Plant Archives Volume 20 No. 2, 2020 pp. 8735-8744 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EVALUATION OF THE SUITABILITY OF ZAKHEKHA REGION LANDS (WEST OF AL-ANBAR GOVERNORATE) FOR CULTIVATION OF THE IRRIGATED SESAME CROP USING GEOSPATIAL TECHNIQUE

Qusay Khaled Khalaf Aldulaimi[1], Ali Hussein I. Al-Bayati[1*] and Abdul Karem Ahmed M.Al-Alwany[2]

[1*]College of Agriculture, Anbar University, Iraq.
[2]Desert Studies Center, Anbar University, Iraq.

Abstract

Depending on the semi-detailed soil survey map for the Zakhikha area, seven topographically and geomorphic ally heterogeneous locations, which representative of the soil units present in the region were selected and determined their geographic locations and dug the geographically representative pedon. Excavated disturbed soil samples from each diagnostic horizon were obtained and transferred to the laboratory for analysis some physical and chemical analysis, the region's lands suability to sesame crop cultivation with irrigation was evaluated according to the method of correlation between the standard method and the method of determinants proposed by Sys *et al.,* (1993) and carrying out the study maps using the GIS program with a scale of 1: 50000, in addition to studying the climatic requirements of the sesame crop. The results showed that the climate of the region is not specific to the growth of this crop, and the assessment of the suitability of the land for sesame cultivation by irrigation in the region has shown that most of the region's lands are within the moderately class S2 form 78.14% of the total area of the region and the fertility status was the limited factor, while the marginally class S3 It constituted 12.51%, while the currently inappropriate and future class N2 constituted 9.35%.

Key words : land evaluation; Zakhekha region; sesame crop; GIS.

Introduction

The land assessment is procedures and interpretation of the results of soil surveys and data on soils, natural vegetation and climate, the purpose of which is to diagnose and compare the suitability of lands within its current and future reality and to determine the appropriate ranges for each soil unit for agricultural purposes according to approved quantitative methods (Al-Alwani, 2001). The pattern of soil distribution in the ground perspective is affected by the factors and processes of soil formation in addition to geomorphological factors from the erosion and sedimentation which affected in any region (Al-Agidi, 1986). For the purpose of realizing the state of changes and prediction in the characteristics of the soil of a region, it is necessary to integrate remote sensing information and field survey, surveys as well as Automated processing systems known today as GIS (Khoram and Shariat., 2004). Behzad *et al.,* (2008), when studying the qualitative assessment of the suitability of land in the Jacquard region within the southwestern Khuzestan province of Iran, indicated that the physiological requirements for wheat, alfalfa, corn, and barley crops were estimated based on the standard method and simple determinants method. The suitability index was higher for the crops of barley, wheat and alfalfa compared to the corn crop, and the factors determining the production of these crops in the region were the climate as well as the physical properties of the soil (especially the soil carbonate content), soil salinity and the drainage class, and the use of both methods gave realistic results in relation to the cultivation of these Crops in the region conditions. Hamad (2009) used remote sensing and geographic information systems techniques in assessing Abu Ghraib lands as a model for soils in the Iraqi sedimentary plain, as results showed that the TW565 series was moderately suitable for wheat

