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FERTILITY EVALUATION OF SOIL IN DATE PALM GROVES IN ABI AL-KHASEEB DISTRICT, BASRA GOVERNORATE, IRAQ, USING GIS

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Abstract

The study was conducted in Basra Governorate \ Abi Al-Khaseeb District, whose soil is sedimentary soils that consisted of sediments of the Tigris and Euphrates rivers and their tributaries mainly as well as the Shatt Al-Arab and Karon. This study aims to apply a proposed formula from (Sys, 1993) to evaluate the soil of palm groves of the private sector, as the study area is located between two longitude (30^{o}.27'.95", 30^{o}.29'.60") and two latitudes (47^{o}.56'.116", 47^{o} 50'.182"). Geographic information systems are used to predict the most important criteria for soil fertility and produce a fertility assessment map for the region by adopting the evaluation and using the standard method of collection using the following soil characteristics (soil texture, organic carbon, CEC, $CaCO_3$, available N, P, K, soil reaction level, EC,% ESP). 41 locations of soil samples from date palm groves of the private sector were identified and soil samples were taken from the surface layer of depth from (0-60 cm) to conduct physical and chemical analyzes with 4 profiles in the study area for the purpose of knowing the depth of the soil and the depth of spotting for the purpose of conducting the fertile assessment of the soil of an area studying. The results of the morphological description of the study area profiles showed that the soil depth and spotting depth are somewhat same. The results of the analysis of the size distribution of soil particles showed that the soil of the study area with SiL to SiCL. The results of the fertile evaluation of the soil area of the study showed that there are three classes of soil fertility classes, as follows: Very fertile F1: This category included soil samples whose fertility ranges from fertility to more than 80% and fertility: F2 This category included soil whose fertility ranged between 60-80% and medium fertility F3: This category included soil whose fertility ranged between 40-60%.

Key words: Fertility Evaluation, soil, Date palm groves.

Introduction

The fertility evaluation process is the assessment of the ability of the soil to supply nutrients to the plant in quantities and images appropriate for the optimum growth and outcome. This evaluation includes many laboratory and field operations and a number of mathematical relationships that link the relationship between the soil content of nutrients and the ability of the plant to absorb nutrients and it is a necessity to know the ideal methods To assess the state of the fertile soil and know the deficiency of the main nutrients Among the most important different challenges facing the soil system, improving fertility has become necessary and significant from day to day and soil fertility assessment has become a routine work for our soil management, sustainability and increased crop production. There are various technologies for assessing soil fertility, among which is an indispensable soil analysis. In soil management and fertility for sustainable soil productivity (Havlin *et al.*, 2014). There are many methods of the laboratory fertility assessment process, which are based on soil and plant analyzes and modern ones, such as the use of satellite-based technologies and computer software. Soil analysis is useful for understanding and increasing crop production and obtaining data on physical and chemical characteristics. Determination of soil characteristics is a prerequisite for assessing and knowing the fertile condition.

The traditional soil Test gives information about the fertility and management of the soil and the size of the plant gives evidence of the plant's response to soil properties and management often dependent on soil analysis, therefore the current soil examination methods are weak in predicting production and spatial and temporal change and the inability to reflect the ever-changing soil parameters that affect In nutrient readiness and vulnerability in a careful test of nutrient mineralization and deficiency in nutrient response functions (Ali *et al*., 2014).

The use of GIS software has an effective and very beneficial effect in modifying the survey and classification maps of the soil prepared by the relevant authorities. The preparation of maps suitable for lands for agriculture is of importance in agricultural planning and distribution of crops according to their suitability for soils, as well as monitoring the nutritional status of the plant with the stages of growth and remediation of any defect. Predicting the dates of ripening, harvesting and marketing, as well as emphasizing the investment of highly fertile and highly productive lands, the availability of production requirements in the first place and remediation of the shortfall in soil fertility.

The Abu Al-Khaseeb district is one of the most famous areas in Basra Governorate, which is famous for

