), parts per million, with an average of 91.2 parts per million. This level in sandy soil is sufficient for the needs of crops from this element, and there is no need to add fertilizers Potassium at the present time, and after planting, it is necessary to conduct a soil analysis to ensure that the level of this element is still at the required level (Table 4).

Table 4 Nutrient elements in soil**.**

Parameters / Locations	Phosphorus (ppm)	$CaCO_3$ (%)	Na (ppm)	K (ppm)	Mg (ppm)
Kroom Al Khail (1)	Trace	0.17	572	70	91
Kroom Al Khail (2)	Trace	0.12	899	94	517
Tasleeh (1)	Trace	0.33	400	74	91
Tasleeh (2)	Trace	0.17	575	105	243
Sagifa	Trace	0.17	299	113	182
Average	--	0.19	549	91.2	224.8

3. Calcium carbonate: The presence of calcium carbonate affects the texture, especially if it is present in the size of fine grains such as (silt - clay), and also affects the chemical properties, as it stabilizes nutrients such as phosphorus and trace elements when the pH number is high.

The results showed that calcium carbonate in the samples ranged between (0.12-0.33%) with an average of (0.19%), which is a low percentage that does not have any effect on the natural and chemical properties of the soil (Table 4).

4. Calcium and Magnesium: From the analysis carried out on the soil samples (Table 5), it was found that calcium ranges from (400-1000) ppm, and this level is sufficient to supply the plant with the necessary calcium in sandy soil. As for the utilizable magnesium in plants, it ranged between (91-517) ppm, with an average of (225) ppm.

5. Iron: The iron content in the soil samples ranged from (1.52 - 2.68) ppm, with an average of (1.97) ppm (Table 4), and this amount is low, so this element must be added in the form of sulfate compounds Ferrous by spraying on plants or through the soil.

6. Zinc: The analysis of soil samples showed that the concentration of zinc ranges from (0.46 - 0.76) ppm, with an average of (0.57) ppm, which is an insufficient amount to supply the plant with its needs of this element, so it must be added to the plant. By spraying or through the soil in the form of zinc sulfate.

7. Manganese: It was also found from the soil analysis that the concentration of manganese ranged from (0.78 - 0.96) ppm, with an average of (0.86) ppm, which is a low concentration that is not sufficient to supply the plants with their necessary needs of this element, and therefore it is necessary It was added by spraying or through the soil in the form of manganese sulfate.

8. Copper: From the results of analyzing soil samples, it was noted that the concentration of copper ranges from (0.30 – 0.44) ppm, with an average of (0.35) ppm, which is an insufficient amount to supply the plant with its needs of this element, which must be added. Spraying or through the soil in the form of copper sulfate.

To find out the distribution of concentrations of cations in the soil, they were represented graphically as in Figure 12, where they showed higher concentrations of calcium and sodium compared to the rest of the cations in the soil. Characteristics of carbonate composition.

On the other hand, Figure 13 gives the general shape of the distribution of the percentage of calcium carbonate in the soil of the five study sites, where the highest percentage was represented in site of Tasleeh (1) compared to the rest of the sites, and this is an indication of the nature of this soil, which is dominated by an increase in the percentage of calcium carbonate or calcareous soils.

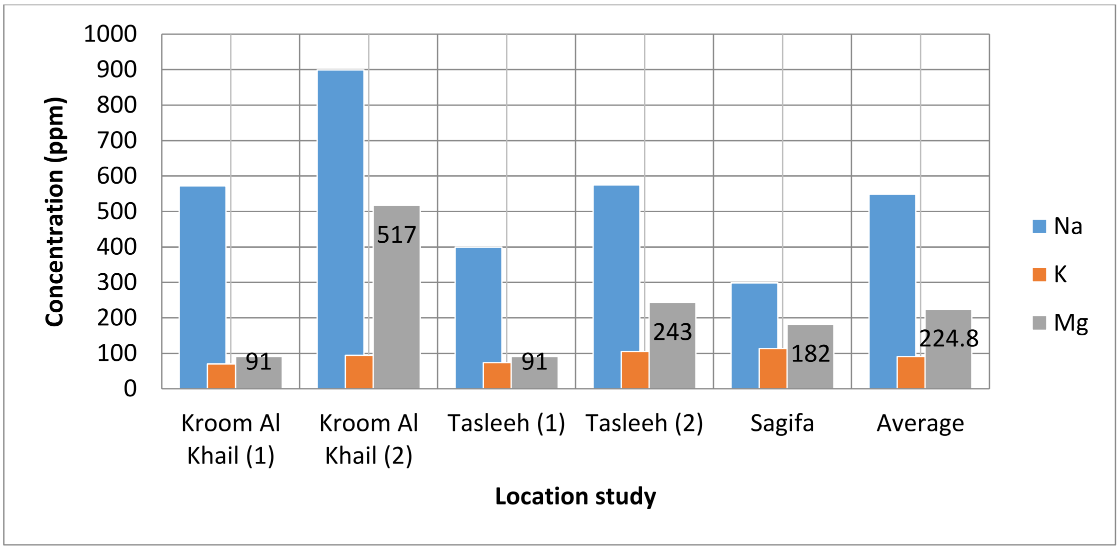

Figure 12 Concentration of nutrients in the soil.

