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Contribuations of Remote Sencing and Giographic Information Systems in Sustainable Agricultural Development

a. Developing Soil Fertility Maps of Farafra Oasis Using Remote Sensing and GIS Techniquesto Manipulate and Produce Fertility Maps

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ABSTRACT

Geographic Information Systems (GIS) constitutes an efficient and versatile tool to manipulate and produce-fertility maps. Status of some soil fertility indicators are importance for sustainable agricultural development. Some macro and micronutrients, salinity and soil organic matter are studied. Soil fertility variables in the study area were assessed using GIS techniques. WhereasArc View GIS system is used to perform the soil fertility maps. One hundred and sixsurface layers samples representative (0-30 cm) in area of Farafra Oasis areinvestigatedto producesoil maps of elements of fertility status. The obtained results from data and fertility maps could be summarized as follows: - Electrical conductivity Percentages were 17.5, 53.8, 19.9 and 8.8 % represented low, medium, high and very high amounts respectively, electrical conductivity values ranged from 1.3 to 89.4 dSm^{-1}.- All the studied surface layers are considered low level for organic matter content, Pand Zn.- Total inorganic nitrogen (TIN) were 75 and 25 % represented low and medium classes respectively, and values ranged from 9 to 375µg g^{-1}.- Levels of K were 60 and40 %, represented low and medium classesrespectively.- Available B content in the studied soil profiles range from 0.5 to 22.5µg $g^{-1}$with an average 3.1-µg g^{-1}.- Available Fe percentages were 3.7, 62.6 and 33.7% represented low, marginal and sufficient values, respectively.- About 100 % of Zn total area represent 3493.2faddan is considered high level. - The critical values of the surface layers reached to 25 % Cu. - The statistical analysis of the simple correlation coefficients between macro-micronutrients and some propertied of soils.

Keywords: Soil fertility, GIS, micronutrients and Farafra Oasis

INTRODUCTION

Maps are fundamental to site-specific soil fertility management (SSFM) because they represent either the spatial state of a condition of interest, the prescription of inputs needed to manage a particular condition site-specifically, or a record of inputs or outputs. Pierce and Nowak, (1999).

Modern information technology that link geographic information system (GIS) capabilities with remote sensing (RS) data contribute significantly to the assessment and management of the planned agricultural development Zhou *et. al*.(1989) and Davis *et.al*(1991). Geographic Information Systems (GIS) benefit land use planning and precision agriculture practices. It constitutes an efficient and versatile tool to manipulate and produce soil fertility maps.

Soil related limitations affecting crop productivity include nutritional disorders, and can be detected by evaluating the fertility status of the soil. Micronutrient cycling is quite different among various terrestrial ecosystems (Han *et. al*., 2007). Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability. Soil properties that can be changed in a short time by land use are dynamic soil quality indicators (Chan*et. al*., 2001). Adesanwo*et. al*., (2009) reported that management of soil fertility is the first conditionfor sustainable crop production and can reduce food importation in many countries. The current study aimed to identify soil fertility status using the integration of GIS techniques of the studied area at south Farafra Oasis for sustainable agriculture development,

MATERIALS AND METHODS

Location

The studied area is located south of Farafra city. Its bundled by six coordinate points illustrated as follows: point 1 :N 26 29 746 E27 43 415, point 2: N 26 29 741 E27 44 794, point 3: N 26 26 486 E27 42 692, point 4: N 26 26 559, E27 41 446, point 5: N 26 28 285 E27 41 347 and point 6: N 26 28 280 E27 42 44 Fig. (1). The studied area covers approximately 3430feddan (≈1372 ha).

Soil sampling and analysis

One hundredand six surface soil samples (0-30 cm) were collected from different sites at south of Farafra Oasis (Fig. 1). The samples were air-dried, ground in a wooden mortar and passed through 2 mm sieve. Proportion of this 2 mm sieved-soil was finely ground to pass 1 mm sieve for trace elements analysis.

The amounts of -soil micronutrients are obtained by extracting with DTPA-reagent according to Lindsay &Norvell(1978) and its concentration is measured by Perkin Elmer atomic absorption spectrophotometer, others chemical and physical analyses are carried out according to Page *et. al*.,(1982).