***Author for correspondence :** E-mail: albayai1961@yhoo.com

and barley crops and suitable for corn crop and constituted 9.7% of the total study area, while the DP47 series was not suitable for corn crop cultivation, and 35.5% of the total area which constituted other soil series were not suitable for cultivation all studied crops. Suleiman and Al-Qassab (2012) studied the evaluation and classification of lands of some sedimentary soils from the middle of the Iraqi sedimentary plain. The Ckfl- Shanaf project for the irrigated agriculture purposes of economic crops. They concluded that the most important determinants of wheat cultivation in the project lands are salinity and the presence of cracks in the surface horizons of the soil. Hedial and Abd Elkawy (2016), when assessing the suitability of Siwa Oasis lands in the southeastern sector of the Arab Republic of Egypt, indicated that there is a large variation in the soil properties of the region, as the electrical conductivity values ranged between 0.5 to 208.0 $dS.m^{-1}$ and ESP between 8.1-91.5% and the total carbonate content between 14.3-70.1% and the soil depth between 20-200 cm, and the groundwater class in the area was within class C_3S_1. As for the evaluation results, it has been shown that most of the lands of the study area are considered within the high and moderately class (S_1 & S_2) to cultivation alfalfa, wheat, barley, sugar beets and onions crops, while it is from marginal class S_3 to cultivation pear, palm, sunflower, cotton, figs, olives and grapes. The limitation for the suitability of the land to cultivation the studied crops was soil texture, salinity and soil permeability as well as ESP. Khallouf *et al.,* (2017) indicated when assessing the suitability of the lands of Lattakia Governorate - Syrian Arab Republic for olive trees cultivation by comparing the characteristics of the six land units (flat coastal floods unit, flat waterbeds valleys unit, light slopes unit, intermediate slopes unit, highly slope unit, steep flat peak unit) and olive tree environmental requirements, using LAMIS and GIS software. That 43.07% of the land was suitable (S_1) for olive cultivation and concentrated in both the coastal floods, and light slopes units and 27.91% of the lands were of moderately suitable (S_2) its concentrated in each of the lands of the flat waterbeds valleys unit and steep flat peak unit, and the lands within intermediate slopes unit, highly slope unit was marginal suitability class (S_3) and constituted 20.24% of the lands of the study area. Al-Bayati and Al-Azzawi (2017) studied the relationship of the physiological location in the extent of the suitability of the land for barley cultivation in some agricultural projects within the Iraqi sedimentary plain, the results indicated that the moderately suitable class (S_2) accounted for 55.43% of the total area of the three projects with growth determinants were fertility status of 1.9 % was recorded at the 7 April project, while the physical factor caused by the presence of calcium carbonate was the main determinant of the suitability of the study areas for barley cultivation with the emergence of water logging caused by poor drainage which recorded at the Al-Majar Al-Kabeer Project. As for the marginal suitability lands (S_3), it was recorded at 10.23%. It was noticed present in the North Kut Project, The determinant factor of soil capability within this unit was the chemical conditions due to the high content of salts. As for the currently non suitability class (N_1), it recorded 25.36%, at the Al-Majar Al-Kabeer Project. While the class N_2, which is not suitable for cultivating barley, it recorded 8.48% as part of the North Kut project. The physiological units of river levee and irrigation levee were within the moderately suitable class (S_2), while the river basin unit showed deterioration in the class from S_2 at the 7 April project to S_3 at the North Kut project. Whereas, the depressions unit of the class (S_3) at the North Kut project turned to (N_1) in the Al-Majar Al-Kabeer project, whereas the silted hor unit showed not suitability class in both North Kut and the Al-Majar Al-Kabeer projects.

Ostovari *et al.,* (2019), when studying to assess the suitability of calcareous lands in semi-arid regions in northwest Iran to cultivate rape using remote sensing data, by obtaining random soil samples from the surface layer of depth 0-30 cm at 92 test sites, showed that 0.81% of the total area was within the high suitability class (S_1), while 42.33% was within the moderately class (S_2) and 11.78% within the marginal suitability class (S_3), and 39.72% within the class N_1 which is currently not suitable for rape cultivation and that only 0.95% of area within N2 currently and in the future not suitable for cultivating this crop.

In view of the importance of the study area, which was covered a 12619 hectares, most of them are agriculturally used, and the nature of the expansion taking place in the exploitation of the lands of the region, in addition to the lack of previous studies in the field of its classification and evaluation of its lands, this study was carried out to assess the suitability of the region's lands for irrigating sesame crops.

Materials and Methods

Study area

The Zakhikha area was chosen for study, with an area of 12619 hectares located between longitude 296000E and 276000E and latitude 3754000N and 3741000N (UTM) bordered to the north, east and west by the Euphrates River and to the south by the Ramadi-Qaim Road (Map 1).

Introductory procedures

Satellite images, topographic and geological maps and climatic information available about the area were used in order to determine the factors of soil formation and pedogenic processes prevailing in the region as well as the available natural resources. The semi-detailed and completed soil survey map for the area was used by Al-Dulaimi (2020) (Map 2). Within it seven heterogeneous sites were selected within the diagnosed soils series in the region, their geographical locations being determined.

Field procedures

Pedons which site-represented of soil series located within the selected area were dug, which were field-located within the preliminary procedures and morphological description according to the American Soil Survey Manual (1993). Disturbed soil samples which represented for each diagnosed horizon were taken and placed in plastic bags and transferred to the laboratory for analysis the purpose chemical and physical properties.

Laboratory procedures

All obtained sample subject to a soil particles distribution according to the Day method, described in (Black, 1965). The chemical properties of the soils were estimated according to the methods in (Richards, 1954), included the electrical conductivity (ECe), the soil reaction degree (pH), The cation exchangeable capacity has been estimated by displacing by sodium acetic with pH 8.2 and replacing the ammonium with sodium. Positive ions are also estimated. As for the bases saturation ratio, it was estimated according to the following formula:

Bases saturation ratio = The sum of the exchangeable cations/ CEC × 100

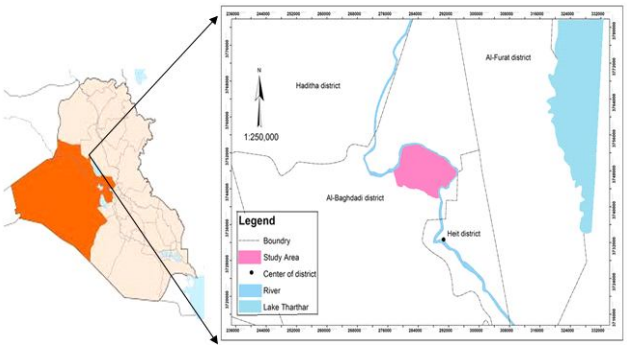
According to the methods mentioned in (Page *et al.,* 1982.). The equivalent total carbonate was estimated by Piper (1979) method by neutralizing it with 1N HCl and titration with 1N NaOH. The soil content of organic matter was estimated using the Wackily and Black method mentioned in (Jackson, 1958), the soil content of gypsum was estimated by precipitation method according to the method proposed by Al-Zubaidi *et al.,* (1981) using a mixture of 80% acetone with 20% acetic acid and a few drops of calcium nitrate In Rahi *et al.,* (1991). The cation exchangeable capacity of the clay part is estimated according to the Savant method (1994) according to the following formula:

Apparent CEC = (CEC soil / Clay%) × 100

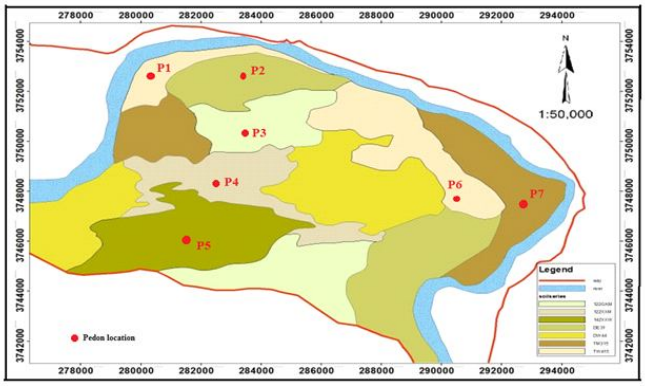
The soil was classified according to the staff survey Soil (1999) to family level and completed the classification to the level of series based on the classification proposal for the level of series for Iraqi soils (1 and 2).

Office procedures

The region's soil survey map has been entered into (Arc GIS 10.2.1) program. And regions lands was assessed and classified its suitability for the sesame crop cultivation, by following the method of correlation between the standard method and the method of determinants proposed by Sys *et al.,* (1993) and completing the appropriate maps with a scale of 1: 50000.



Map 1: The administrative location of the study area.



Map 2: The locations of the selected pedons for the study. Source: Al-Dulaimi (2020).

Evaluation and classification of the land suitability cultivation the irrigated sesame crop

These included the following steps:

1. Determination and evaluation of the Agro-Ecological characteristics, which include all the surrounding characteristics that directly affect the suitability of the land for sesame crops cultivation, there are soil characteristics and eco-climatological characteristics, which include climate and hydrological conditions of the soil as well as topography. Where the process of evaluating these characteristics was done by following the correlation between the parametric method and the limitation method proposed by (Sys *et al.,*1993) (Table 1).

2. Determining the suitability of the climatic

characteristics for sesame crop cultivation through relying on the climate data of the Heet weather station, which is close to the study area for the period from 1995 to 2018.

3. The suitability of climatic characteristics was determined according to the information obtained from the Environmental Division (2000) and according to the stages of crop growth for both maximum and minimum temperatures.

4. The general rate of suitability of climate traits was extracted and linked to the suitability of soil characteristics for the purpose of determining the appropriate varieties for sesame crop cultivation, according to the classification of suitability of the climate according to Sys *et al.,* (1993). Then the values representing Index (Ci) Climatic were entered into climate equations.

5. The lands were classified according to their suitability for sesame crop cultivation, as the Land index was calculated by multiplying the individual estimates of the properties according to the standard method, and then determining the class of the system according to the values of the land evidence proposed by Sys *et al.,* (1993).

6. Then the characteristics of the land (climatic, soil, and topographic features) were matched with those of the equivalent characteristics mentioned in the requirements table proposed by Sys *et al.,* (1993).

7. The results are represented in the form of maps suitable for the lands of the present region for the cultivation of the crop. classes areas were estimated cartographically.

Table 1: Correlation between determination levels, suitability classes, and estimates for all determination levels (Sys *et al.*,1993).

Symbol	Intensity of limitation	Rating	Equivalent Suitability
0	NO	100-96	Suitable(S1)
1	Slight	95-86	
2	Moderate	85-61	Moderately suitable (S2)
3	Severe	60-41	Marginally suitable (S3)
4	Very severe	40-25	Unsuitable (N1)
		<25	Unsuitable (N2)

Results and Discussion

1. Assessment of climatic conditions

Climate of the study area

Based on the data for Heet district meteorological weather station and analyzing the climatic characteristics table 2, it is clear that the study area is characterized by a semi-desert climate with a long hot dry summer and a moderate short winter. The annual average of temperature reaches 21.9° C in the region, as temperatures begin to rise from April to September, with rates ranging between 13.9-25.4° C and temperatures rise to 31.5-34.1° C during the months of June, July and August (Public general authority Weather forecast and seismic monitoring, 2019).