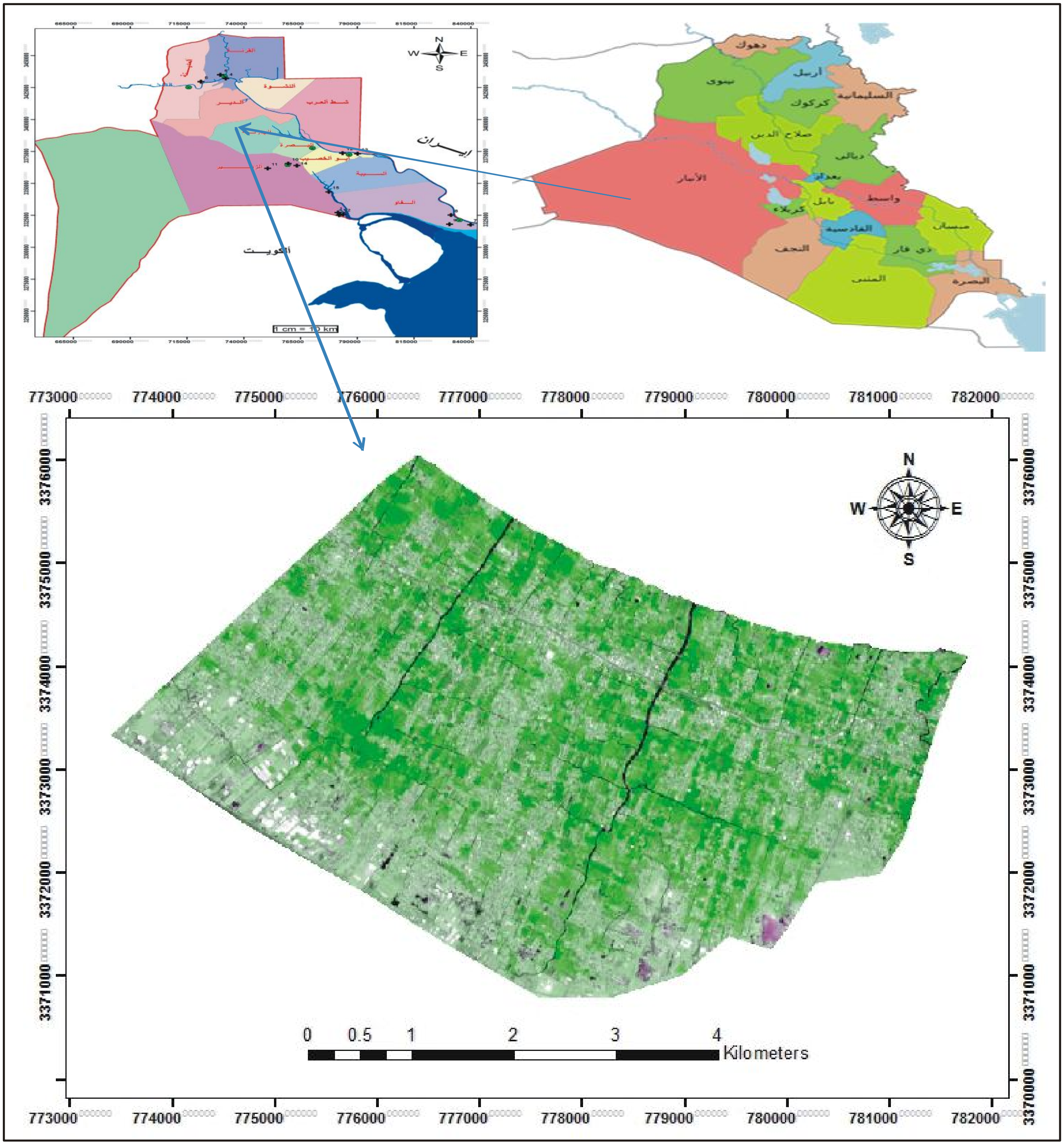

Fig. 1: Study area.

Table 1: Evidence values and fertility assessment classes.

Soil properties	Soil fertility assessment and cultivar scale						
	F1	F2		F3	N1	N2	
	100	80		60	40	25	0
Slope (%)	0	1	2	3	4	5	
Texture/struct	L	SiL	scl	-	S C	S	-
Drainag	MD	MWD	SPD		SED, ED	VD	PD
Soil depth (cm)	>150	150	120	20- 0	75	0	35
PH H2O	7	7.5	7.8	8.2	-	8.5	8.8
Ece ($ds.m^{-1}$)	4	8	-	16	25	40	50
$Caco_3$ (%)	15	20, 25	-	30	35	40	>40
% ESP	8-May	15	-	20	-	25	30
CEC	30-24	16	-	10	-	-	4
% Organic carbon	1.75-1.2	0.9	-	0.6	0.4	-	-
Base saturation (%)	100-80	50	35	-	20	-	-
Sum of basic cations	15-0	5	-	-	2		0
Available n mg kg^{-1}	>60	-	60	40	-	20	10
Available p mg kg^{-1}	>30	30	-	20	15	-	10
Available k mg kg^{-1}	>300	-	-	300	225	150	75

cultivating palm trees on the two banks of the Shatt Al-Arab. Recently, the judiciary witnessed a clear decline in the area of palm groves, where its area became 35.23 km² in 2018, after it was 327 km² in 1973 (Tawfiq, 2019).

• **So the aim of this study is to:**

Preparing spatial distribution maps of some chemical and physical properties of soil in the study area orchards using the IDW method in the ARC MAP (GIS) program and preparing a fertile evaluated map for it.

Materials and Methods

Location and size

The Abu Al-Khaseeb district is located in the southeastern part of Basra Governorate, overlooking the Shatt al-Arab from the eastern side, the Faw district from the south, the Zubair district from the west and the Basra Governorate center in the north of the district, located between longitudes 47° 50' and 47° 56' east and two latitudes 30° 29' and 30° 27' north and the study area is estimated at 2439,852 hectares. The governorate is located in a hot and dry desert climate, with a precipitation of 191.9 mm annually. So the soil of the study area is considered to have a Hyperthermic type thermal system, because the annual average temperature is more than 22°C and its Torric (Aridic) humidity system shows the soil drought throughout the year (Al-attab, 2008).

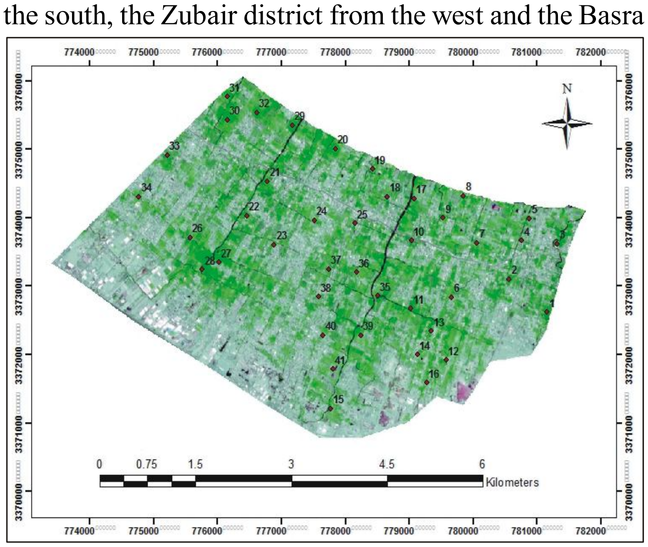

Fig. 2: Soil and plant samples specified for the study area.