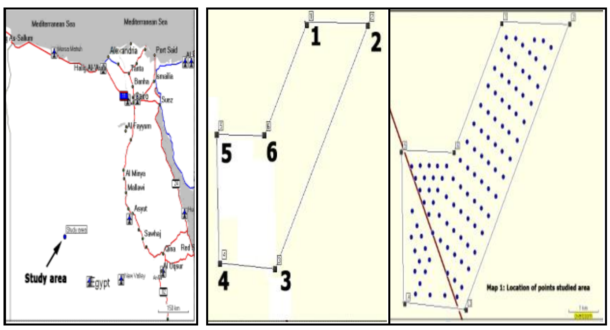


Fig. 1. Location of the study area, boundaries' coordinates and profiles sites.

Descriptive statistical analysis

The data analyses are carried out using descriptive statistical parameters (minimum, maximum, mean, median, standard deviation, and variance) and are calculated for the different variables by SPSS software (2003).

Building up digital georeference database

Data input process is the operation of entering the spatial and non-spatial data into GIS using ArcView software ESRI (1999). Each soil observation is geo-referenced using the Global Position Systems (GPS) and digitized, (Table1).

Table 1. Latitudes longitudes and elevation points of the studied surface layers

Prof. No.	X	Y	Elevation	Prof. No.	X	Y	Elevation
1	N26 29.476	E27 44.412	158	54	N26 27.892	E27 42.578	154
2	N26 29.550	E27 44.260	155	55	N26 27.980	E27 42.427	154
3	N26 29.562	E27 44.077	155	56	N26 27.365	E27 43.016	154
4	N26 29.244	E27 44.355	156	57	N26 27.542	E27 42.731	160
5	N26 29.343	E27 44.110	156	58	N26 27.616	E27 42.588	161
6	N26 29.416	E27 43.980	156	59	N26 27.615	E27 42.525	164
7	N26 29.499	E27 43.833	155	60	N26 27.696	E27 42.521	154
8	N26 29.577	E27 43.695	156	61	N26 27.774	E27 42.288	155
9	N26 29.589	E27 43.505	154	62	N26 27.169	E27 42.880	154
10	N26 29.033	E27 44.143	154	63	N26 27.235	E27 42.734	157
11	N26 29.132	E27 43.972	154	64	N26 27.308	E27 42.645	161
12	N26 29.204	E27 43.840	155	65	N26 27.401	E27 42.446	155
13	N26 29.288	E27 43.693	155	66	N26 27.474	E27 42.301	155
14	N26 29.366	E27 43.554	155	67	N26 27.564	E27 42.146	155
15	N26 29.448	E27 43.408	150	68	N26 26.959	E27 42.740	154
16	N26 28.835	E27 44.009	154	69	N26 27.039	E27 42.598	152
17	N26 28.929	E27 43.839	154	70	N26 27.119	E27 42.455	152
18	N26 29.005	E27 43.707	155	71	N26 27.199	E27 42.313	150
19	N26 29.082	E27 43.556	155	72	N26 27.279	E27 42.171	150
20	N26 29.158	E27 43.415	147	73	N26 27.367	E27 42.014	150
21	N26 29.235	E27 43.273	147	74	N26 26.749	E27 42.602	155
22	N26 28.626	E27 43.868	154	75	N26 26.828	E27 42.456	157
23	N26 28.719	E27 43.701	154	76	N26 26.906	E27 42.314	157
24	N26 28.794	E27 43.568	157	77	N26 29.532	E27 43.446	157
25	N26 28.877	E27 43.421	154	78	N26 28.175	E27 42.431	154
26	N26 28.954	E27 43.282	154	79	N26 28.158	E27 42.368	154
27	N26 29.036	E27 43.138	154	80	N26 27.926	E27 42.338	154
28	N26 28.417	E27 43.726	157	81	N26 27.855	E27 42.464	156
29	N26 28.505	E27 43.570	157	82	N26 27.546	E27 42.527	157
30	N26 28.580	E27 43.425	156	83	N26 27.433	E27 42.750	156
31	N26 28.659	E27 43.278	156	84	N26 27.180	E27 42.206	155
32	N26 28.736	E27 43.137	156	85	N26 27.355	E27 42.310	153
33	N26 28.815	E27 42.990	157	86	N26 27.420	E27 42.647	153
34	N26 28.215	E27 43.573	158	87	N26 27.988	E27 42.207	153
35	N26 28.295	E27 43.430	159	88	N26 27.713	E27 42.026	152
36	N26 28.369	E27 43.285	157	89	N26 27.576	E27 41.933	154
37	N26 29.036	E27 43.138	157	90	N26 27.852	E27 41.940	150
38	N26 28.524	E27 42.996	157	91	N26 28.128	E27 42.109	150
39	N26 28.606	E27 42.848	157	92	N26 28.130	E27 41.938	148
40	N26 28.085	E27 43.292	157	93	N26 27.852	E27 41.754	152
41	N26 28.165	E27 43.147	162	94	N26 27.988	E27 41.665	144
42	N26 28.242	E27 43.003	162	95	N26 28.130	E27 41.759	147
43	N26 28.317	E27 42.860	151	96	N26 28.123	E27 41.582	139
44	N26 28.400	E27 42.710	157	97	N26 27.449	E27 41.690	147
45	N26 27.875	E27 43.153	158	98	N26 27.320	E27 41.576	147
46	N26 27.957	E27 43.009	156	99	N26 27.161	E27 41.649	145
47	N26 28.029	E27 42.863	156	100	N26 27.188	E27 41.863	150
48	N26 28.107	E27 42.721	154	101	N26 27.042	E27 41.743	148
49	N26 28.192	E27 42.570	154	102	N26 26.929	E27 41.648	145
50	N26 27.588	E27 43.159	157	103	N26 26.669	E27 41.665	148
51	N26 27.665	E27 43.013	160	104	N26 26.790	E27 41.753	145
52	N26 27.745	E27 42.866	158	105	N26 26.924	E27 41.859	145
53	N26 27.822	E27 42.726	152	106	N26 27.058	E27 41.948	151