The rain in the study area is characterized by fluctuation in its quantities, as it falls only in the autumn and winter seasons and there is no rainfall in the summer months. According to the data recorded in the climatic station, the top of the rainfall is in the month of April, as this month recorded the highest rate of rainfall of 27.3 mm, while the months November, January, January, February, and March. Rainfall rates were 14.5, 17.3, 16.0, 18.3, and 20.4 mm in succession, as the annual rate of precipitation reached 118.5 mm. Rain retention starts from May, with an average of 1.2 mm. As for the months of June, July and August, did not record any rainfall.

2. Physical and chemical properties of the study area soils

Soil units in the study area, which is task to classify and evaluate soils and lands of the region.

3. Classifying the suitability of lands for irrigating sesame cultivation

1-3 Evaluation of the study area climate for irrigating sesame

Sesame is grown in the central and western region of the country during the month of February and the harvest takes place at the end of May. Sesame is generally considered a plant sensitive to excessive moisture in all stages of its growth, and it is sufficient, when cultivated in loamy textural soils, to three to four irrigations, with an interval of 10-15 days between the irrigation and the other, according to the soil water content and the humidity. It is advised to stop irrigation about two weeks before harvest so that the plants are dry and the seeds are ripe. The ripening of the crop begins after about 90-100 days, depending on the cultivated variety, and the fruits acquire brown color, yellowing of the stem and leaves. Harvesting is recommended when the physiological maturity of the seeds is complete. Early harvest is not recommended when the seed water content is high (8).

The results of the evaluation of the study area climate and according to the climate factors determined for sesame cultivation and growth proposed by (Sys *et al.,*1993), which were adopted as a basis for the evaluation and knowledge of the suitability of the climate to grow this crop and based on climatic data issued by the Heet meteorological station (Table 4). The climate of the Zakhikha region is suitable for growing this crop, as a climatic index was obtained, which was used to obtain a

Table 2: Climatic Data for Heet district weather station Duration (1995-2019) *.

The month	Minimum temperature average (C°)	Minimum temperature average (C°)	Minimum temperature average (C°)	Monthly temperature average of soil at depth 50 cm(C°)	The amount of rain (mm)	Relative humidity %	The evaporation (mm)
January	3.2	14.1	8.6	13.6	16.0	75.8	80.3
February	4.6	17.7	11.1	14.5	18.3	67.5	148.2
March	8.7	22.4	15.5	14.7	20.4	55.9	196.3
April	13.9	28.2	21.2	25.9	27.3	50.5	265.3
May	19.1	35.2	27.1	25.6	1.2	39.8	406.3
June	22.8	40.3	31.5	30.8	-	33.7	521.8
July	25.4	42.8	34.1	34.5	-	31.6	589.0
August	24.8	42.7	32.7	35.1	-	34.8	531.1
September	21.3	40.1	30.1	32.2	-	37.9	387.0
October	15.5	32.5	24.0	27.4	3.5	49.9	259.8
November	9.1	23.5	16.3	22.3	14.5	65.9	141.7
December	4.5	18.2	10.3	16.0	17.3	74.3	84.4
Annual rate	14.4	29.8	21.9	24.4		51.5	
The total					118.5		3611.2

*Heet meteorological weather station (33.63333°N – 42.81667° E),70m above sea level.

total and final estimate of the influence of the climate factor. The climate assessment estimates reached 81.7, which indicates that the climate in the study area is within highly suitable class (S_1) for sesame cultivation.

2-3 Evaluation of the Zakhikha area lands according to its soils characteristics and the topographical characteristics to cultivating the sesame crop

The evaluation included the following paragraphs

Determination of soil and topographical requirements for sesame crop growth. Based on the requirements for soil properties and hydrological and topographical conditions for sesame production. these traits evaluated with their ranges of different limitation levels. According to the proposal before (Sys *et al.,*1993).

2. Evaluating the Zakhikha area lands of according to the characteristics of its soils and the topographical characteristics for sesame crop cultivation.

1. Topographic conditions (t)

It is noted that the topological factor was not a determining factor in most of the study sites, as its estimate ranged between (95-100) in the pedons P_7, P_6, P_5, P_2, P_1 and with the increase of the gradient it reached (85) in the pedon P_3, while the lowest estimate value was recorded at the higher slope lands reach (25) at pedon P_4. So that was the main determining factor for this soil series to produce this crop.

2. Hydrological conditions (w)

The results of table 3 showed that the hydrological conditions, which are evaluated according to the drainage class, are not a determining factor for the growth of sesame crop in the lands of the region, because its estimate has ranged between (95-100) for all soils of the region.