Field work

(41) locations were determined based on the plant density randomly and soil samples were taken from depth (0-60) cm and by 3 replicates for each sample, as well as 41 plant samples (palm fronds) and using the GPS device Carmen type GPS with UTM coordinate system, the coordinates of the sites were read Soil samples in the study area were spatially dropped in the ArcGIS10.3.1 program, in order to meet the requirements of spatial analysis. Also 4 profile were drilled for the purpose of knowing the depth of the soil and the depth of staining. Then the samples were dried and crushed and passed through a sieve with a diameter of 2 mm and physical and chemical tests were performed:

Laboratory work

Estimated: Volumetric distribution of soil particles Where the volume distribution of soil particles was estimated using the pipette method according to the method described in Black *et al*., (1965). Soil reaction

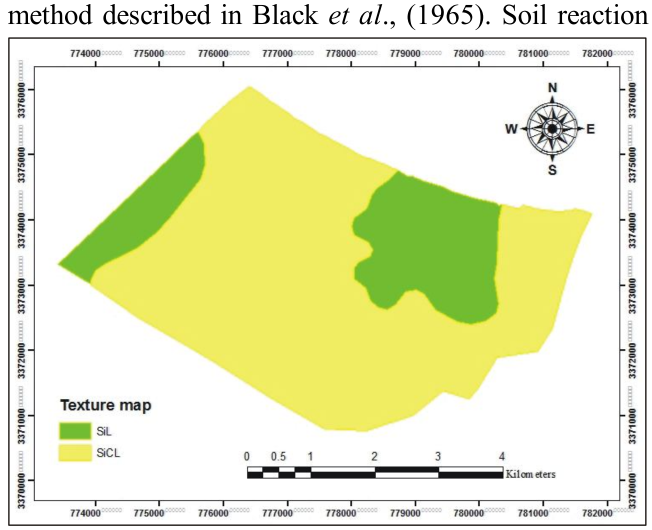

Fig. 3: Map of soil tissue distribution in the study area.

(pH), the soil reaction (pH) was measured with a pH meter according to the method described in (Jackson, 1958). Electrical conductivity (EC) Electrical conductivity (EC) was measured in soil extract 1:1 according to the method mentioned in (Jackson, 1958). Positive ion exchange capacity (CEC): estimated using sodium nitrate (pH = 7.0) according to the method described in (Black, 1965). The percentage of ESP exchanged sodium was estimated according to the method described in (Page *et al*., 1982). Calcium carbonate $CaCO_3$ Calcium carbonate is estimated as described in (Jackson, 1958). The organic matter was estimated by the wet digestion method according to the Walkly and Black method contained in Jackson, 1958. Available Nitrogen (N) Determination of ready nitrogen in soil according to the Keeney and Nelson method described in Page and others, (1982). Available Phosphorus (P): Estimated according to Olsen's method (Page *et al*., 1982). Available Potassium (K): Ready Potassium was extracted in the soil according to the method described in Page *et al*., (1982).

• Using the Inverse Distance Weighted (IDW) method:

It is an inevitable interpolation method. In this method it is assumed that the rate of correlation and similarity between adjacent samples is proportional to the distance between them and can be defined as a function of the inverse distance of each of the contiguous points (Yasrebi *et al.,* 2009). Estimates are based on a known and near location and the specific weights in the interpolation points are the opposite of internal completion and therefore the closing point is equivalent to obtaining weights more than the distance points and vice versa (Buhina *et al.,* 2016).

Xie *et al*., (2011) is known as the spatial completion equation which:

$$Zi(x) = \Sigma\ n\ i = 1\ Wi\ Zi / \Sigma\ n\ i = 1\ Wi \qquad ...1$$

And $$Wi = di - u \qquad ...2$$

whereas :

Z (x): is the expected value at a specified point

Zi: is the expected value at a known point

N: is the sum of the numbers at a given point used for spatial completion

di: is the distance between the point i and the prediction point

Wi: is the weight assigned to point i.

u: The weighting power that determines how this decreases with increasing distance.

The main factor affecting the accuracy of the IDW is the known power value.

In this way it allows a large number of data to be processed on a large scale without exceeding our available values and it also shows a sensitivity to the weight dependence that depends on the distance between the unknown points and the neighboring known points. (Al-Humairi*,* 2019) also found the possibility of representation and spatial analysis of the physical properties of the soils of the district of Al-Kahla in Maysan governorate by way of (IDW) in the form of maps with high accuracy using cartographic modeling.

Results & Discussion

Physical and chemical properties

• Particle size analysis: The result shows the volumetric distribution of soil minutes for all study area samples that the dominance was for the silt minutes, as the amount of silt minutes ranged between 511-661 g kg^{-1} and the clay minutes ranged between 244.8-418 g kg^{-1} and the lowest amount of sand particles ranged between 64.3-124 g kg^{-1}. The dominance of the silt and clay minutes may be attributed to the precipitation conditions and the location of the study area in relation to the source of sediment and the contents and intensity of the transported momentum as well. As a result of the negative impact of the nature of the prevailing environmental factors in the region, such as drought, short life time and the nature of the original material (Al-Atab, 2008). Add to that in this region, the river's slope is very little and the movement of water is slow, thus carrying the largest amount of clay and silt with a small amount of sand, especially fine sand and thus most of the soil has a soft texture:

• pH soil reaction: The results showed that the soil reaction values for the samples are located under moderate to medium soil alkalinity (Soil Survey Division Staff, 1993). As it ranged between 7.54-8.18, the variation

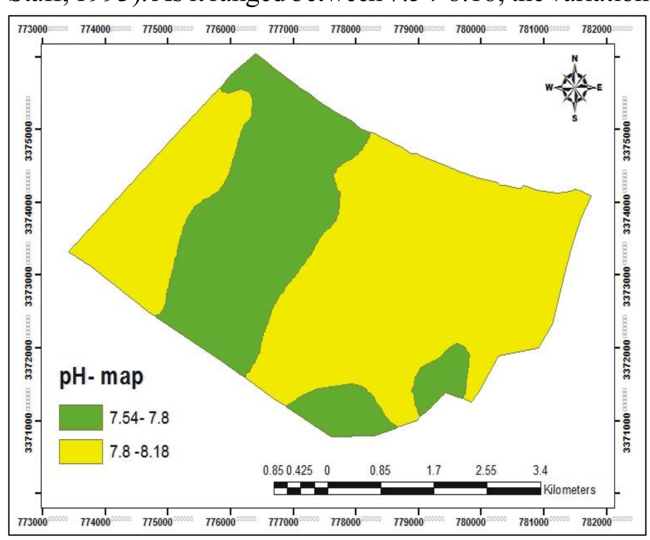

Fig. 4: pH distribution map study area.

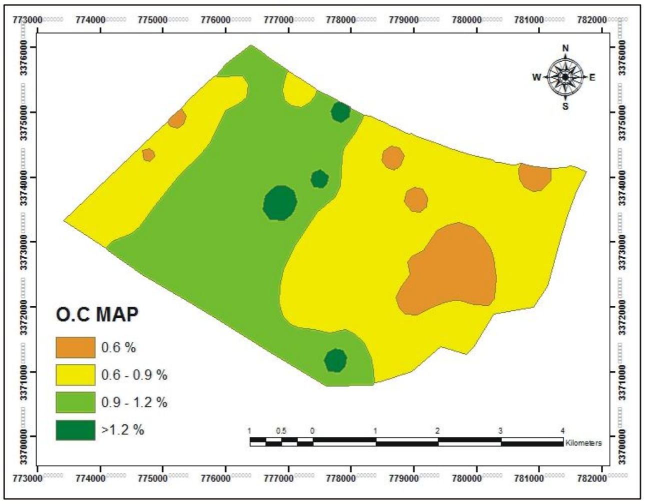

Fig. 5: Organic Carbone distribution map study area.

between the sites resulted from the difference in the soil content of carbonate, the concentration of salts, the concentration of sodium ion and the texture of the soil, especially its content of clay minutes. Fig. 4 shows that the value of the degree of soil interaction in the study area is considered a soil tendency for basal as the increased soil content of calcium carbonate led to an increase in the degree of its interaction towards basal. As the soil pH is a determining factor for soil fertility and is very important in the fertility assessment process due to the direct and important impact on the soil chemical qualities and the readiness of nutrients, the extent of the existing pH values in the study area is the appropriate range for most plants and nutrients, so the effect is little specific to the condition Fertility and soil growth of crops (Sposito, 2012; Al-Naimi, 1999 and Ali *et al*., 2014).

• **Organic Carbone:** The results of the study indicate that the content of organic matter in the study area ranged from 0.52-1.46% of organic carbon. Fig. 5 shows the distribution of organic carbon ratios in the study area, where the proportion of organic carbon reached 51.93%

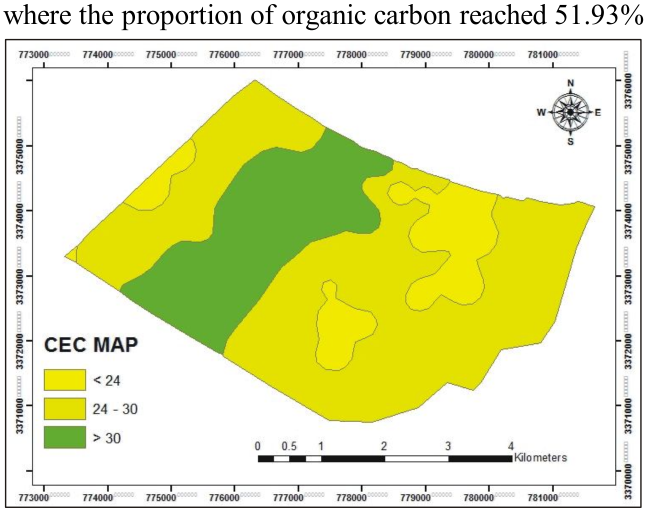

Fig. 6: CEC distribution map study area.

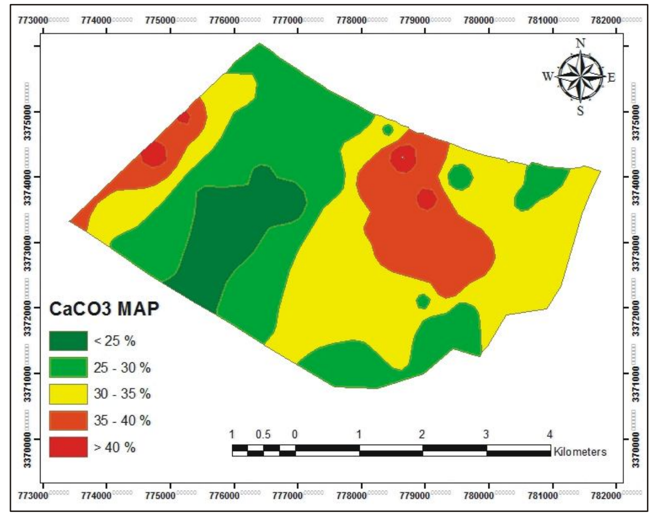

Fig. 7: $CaCO_3$ distribution map study area.

for the level from 0.6-0.9% with an approximate area of 1266.59 Ha, the level from 0.9-1.2, with an approximate rate of about 925.75 hectares and at a rate of 37.95%. On the other hand, values less than 0.6% are estimated at 8.2%, with an approximate area of 200 hectares and the largest level of 1.2% occupied only 1.92% of the total area and an area of 46.72 hectares.