The different soil attributes are coded, and new fields are added to the profile database file in Arc view software. Soil fertility maps are done for soil salinity, soil organic matter. Nitrogen, Phosphorus, Potassium, Iron, Manganese, Zinc, Cu and Boron using module Arc Scripts in ArcView 9.3.

To produce fertility maps, the value of each soil characters is classified into three levels (low, medium and high), except EC values 4 levels are reported according to literature by several authors. The critical levels for different element are summarized in Table 2 and Fig. 2.

Table 2. Critical limits of the studied items and their percentages.

Item	Level	Critical limit	M^2	KM^2	Fadden	Hectare	%
EC	Low	<4	2515362	2.52	598.90	249.5	17.5
	Medium	4.-8	7745543	7.75	1844.18	768.4	53.8
	High	8.-16	2869951	2.87	683.32	284.7	19.9
	V H	>16	1274303	1.27	303.41	126.4	8.8
	Total		14405159	14.41	3429.80	1429.1	100.0
OM	Low	<1.7	14405159	14.41	3429.80	1429.1	100.0
	Medium	1.7-2.6	0.00	0.0	0.0	0.0	0.0
	High	>2.6	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0
IN	Low	<1.7	10814950	10.8	2575.0	1072.9	75
	Medium	1.7-2.6	3590209	3.6	854.8	356.2	25
	High	>2.6	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0
P	Low	<5	14405159	14.4	3429.8	1429.1	100.0
	Medium	5.-10	0.00	0.0	0.0	0.0	0.0
	High	>10	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0
K	Low		8521206	8.5	2028.9	845.4	60
	Medium	<85	5883953	5.9	1400.9	583.7	40
	High	85-170	0.00	0.0	0.0	0.0	0.0
	Total	>170	14405159	14.4	3429.8	1429.1	100.0
B	Low	<1	956650	1.0	227.8	94.9	6.6
	Medium	1.-5	10896210	10.9	2594.3	1081.0	75.6
	High	>5	2552299	2.6	607.7	253.2	17.7
	Total		14405159	14.4	3429.8	1429.1	100.0
Fe	Low	<2.5	531883	0.5	126.6	52.8	3.7
	Medium	2.5-4.5	9163897	9.2	2181.9	909.1	63.6
	High	>4.5	4709379	4.7	1121.3	467.2	32.7
	Total		14405159	14.4	3429.8	1429.1	100.0
Mn	Low	<1	14405159	14.4	3429.8	1429.1	100.0
	Medium	1.-2	0.00	0.0	0.0	0.0	0.0
	High	>2	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0
Zn	Low	<0.5	14086030	14.1	3367	1402	98.2
	Medium	0.5-1	319129	0.3	61.8	148	1.8
	High	>1	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0
Cu	Low	<0.2	3568047	3.6	849.5	354.0	24.8
	Medium	0.2-0.4	10837112	10.8	2580.3	1075.1	75.2
	High	>0.4	0.00	0.0	0.0	0.0	0.0
	Total		14405159	14.4	3429.8	1429.1	100.0