3. Soil physical conditions (s)

3.1 Soil texture

(Table 5) showed that all the pedons have given the values of determination (100) because the texture of the soils in the region are loamy, sandy loam and clay loam, and depending on the requirements of this crop contained by Sys *et al.,* (1993), which indicates that this characteristic is not limited to the production of sesame crop in the region.

2.3. Soil depth

It is observed from table 5 that the soil depth in the Zakhikha area is not a determining factor for the growth and production of sesame crop, as the values of their determination reached between 85-100, and that the lowest determination was recorded at the soil series represented by pedon 5.

3.3. The soil content of calcium carbonate and gypsum

The results of table 5 showed that the soil content of

Table 3: some morphological, physical and chemical properties of study soils.

Soil series	Pedon. No	Horizon depth cm	Slope %	Soil drainage Class(1)	Sand	Slit	Clay	Texture Class (2)	EC_e $dS.m^{-1}$	pH	S.O.M $m.kg^{-1}$ soil	$CaCO_3$ $gm.kg^{-1}$ soil	$CaSO_4 2H_2O$ $gm.kg^{-1}$ soil	CECC $mol.(+).kg^{-1}$ soil	ESP	Base Saturation (%)
					%											
TM315	P_1	0-20	<1%	W	45.4	32.6	22.0	L	1.8	7.8	8.3	290	9	18.3	1.241	80.4
		20-40			26.3	49.3	24.4	L	1.5	7.8	4.1	225	8	15.4	0.962	75.6
		40-55			83.9	4.5	11.6	LS	1.4	7.8	1.2	200	30	7.4	0.951	68.4
		55-70			81.5	7.2	11.3	LS	1.9	7.9	0.5	230	40	7.8	1.158	65.9
		70-105			41.4	39.3	19.3	L	2.9	8.3	0.2	430	30	14.2	1.786	79.8
		105-140			36.4	46.9	16.7	L	3.0	8.3	nil	400	26	14.6	1.824	78.3
DE31	P_2	0-21	<2%	E	53.8	23.7	22.5	SCL	2.8	8.5	8.0	420	50	20.1	1.771	72.8
		21-40			52.8	30.0	17.2	SL	2.3	8.0	3.6	300	10	15.5	1.440	65.9
		40-72			78.1	4.5	14.4	LS	2.1	8.2	0.8	325	25	8.2	1.316	80.4
		72-95			83.1	2.5	14.4	LS	2.2	8.2	0.2	330	20	7.8	1.421	75.8
		95-120			85.4	7.6	7.0	LS	2.2	8.3	nil	325	165	6.9	1.361	76.3
122XXM	P_3	0-19	2-6%	M	72.9	13.7	13.4	SL	3.5	8.3	5.3	345	170	6.0	2.048	80.4
		19-45			77.9	6.8	15.3	LS	2.8	7.4	1.1	175	61	12.6	1.703	76.8
		45-70			63.8	18.6	17.6	SL	2.6	7.5	nil	125	165	8.6	1.693	76.5
		70-90			45.8	34.2	20.0	L	2.4	7.6	nil	250	179	15.7	1.761	81.4
TM315	P_4	0-15	6-12%	M	67.5	19.3	13.1	SL	2.2	7.8	6.3	230	165	12.2	1.430	80.2
		15-30			52.7	31.6	15.7	SL	2.3	7.5	4.1	275	397	11.8	1.372	79.3
		30-55			72.9	9.2	17.9	SL	2.5	7.6	0.1	350	407	12.1	1.622	75.6
		55-80			70.1	14.4	15.5	SL	2.1	7.4	nil	158	449	12.2	1.342	75.8
TW415	P_5	0-10	2%	W	42.0	38.0	20.0	L	3.3	7.8	0.3	339	42	17.3	1.950	62.9
		10-40			18.0	41.0	41.0	CL	9.9	8.1	0.1	393	61	23.2	4.345	63.8
		40-75			20.5	37.5	42.0	CL	10.1	8.1	0.05	396	357	22.6	4.380	68.8
TM315	P_6	0-25	<1%	W	35.4	42.2	22.4	L	2.8	7.2	4.1	175	483	15.4	1.703	81.3
		25-50			40.5	35.0	24.5	L	2.4	7.9	1.8	300	10	12.6	1.476	80.5
		50-72			33.8	39.1	27.1	CL	2.3	8.2	0.1	343	20	23.8	1.498	68.4
		72-127			34.3	36.1	29.6	CL	2.1	8.3	nil	355	80	22.5	1.316	72.5
122XXM	P_7	0-23	<1%	M	76.0	11.4	12.6	SL	2.0	8.3	7.3	225	28	13.5	1.244	79.2
		23-40			76.0	9.6	15.4	SL	2.2	7.8	3.3	205	38	12.3	1.413	78.5
		40-65			72.9	13.7	13.4	LS	2.4	7.8	1.1	232	20	7.8	1.468	80.1
		65-110			30.5	57.2	12.3	SiL	2.9	8.0	0.1	303	33	20.3	1.786	83.3
		110-140			26.3	49.3	24.4	L	3.3	8.2	nil	354	30	17.1	1.957	80.1

(1) Soil drainage class: E: Excessively; W: well; M: Moderate.