• **The exchange capacity of the positive ions:** The results are shown in table 2 and fig. 6. The values of the CEC exchange ranged from 21.6-36.6 and we will finance its shipment. Kg^{-1}. Where the category formed between 24-30 the majority of the study area, at a rate of 61.5%, while the category <24 was 13.33%, while the category> 30 has reached 25.17%. In general, these levels of CEC values are considered good relative to soil fertility, since the soil that owns these levels it is highly capable of holding ions and nutrients necessary for the plant.

The results indicated that

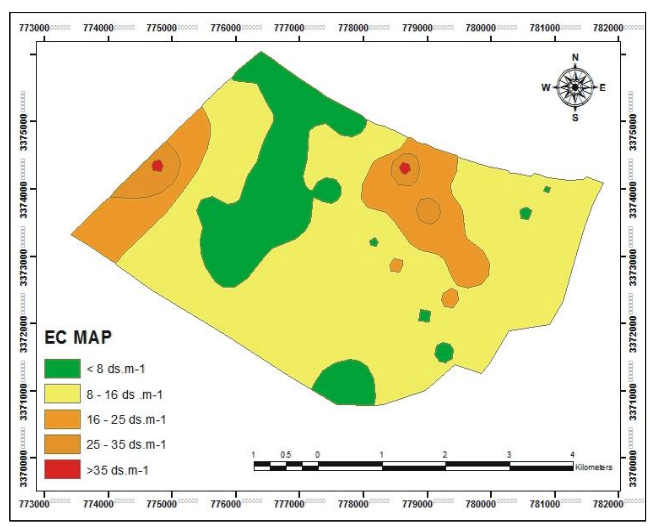

Fig. 8: Electrical conductivity distribution map study area.

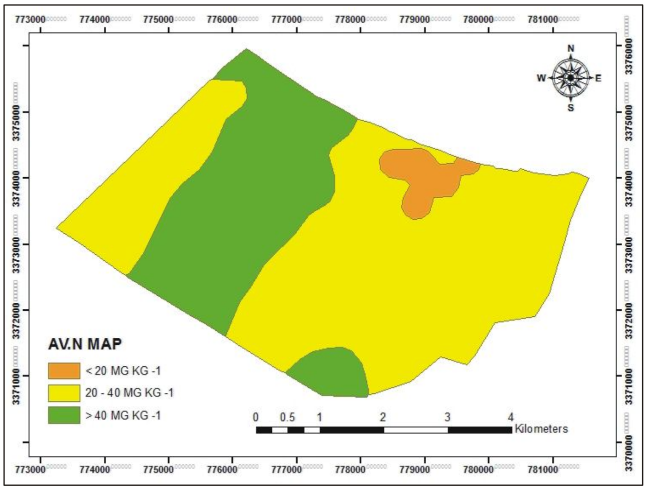

Fig. 9: Available Nitrogen distribution map study area.

the lime content in the study area ranged from 20.5%-45.5 gm^{-1} kg. Where the category between 25-30 accounted for 34.14% of the total area of the study area with an area of 832.3 hectares and the level 30-35 constituted 39.23% with an area of 956.9 hectares while the category <25 reached 9.33% while the two categories reached 35-40% and> 40% their ratios reached 15.89% and 1.43% with an area of 227.49 and 34.87 hectares, respectively, of the total area of the study area.

• **Electrical conductivity:** The results show in table 2 the values of the electrical conductivity of the samples of the study area and parallel to the Shatt al-Arab, the rise in values in general compared to other tracks, as these values ranged between 4.4-37.9 decimeters M^{-1}. This may be due to the property activity Capillary that leads to the accumulation of salts in the upper horizons, due to the proximity of the ground water to the surface of the soil and with high temperatures and evaporation of water from the soil surface. Salt accumulates in the surface horizon and the phenomenon of saline tides that

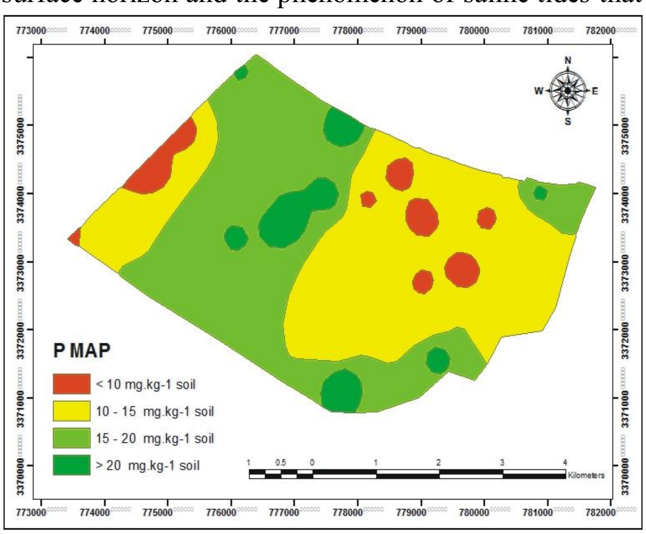

Fig. 10: Phosphorous distribution map study area.