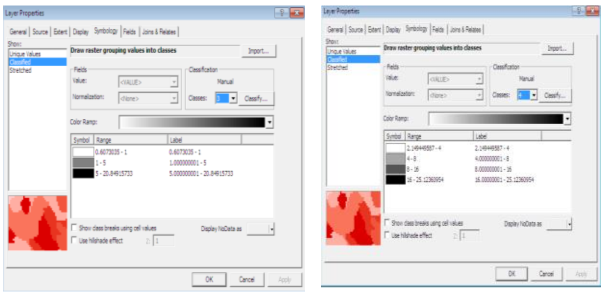


Fig. 2. Classify of the studied items to three and four classes

RESULTS AND DISCUSSION

Fertility maps of salinity and organic matter

***Salinity status*(EC)**

Area distribution according to Electrical conductivity (EC) levels is as follows, about 600faddan (17.5%) of the total area is nonsaline, 1844 faddan (53.8%) is moderate saline, 684 faddan (19.9%) high saline and 303 faddan (8.8%) very high saline Fig 3 and Table 2. EC Values of the investigated surface layers varied from 1.3 to 89.4 dS/m with an average 7.3 dS/m Table 3. The minimum value is recorded in location No. 53 while the maximum value is shown in site No. 82. Both of two sites are having medium texture (sandy clay loam). The literature index values of salinity are < 4, 4-8, 8-16 and > 16 dS/m representing low, medium, high and very high, respectively, these values reported by Rechards (1954). The EC value lower than 4 dS/m is considered a limit of nonsaline soil. Electrical conductivity (EC) has positive correlations with CEC (r=0.806), organic matter (r=0.618)، K (r=0.876). Mg (r= 0.848) and B (r=0.725). Table 4.

Organic matter status (OM)

Percentagesof OM, in the surface samples of the studied area are lowerthan (<1.7 %) OM (Fig.3). Values of organic matter percentages varied from 0.05 to 1.35 %with an average 0.34 % Table 3.

The minimum value is recorded in location No, 47, while the maximum value is shown in site No, 90. Minimum and maximum values have coarse texture (sandy soil). The limits of OM are as follows< 1.7, 1.7-2.6 and > 2.6 % representing low, medium and high levels respectively reported by Richards (1954). Organic matter percentage has positive correlations with CEC (r=0.799), EC (r=0.618) and Cl (r=0.724), (Table 4).

Fertility maps of some macronutrients

Nitrogen (N)

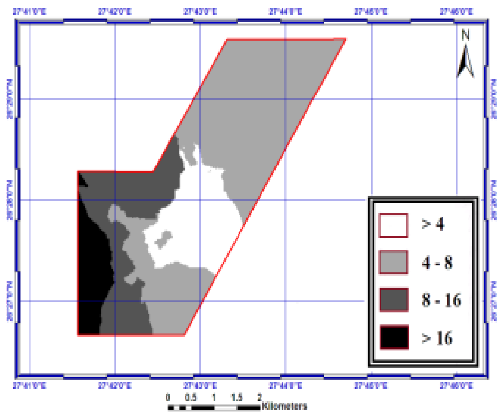
InorganicNitrogen content (NH_4 and NO3) inthe studied soils varied from 9 to 375µg g^{-1} with an average 29µg g^{-1},(Table 3). The minimum value is detected in location No. 42 while the maximum is found in site No, 82. The limit values of N are < 40 low. 40-80 medium and > 80 µg g^{-1}.

Regarding the soil fertility map of N, the areas and percentages are as follow, about 2575faddan (75%) of the total area is low and 855 faddan (25%) is moderate, Table 2 and Fig (3). The NO3 N form has positive correlations with EC (r=0.915), CEC (r=0.686) and Organic nitrogen ON (r=0.620),(Table 4).