(2) Soil texture class: SL: sandy loam; L: loam; CL: clay loam; SiL: silty loam; LS: loamy sand; SCLl: sandy clay loam.

Table 4: Assessment of climatic conditions of the study area for sesame crop cultivation according to Sys *et al*. (1993).

Climatic condition for Groundnuts growing cycle	Data	Degree of limitation	Rating
Mean temp. of the growing cycle (C°)	18.7	1-2	85
Mean max. temp. of the growing cycle(C°)	25.9	0-1	90
Mean min. temp. of the growing cycle(C°)	13.9	1-2	60
Relative humidity growing cycle (%)	53.4	0	100
Climatic index(Ci)			45.9
Suitability class of climate		S1	81.7
Over all climatic rating			100

both components is not a determining factor for sesame crop growth, according to the crop requirements.

4. Soil fertility conditions (f)

The results of table 5 showed that the values of its determination factor have ranged between 77.0 to 87.0 currently due to the low soil solution content of positive ions, in addition to the high values of the soil reaction which negatively effects on the growth and production of sesame crop, and it is possible to raise the values of this determination by adding chemical fertilizers with the use of some acidy affected amendments.

5. Salinity and alkalinity (n)

It is observed from the results of this trait that it is not a limited factor for sesame crop cultivation in most of the lands of the study area, except for the soil unit (represented by pedon, P_5), which has a specific factor for cultivating this crop, and it is possible to transform this trait in the future so that according to the appropriate administrative means to reduce it and limit its impact on crop growth.

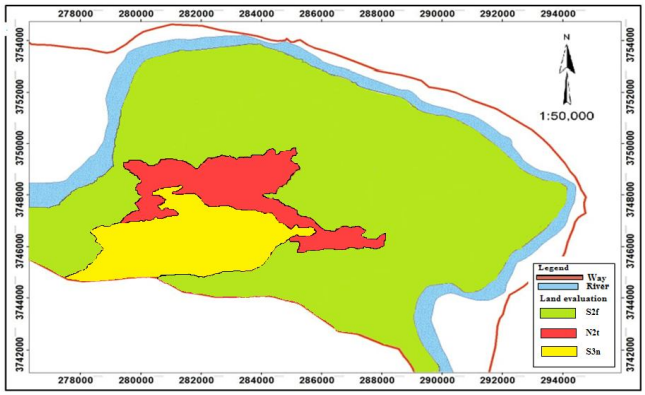
4. Classifying the suitability of lands for irrigated sesame crops

The results of the evaluation of the characteristics of the land shown in table 5 showed that the determining factor for sesame crop cultivation in the study area is the topography and salinity as well as the fertility status, so the classes of suitability of the lands of the region for growing this crop were distributed to:

1. Class S_2f: moderately suitable lands for sesame crop cultivation and the determining factor in it is the fertility factor due to the high degree of soil reaction as well as the redaction soil solution content of positive ions, and its effect can be reduced by adding soil improvers with acidic action and adding organic and inorganic fertilizers to the soils of this class of land suitability, and this class of suitability formed most of the Zakhikha area, its percentage according to the categorical analysis of the map (3) 78.14% from the total area of the region (11609.17 hectares) (Table 6).

2. class S_3n: marginal suitability lands for sesame cultivation (S_3) and the specific factor in it is salinity. This sub class has reached 12.51% of the total area (1580.32 ha) represented by the soil series 142XXW (Table 6).

3. Class N_2t: lands currently and in the future not suitable for sesame crop cultivation, its constituted an area of 1181.13 hectares (9.35%) and has been recorded by the great slope (topography) as a determinant of the growth and production of this crop as in the pedon P_4 (soil series 122XXM).



Map 3: The Zakhikha area lands suitability evaluation for irrigated sesame crop cultivation.

Conclusions

1. The study area is characterized by high temperatures and less precipitation, and the assessment of climate elements for irrigated sesame crop has shown its suitability for cultivation.