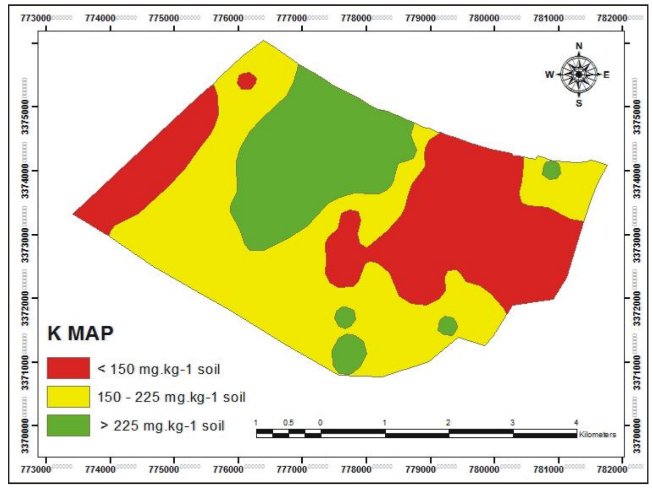

Fig. 11: Potassium distribution map study area.

the southern Basra Governorate regions, especially the Abu Al-Khaseeb district, have led to a significant rise In the salinity of the soil as a result of the accumulation of salts in the region, which led to the deterioration of agricultural lands in it (Al-Atab and others, 2013). In general, the salinity factor is considered one of the most important characteristics of the soil affecting fertility assessment due to the salinity tide experienced by the logic and Basra Governorate, especially in the past few years in general, which led to high soil salinity in addition to the farmers neglecting palm groves in the study area.

• **Available nitrogen:** Table 2 shows the values of ready nitrogen in the study area between 15.6-59.8 if these proportions are relatively high due to the good soil content of the organic matter as well as the type of agricultural exploitation in palm groves in the Abi Al-Khaseeb district where The organic matter is added continuously in order to maintain the productivity of orchards and the cultivation of some vegetable plants (lettuce and groats) and to fertilize it with human and animal wastes, which are primitive and ancient methods

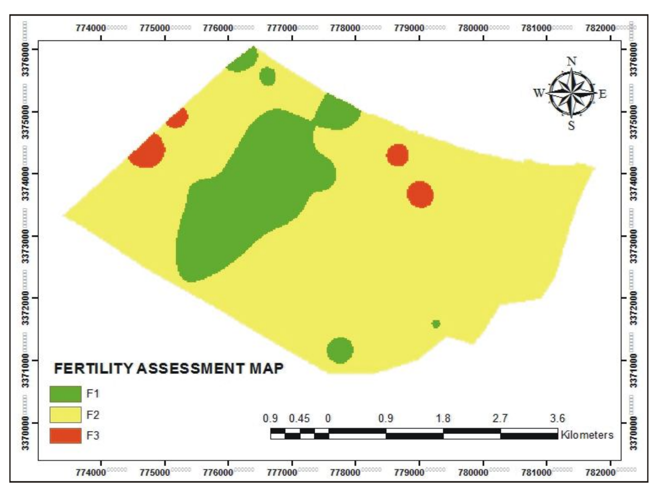

Fig. 12: Fertility Assessment distribution map study area.

Table 2: Some chemical and physical soil characteristics and fertility evaluation of the study area.