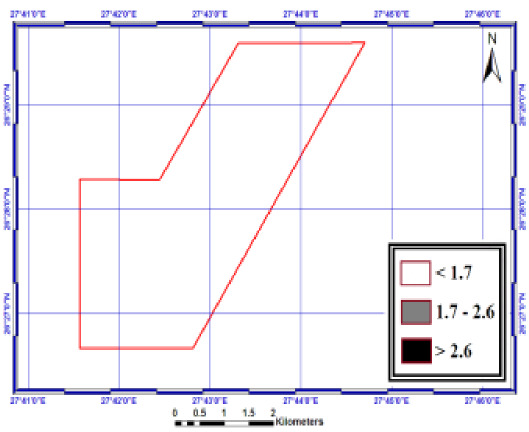
Phosphorus (P)

Values of soil P varied from 1.8 to 6.1 µg g^{-1} with an average 3.6 µg g^{-1}, Table (2). Both minimum and maximum values have coarse texture. The literature index values of soilP are < 5, 5-10 and > 10 µg g^{-1}, representing low, medium and high, respectively.As for soil fertility map of P,mostsamples are considered low value (Fig 3).

EC



OM



N

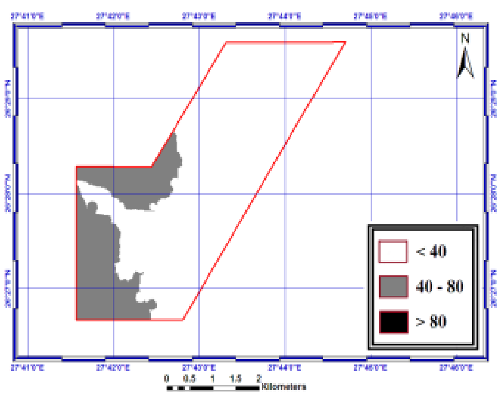
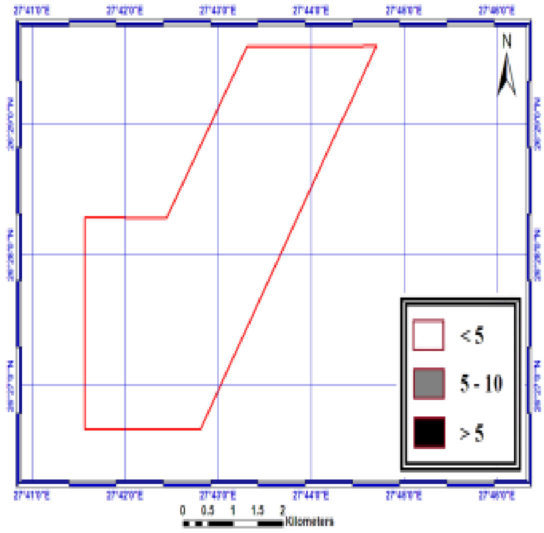
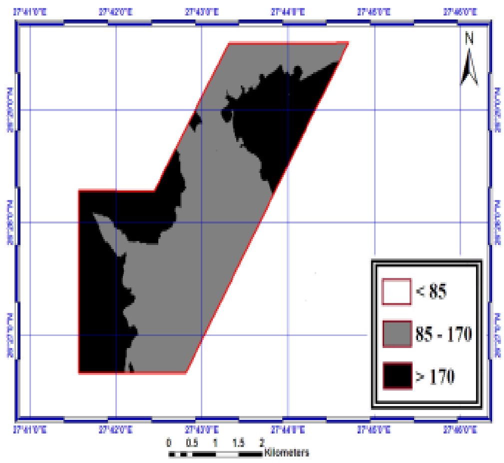