2. The soil of the study area was characterized as varying in depth according to the geomorphological location, with an increase in soil salinity in the higher topographic sites, with medium fertility characteristics due to the dominance of the two components (gypsum and calcium carbonate) within the soil components. The soil texture classes were distributed between moderate

Table 5: Assessment of the Zakhikha area lands suitability for irrigated sesame crop according to the characteristics of the land

Pedon N0.	Soil Series	Top.(t) Slope %	Wetness (w) Drainage	Physical Soil condition (s)				Fertility condition (f)						Salinity/ ds.m^{-1} ESP(%) (n)	Land index	Land class
				Texture	Depth (cm)	$CaCO_3$ (%)	Gypsum (%)	Apparent CEC Cmol(+). Kg $^{-1}$. Clay	Base saturation (%)	Sum of bases Cmol. (+). kg^{-1}soil	pH	S.O.M (%)	Mean			
P_1	TW415	<1	well	L	>90	29.6	2.1	71	79.4	0.97	7.9	0.74		2.02/1.2		
		0	0	0	0	0	0	0	0	3	2	1		0		
		(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(40)	(60)	(85)	(77.0)	(100)	77.0	S_2f
P_2	DE31	<2	well	SL	>90	30.3	2.6	82	71.6	1.54	8.2	0.72		2.31/1.7		
		1-0	0	0	0	0	0	0	0	3	2	1		0		
		(95)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(40)	(60)	(85)	(77.0)	(100)	73.2	S_2f
P_3	122GKM	2-6	mod.well	SL	90	21.3	13.9	64	79.5	1.91	7.9	0.66		2.81/1.4		
		2	1-0	0	1-0	0	0	0	0	3	2	1		0		
		(85)	(95)	(100)	(95)	(100)	(100)	(100)	(100)	(50)	(60)	(85)	(79.0)	(100)	60.6	S_2f
P_4	122XXM	6-12	mod.well	SL	<90	25.3	37.2	72	79.8	1.46	7.5	0.54		2.20/1.4		
		4	1-0	0	1-0	0	0	0	0	3	2	1		0		
		(25)	(95)	(100)	(90)	(100)	(100)	(100)	(100)	(40)	(60)	(85)	(77.0)	(100)	17.4	N_2t
P_5	142XXW	2	well	CL	<90	38.2	19.6	61	63.4	5.39	8.0	0.01		9.10/1.9		
		1-0	0	0	1	0	0	0	0	1	2	1		3		
		(95)	(100)	(100)	(80)	(100)	(100)	(100)	(100)	(90)	(60)	(85)	(87.0)	(60)	42.2	S_3n
P_6	DW44	<1	well	L	>90	29.3	15.0	59	81.3	1.64	7.9	0.41		2.30/1.7		
		0	0	0	0	0	0	0	0	3	2	1		0		
		(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(45)	(60)	(85)	(78.0)	(100)	78.0	S_2f
P_7	TM315	<1	mod.well	SL	>90	25.1	2.9	105	79.1	1.33	7.9	0.14		2.10/1.2		
		0	1-0	0	0	0	0	0	0	3	2	1		0		
		(100)	(95)	(100)	(100)	(100)	(100)	(100)	(100)	(40)	(60)	(85)	(77.0)	(100)	73.2	S_2f

Table 6: Catographical analysis of the Zakhikha lands suitable map for irrigated sesame cultivation.

Pedon No.	Soil series	The area (ha)	Percentage from total studied area	Land suitability	The percentage from total area
P_1	TW415	1615.68	12.79	S_2f	78.14
P_2	DE31	2297.83	18.19		
P_3	122 GKM	1872.12	14.80		
P_6	DW44	2347.10	18.58		
P_7	TM315	1738.22	13.76		
P_5	142XXW	1580.32	12.51	S_3n	12.51
P_4	122XXM	1181.13	9.35	N_2t	9.35

roughness and moderate softness, which was reflected in the internal soil drainage category, which ranged between the excessively well and moderately well drained class.

Recommendations

Based on the results of the current study, we recommend the following: -

1. Recommendation of researchers and those interested in the field of surveying and classifying soils and lands to establish a database on the governorate's soils and lands, and determine the obstacles to the agricultural productive capability of there.

2. Reducing the soil preparation processes for cultivation and crop service operations by following the appropriate administrative methods for the area's soils to reduce the impact of the registered determinants of the productivity of soils by adding organic material and using the agricultural rotation method to avoid soil degradation.

3. The necessity of increasing cooperation between all parties interested in such studies for the purpose of conducting extensive and comprehensive studies aimed at increasing agricultural production and preserving the natural resources available in the province.

4. Utilizing the lands of the Zakhikha area to grow sesame crop primarily within the region to suit climatic conditions and provide natural resources appropriate for the growth of this crop.

References

Al-Agidi, W.K.H. (1976). Proposed soil classification at the series level for Iraqi soils. I- Alluvial soils. Soil Sci. Dept. Univ. Baghdad.

Al-Agidi, W.K.H. (1981). Proposed soil classification at the series level for Iraqi soils. II- Zonal soils. Soil Sci. Dept. Univ. Baghdad.

Al-Agidi, W.K. (1986). Biology, Surveying and Classification of Soil. Ministry of Higher Education and Scientific Research - Dar Al-Kutub Press for Printing and Publishing, Mosul University.