Sample	Slope	Texture	Soil depth	Drainage	pH	ECe dS m^{-1}	% $CaCO_3$	% ESP	O.C. %	CEC	B.S	B.C	K	P	N	Evaluation	Class
1	1	SiCL	130	MWD	7.91	11.22	34.5	12.94	0.66	25.96	84.13	21.84	94.14	10.44	32	66.69	F2
2	1	SiCL	130	MWD	7.92	13.96	35	13.37	0.6	25.06	84.43	21.16	106.89	11.12	30	66.1	F2
3	1	SiCL	130	MWD	7.83	9	32.5	12.04	0.61	27.26	82.94	22.61	132.37	15.6	35.6	60.28	F2
4	1	SiCL	130	MWD	7.81	7.44	28.5	10.76	0.69	27.14	82.24	22.32	128.73	12.92	39.2	74.38	F2
5	1	SiCL	130	MWD	7.85	7.95	27	10.11	0.57	28.38	81.81	23.22	157.86	21	37.6	79	F2
6	1	SiL	130	MWD	8.02	20.3	39	14.81	0.53	22	86.4	19.01	86.22	7.8	21	60.02	F2
7	1	SiL	130	MWD	7.9	10.04	34.5	12.9	0.6	22.64	81,97	18.56	86.86	9	22.2	64.28	F2
8	1	SiL	130	MWD	7.86	9.13	32.5	12.51	0.65	22.7	82.73	18.78	94.14	10.2	18.6	71.24	F2
9	1	SiL	130	MWD	7.94	14.17	35	12.41	0.69	22.56	88.65	20	166.97	14.76	17.9	69.55	F2
10	1	SiL	130	MWD	8.13	30.8	42.5	17.45	0.56	22.8	88.29	20.13	85.22	7.5	16	54.48	F3
11	1	SiCL	138	MWD	7.96	14.13	38.5	13.53	0.59	22.16	84.52	18.73	85.11	8.8	21.2	61.61	F2
12	1	SiCL	138	MWD	7.75	8.04	27.5	10.14	0.61	27.4	82.3	22.57	132.37	15.4	32	73.82	F2
13	1	SiCL	138	MWD	8	17.6	39.5	14.27	0.53	26.84	83.12	22.31	125.08	12.36	22.2	63.91	F2
14	1	SiCL	138	MWD	7.81	7.08	29	11.12	0.52	26.6	83.34	22.17	114.16	12	38.6	71.68	F2
15				MWD													
16	1	SiCL	138	MWD	7.72	7.3	25	8.3	0.69	27.08	79.35	21.49	163.33	22.92	39	80.55	F1
17	1	SiL	135	MWD	8.01	19.71	39	14.74	0.65	23.8	85	20.23	103.24	10.89	17.9	61.87	F2
18	1	SiL	135	MWD	8.18	37.9	45.5	19.68	0.52	21.64	94.96	20.55	165.4	7.4	15.6	54.44	F3
19	1	SiCL	135	MWD	7.82	8.27	29.5	12.07	0.72	31.56	80.86	25.52	174.16	12.24	21.8	72.22	F2
20	1	SiCL	135	MWD	7.61	5.25	25	8.91	1.3	36.36	80.03	29.1	197.89	27.2	56.6	87.11	F1
21	1	SiL	135	MWD	7.73	6.44	25.5	9.03	1.05	33.32	78.09	26.02	174.21	18.3	46.2	85.59	F1
22	1	SiL	145	MWD	7.8	6.93	24.5	10.86	1.04	31.84	79.49	25.31	171.46	16.8	44.8	82.82	F1
23	1	SiCL	145	MWD	7.54	5.2	20.5	8.49	1.46	31.68	80.71	25.57	261.6	28	59.8	90.7	F1
24	1	SiCL	135	MWD	7.7	6.19	25.5	8.96	1.3	35.8	78.77	28.2	207	24.2	57.6	86.25	F1
25	1	SiL	135	MWD	8	18.33	39	14.5	0.65	35.16	83.5	29.36	188.68	9	22.2	65.29	F2
26	1	SiCL	145	MWD	7.76	7.08	24.5	10.37	1.03	28.44	79.39	22.58	137.83	15.8	43.4	80.93	F1
27	1	SiCL	145	MWD	7.74	6.99	20.5	9.91	1.08	36.6	76.94	28.16	159.67	21.5	45.2	83.93	F1
28	1	SiCL	145	MWD	7.77	7.08	24.5	10.41	1.05	34.76	78.3	27.22	148.75	17.5	44.8	81.95	F1
29	1	SiL	135	MWD	7.8	6.95	28	10.97	0.76	25.6	82.96	21.24	110.52	15.23	41.4	77.11	F2
30	1	SiCL	135	MWD	7.83	9.04	33.5	12.46	0.8	26.4	82.69	21.83	112.35	15.8	36.4	74.12	F2
31	1	SiCL	135	MWD	7.72	6.29	26.5	9	1.05	29.2	79.65	23.26	148.75	20.8	46.2	82.65	F1
32	1	SiCL	135	MWD	7.78	7.3	25.5	10.41	1.02	28.42	80.78	22.96	137.83	17.6	40.6	80.49	F1
33	1	SiL	135	MWD	8.04	21.2	40.5	14.27	0.56	22	90.04	19.81	86.86	7.61	21.8	57.89	F3
34	1	SiL	138	MWD	8.1	35.7	41.5	14.15	0.59	22.12	90.19	19.95	85.94	7.8	21	56.2	F3
35	1	SiL	138	MWD	8.04	16.76	37	14.23	0.64	24.8	86.53	21.46	97.78	10.78	21.2	63.45	F2
36	1	SiL	138	MWD	7.81	7.34	35.5	11.12	0.66	24.44	84.86	20.74	130.54	13.48	39.2	73.17	F2
37	1	SiL	138	MWD	7.86	11.61	33.5	13.14	0.72	25.64	86.93	22.29	110.52	11.34	26.5	67.47	F2
38	1	SiCL	138	MWD	7.92	11.66	34.5	13.45	0.74	23.48	89.24	19.78	110.5	11.2	26.4	67.52	F3
39	1	SiCL	138	MWD	7.9	10.03	33	12.77	0.81	23.4	85.25	19.95	125.08	12.2	27.8	68.73	F2
40	1	SiCL	138	MWD	7.88	9.3	33.5	12.65	0.74	22.28	87.34	19.46	108.7	11.2	26.4	68.1	F2
41	1	SiCL	138	MWD	7.87	9.74	32.5	12.54	0.88	23.04	89.02	20.51	165.08	12.4	36.2	73.73	F2

that the farmer touches until the present time.

• **Available phosphorous:** Results in table 2 a difference in the values of phosphorus in the soil as the study area gave few to medium values of phosphorus in the soil where it was explained that the values of phosphorus 4.4-27.2 and low values due to the high levels of calcium carbonate in the study area has reached the level 10-15 mg.Kg^{-1} soil 46.02% with an area of 1122.17 hectares and a percentage between 15-20 mg.Kg^{-1} soil has a ratio of 1027.46 hectares with a rate of 42.14%, while the levels <10 and level >20 have reached 131.82 and 157.09 hectares, with a rate of 5.4 and 6.44% of the total area of the study area. Phosphorus is a determining factor for soil fertility and crop cultivation, because it is important for plant growth and that adding it to the soil is subject to many sedimentation and adsorption processes that work to reduce its readiness for the plant, since the study areas contain quantities of calcium carbonate that adsorb phosphorous and form sedimentary compounds, either In the case of the presence of the organic matter, the adsorption capacity by the organic matter is little or no, thus increasing its readiness for the plant by increasing its concentration in the soil solution.