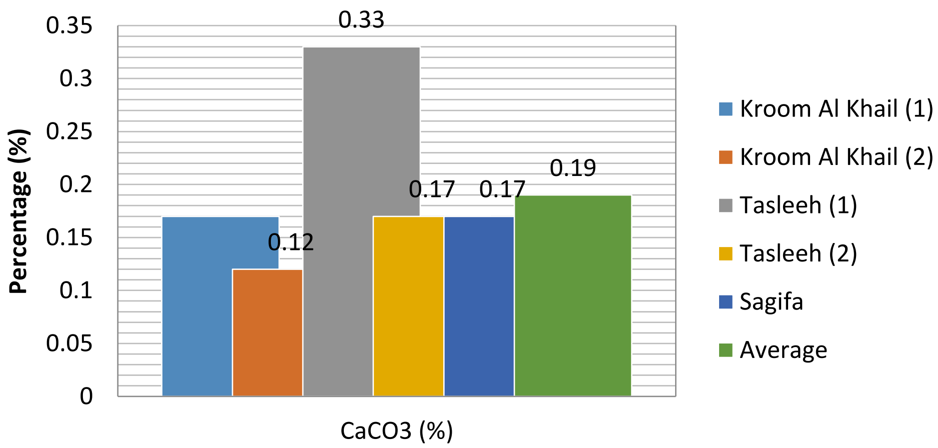

Figure 13 Percentage of calcium carbonate in the soil.

Figure 14 shows the distribution of the content of some trace elements in the study sites, where iron represented the highest concentrations compared to the rest of the elements, especially in site No. 1, and the lowest content in the rest of the sites, followed by zinc, which recorded values that are almost identical in all sites to some extent.

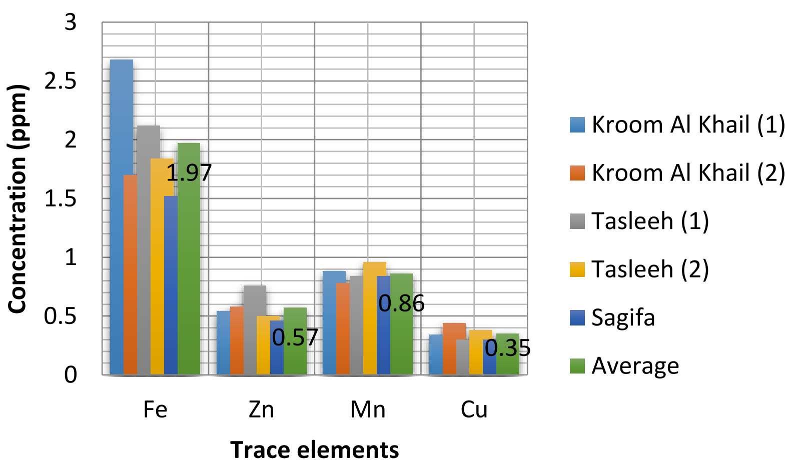

Figure 14 The content of some trace elements in the study sites**.**

Conclusion

In light of this study, we can conclude the following:

1. From the mechanical analysis, the soil can be classified as a sandy soil of texture, and from the reciprocal capacity of the bases, the soil of the Harbana region is saline-alkaline according to the division of the American Salinity Laboratory.
2. It was noticed that the soil is free of phosphorus, and this requires the addition of phosphate fertilizers in the form of tri-calcium phosphate before planting and di-ammonium phosphate after planting.
3. It was found from the analysis of soil samples that the potassium available to plants ranges from (70-113), ppm, with an average of (91.2) ppm. This level in sandy soil is sufficient for the crops' needs of this element, and there is no need to add potash fertilizers in at the present time, after planting, it is necessary to conduct a soil analysis to ensure that the level of this element is still at the required level.
4. By analyzing soil samples, it became clear that the zinc concentration ranges from (0.46 - 0.76) ppm, with an average of (0.57) ppm, which is an insufficient quantity to supply the plant with its needs of this element, so it must be added to the plant by spraying or through the soil on picture of zinc sulfate.
5. It was also found by soil analysis that the manganese concentration ranges from (0.78 - 0.96) ppm, with an average of (0.86) ppm, which is a low concentration that is not sufficient to supply plants with their necessary needs of this element, and therefore it must be added by spraying or through the soil. Pictured is manganese sulfate.
6. It has been observed that the concentration of copper ranges from (0.30 – 0.44) ppm, with an average of (0.35) ppm, which is an insufficient amount to supply the plant with its needs of this element, which must be added by spraying or through the soil in the form of copper sulfate.

Recommendation

1- The soil has a high percentage of total dissolved salts, ranging from (5.03 – 37.56 mmol/cm), at (25 m), which is a high percentage of salts, which requires heavy irrigation of the soil before planting until the total dissolved salts decrease to less than (4 mmolz). / cm), at (25 m), and this process takes place quickly because most of the salts are quickly soluble sodium chloride.

2- Due to the high pH, which ranges from (7.60 - 8.70), as well as the high exchange rate of sodium, which is on average (66%) of the exchange capacity in the bases, it is necessary to use a tri-calcium phosphate fertilizer before planting, which will help in expelling sodium from colloids. soil and thus leads to a decrease in the pH.

3- Nitrogen is a non-existent element in the soil, so it must be added in the form of diammonium phosphate and urea.

4- The soil does not contain phosphorus, and without it, no crop can complete its life cycle, so it must be added to the soil before planting in the form of tri-calcium phosphate, and after planting in the form of di-ammonium phosphate.

5- The soil is poor in the following minor elements (iron, zinc, copper, manganese), so these elements must be added in the form of sulfate in order to nourish the plant and help to reduce the (pH), and these fertilizers are added either by spraying or through the soil.

6- Paying attention to adding organic fertilizers because of their important role in increasing the ability to retain water and nutrients, in addition to helping to reduce pH.

7- The soil is highly permeable and well-drained, and when using irrigation water, it is necessary to refer to the divisions of the American salinity store, which were previously referred to, to choose the appropriate crops.

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