Al-Bayati, A.H. I. and H.H.F. Al-Azzawi (2017). The relationship of the physiographic location to the extent of suitability of land for barley cultivation in some agricultural projects within the Iraqi sedimentary plain. The tenth scientific conference for agricultural research/Ministry of Agriculture The tenth scientific conference for agricultural research / Ministry of Agriculture - the Republic of Iraq.

Al-Dulaimi, Q.K.K. (2020). Characterization and classification of soils in the Zakhekha region in western Iraq. Master Thesis. College of Agriculture - Anbar University.

Al-Alwani, A.K.A.M. (2001). Land evaluation for the Al-Saqlawiyah project in Anbar Governorate to grow wheat and irrigated crops. Master Thesis - College of Agriculture - Anbar University.

Al-Zubaidi, A.H., A.A. Fateh and A. Saleh (1981). Evaluation of different methods for estimating gypsum in soils in Iraq. *Iraqi Journal of Agricultural Sciences,* **16(2):** 33-16.

Al-Younis, A.A., M.M.A. Al-Qadir and W. Abd (1987). Cereal crops. Ministry of Higher Education and Scientific Research. University of Al Mosul.

Behzad, M., M. Albaji, P. Papan, N. Boroomand, S. Naseri and A. Bavi (2008). Qualitative evaluation of land suitability for principal Crops in the Gargar Region. Khuzestan province, south West Iran. *Asian J. of plant Sci*., 1-7.

Black, C.A. (1965). Methods of soil analysis. Am. Soc. of Agronomy, No. 9. Part 1 and 2.

Hamad, A.G.I. (2009). The use of geographical information systems and remote sensing in assessing lands in the middle of the Iraqi sedimentary plain. Master Thesis. College of Agriculture - University of Baghdad.

General Authority for Meteorological and Seismic Observations. 2019. Hit Climate Station.

Hedia1, R.M.R. and O.R. Abd Elkawy (2016). Assessment of Land Suitability for Agriculture in the Southeastern Sector of Siwa Oasis. *Alexandria Science Exchange Journal*, **37(4):** 771-780.

Jackson, M.L. (1958). Soil chemical analysis. Verlag: Prentice Hall, Inc., Englewood Cliffs, N.J.P., 558.

Khallouf, A., W. Al-Mabser, T. Jaafar and M. Al-Athan (2017). Evaluation of the suitability of the lands of the Lattakia Governorate for olives using the LAMIS program and GI. Al-Baath University Journal, **93(52):** 184-157.

Khoram, M., D. and R. Shariat (2004). GIS application for land evaluation and planning of Hamadan province for agricultural activity. Proceeding of the FOSS/ GRASS users Conference. Bangkok, Thailand. (www.ing.unit.it/grass/ conference/GRASS2002/proceedings/pdfs/ MitchellScott.pdf.

Ostovari, Y., A. Honarbakhsh, H. Sangoony, F. Zolfaghari, K. Maleki and B. Ingram (2019). GIS and multi-criteria decision-making analysis assessment of land suitability for rapeseed farming in calcareous soils of semi-arid regions. *Ecological Indicators*, **103:** 479-487.

Page, A.L., R.H. Miller and D.R. Kenney (1982). Methods of Soil Analysis. Part (2). Agronomy 9. Madison, WI.

Piper, C.S. (1979). Total insoluble carbonates. p:52-54. in: Hesse, P.R.(ed). A textbook of soil chemical analysis. *Great Britain. Plant Soil*, **212:** 115-121.

Rahi, H.A., Suleiman, I. I. Khudair and M.A.J. Al-Ubaidi (1991). Chemical soil analysis. Dar Al-Hekma for Printing and Publishing, 530.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. U.S. Salinity laboratory staff. Agric. Handbook No.60.

Savant, N.K. (1994). Simplified methylene blue method for rapid determination of cation exchange capacity of mineral soils. *Soil Sci. Plant Anal*., **25(19 & 20):** 3357-3364.

Soil Survey Staff (1993). Soil Survey Manual. USDA – SCS. Agric. Hand book 18. Washington, DC: U.S. Government printing Office.

Soil Survey Staff (1999). Soil Taxonomy. A basic method for making and print. Office, Washington.

Suleiman, A.H.A. and N.F. Al-Qassab (2012). Classification and evaluation of lands of some sedimentary soils in the middle of the sedimentary plain Tikrit University. *Journal for Agricultural Sciences*, **12(3):** 162-155.

Sys, C. (1980). Land evaluation. Parts I, II and III, Courses I T C, Ghent.

Sys, C., F. Ponkart and W. Verheye (1993). Land evaluation part III crop requirement Agric. Publications No.7.General Administration for development cooperation Brussels. Belgium.

The National Program for Preparing Agricultural Environmental Division Maps in Iraq, 2000. Ministry of Agriculture.