• **Available Potassium:** Table 2 shows the difference in potassium values in the soil, as the study area gave few to medium values of potassium content in the soil. The ratio is less than 150 mg-kg $soil^{-1}$ soil, with a ratio of 32.66% and an area of 796.71 hectares. As for the greater level of 225 mg kg^{-1} soil, with a percentage of 21.67% and an area of 21.67 hectares of the total area of the study area. Potassium is a determining factor for soil fertility and crop cultivation, although the soil was not added by farmers, but the potassium level was ok in the study areas because the potassium soil content is good because its texture is mostly Si.CL and it contains high levels of Potassium-fixing clay, which may be ready to plant over time.

Fertility evaluation

The results of the study indicated, through table 2 that there are three classes of soil fertility in the study area, as follows:

• **Very fertile F1:** This cultivar occupies an area in table 2 and the fig. 12 indicates that this class occupies 17.88% of the total area of the study area and an area of 436.12 hectares. The soil of these orchards is characterized by a high percentage of organic matter and ready nitrogen as well as a good level for both available phosphorus and potassium Likewise, lower soil salinity, the percentage of carbonate minerals and the soil pH value are appropriate for ideal growth.

• **Fertile F2:** This variety occupies an area of about 1950.14 hectares, which is approximately 79.95% of the total area of soils of the study area (Table 2). This variety of soils was distinguished by alluvial mixture tissue, low electrical conductivity values and mutual sodium ratio, with good drainage, medium-high lime ratio and medium content of organic matter and npk with a noticeable rise in ready nitrogen values in the soil. The fertility evaluation ranged between 60.19%-77.12%. The values of these soils are in the fertile land class.

• **Medium fertility F3:** This cultivar occupies an area of about 52.86 hectares, or approximately 2.16% of the total area of soils of the study area (Table 2). The main reason that led to a decrease in the productivity of this soil was the high values of electrical conductivity and low content of npk, especially its content of p and k, which are available in the soil. Soils of this variety were distinguished by the texture of clay-alluvial mixture to alluvial mixture. The proportions of lime and mutual sodium are high and with moderate drainage. As a result, her fertility assessment decreased.

References

Ali, Noureddine Shawky, Hamadullah Suleiman Rahi and Abdulwahab Abdul Razzaq (2014). Soil fertility. Arab Society Library for Publishing and Distribution, Amman, Dar Al-Kutub Al-Alami for Printing, Publishing and Distribution, Baghdad Al-Mutanabi Street. (in Arabic).

Al-Atab, Salah Mahdi Sultan (2008). Variation in soil properties and their classification for some areas of Basra Governorate PhD thesis University of Basra. (in Arabic).

Al-Atab, Salah Mahdi, Muhammad Ahmad Kazem and Hussein Abdul-Nabi (2013). Some physical and chemical properties of the Kutuf soil and river basins varied in Abi Al-Khaseeb district in Basra Governorate. *Basra Research Journal,* **38(1):** 221-237. (in Arabic).

Al-Hameeri, Muhammad Abbas Jaber (2019). Cartographic representation and spatial analysis of the characteristics of the soils of the district of Al-Kahla using geographical information systems (GIS). **44(4):** 429-471.

Bhunia, G.S., P.K. Shit and R. Maiti (2016). "Comparison of GIS-based Interpolation Methods for Spatial Distribution of Soil Organic Carbon (SOC)", *Journal of the Saudi Society of Agricultural Sciences*, in press, 2016.

Yasrebi, J., M. Saffari, H. Fathi, N. Karimian, M. Moazallahi and R. Gazni (2009). "Evaluation and Comparison of Ordinary Kriging and Inverse Distance Weighting Methods for Prediction of Spatial Variability of Some Soil Chemical Parameters", *Research Journal of Biological Sciences*, **4:** 93-102.

Tawfiq, Shahlet Zakir (2019). The areas of palm trees in the Abu Al-Khaseeb region changed for the period (1973-2018). *A* *comparative study in agricultural geography*, *Al-Farahidi Journal,* **(36):** 203-222. (in Arabic).

Sposito (2012). Soil chemistry. Translation of Nour Al-Din Ali Shawqi and Shafiq Jalab Salem. Ministry of Higher Education and Scientific Research University of Baghdad / College of Agriculture. (in Arabic).

Al-Nuaimi, Saadallah Najm (1999). Fertilizers and Soil Fertility, Ministry of Higher Education and Scientific Research University of Mosul / College of Agriculture and Forestry. (in Arabic).

Soil Survey Staff (2006). Keys to Soil Taxonomy. Tenth edition United State Department of agriculture natural recourses conservation service SW. Washington, D.C, USA.

Black, C.A. (1965a). Methods of soil analysis. Part 1. Physical and Mineralogical properties Am. Soc. Agron., 9. Madison, Wisconsin, USA.

Black, C.A. (1965b). Methods of soil analysis.Part 2. Chemical properties Am. Soc. Agronomy 9. Madison, Wisconsin, USA.

Jackson, M.L. (1958). Soil chemical analysis. Prentice-Hall Inc. Engelwood Cliffs, N.J.

Page, A.L. (1982). Method of soil analysis. Part 2. Chemical and microbiological properties. Am. Soc of Agron. Madison, Wisconsin.

Havlin, J.L., J.D. Beaton, S.L. Tisdale and W.L. Nelson (2014). Soil fertility & Fertilizers"An Introduction to Nutrient Management" 8th Ed. Prentice Hall. New J.

Xie, Y., T. Chen, M. Lei, J. Yang, Q. Guo, X. Song Band Zhou (2011). "Spatial Distribution of Soil Heavy Metal Pollution Estimated by Different Interpolation Methods: Accuracy and Uncertainty Analysis", *Chemosphere*, **82:** 468-476.