Fig. 3a. Soil fertility maps of some variables in the study area

P



K



B

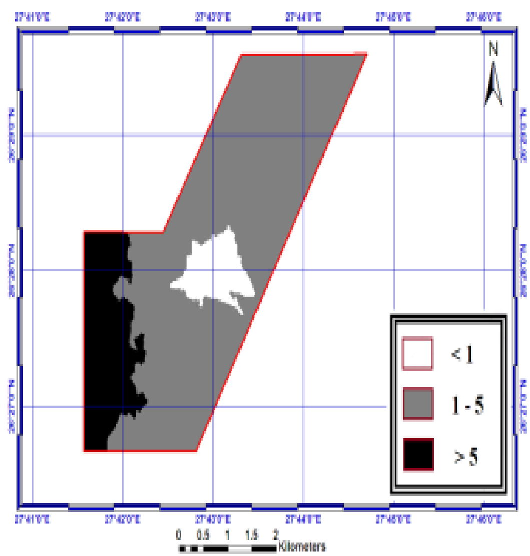


Fig. 3b. Soil fertility maps of some variables in the study area

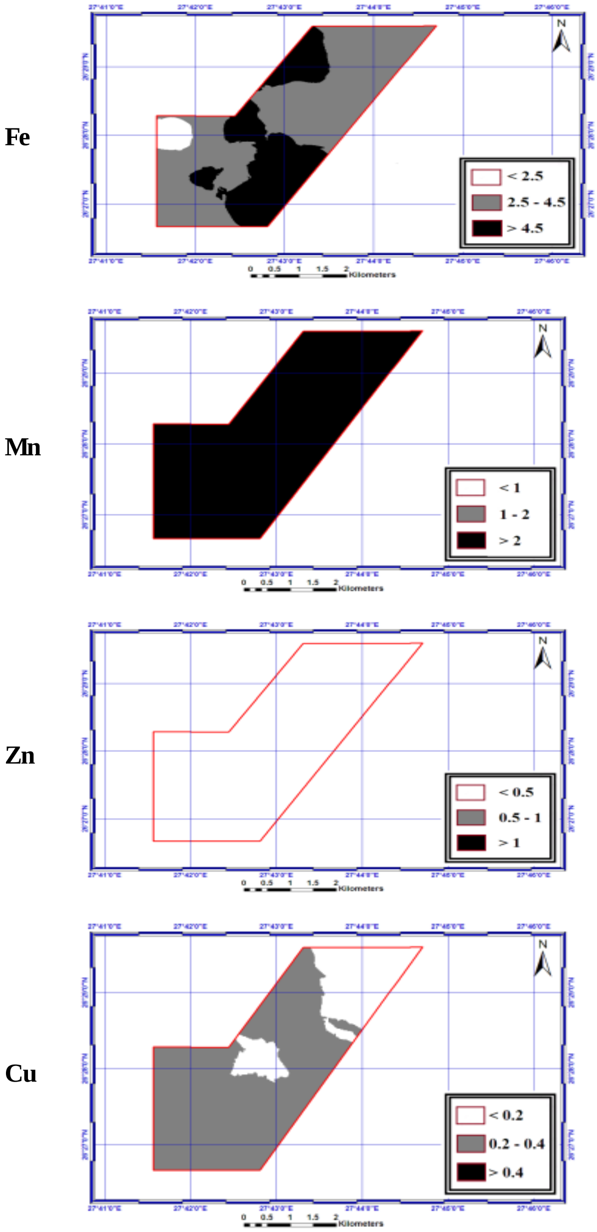


Fig. 3c. Soil fertility maps of some variables in the study area

Fertility maps of some micronutrients

Boron (B)

Data in Table 3 reveal that available B content in the studied soil samples range from 0.5 to 22.5 µg g^{-1}, with an average 3.0µg g^{-1}.The lowest value is found in location No. 24, which is coarse textured i.e., sandy soil. On the other hand, the highest value is in site No. 75 that has fine texture, namely clay soil.

The index values of boron extracted from soils are <1.0, 1.0-5.0 and > 5.0 µg g^{-1}representing unsufficient, sufficient and toxic, respectively, reported by Reisenauer*et. al*.,(19.73). About 6.6 % of the samples under investigation contain unsufficient concentration of available boron, while 75.6 % are sufficient and 17.7 % have toxic limits of extractable B. The high content of boron is found in medium and fine textured soils (sandy clay loam, clay loam and clay) which isassociated with high soil pH.Katyal*et. al*.(1983) mentioned that arid soils show exceptionally high B values but their availability decreases with soil coarse texture and low organic matter. These results are in harmony with Khalil (2014). For fertility map. Fig 3 show three levels of B (low, medium and high) and percentages of their areas. The corresponding areas of these are 227.8, 2594.3 and 607.7faddan respectively, Table (2).

Values of available B have positive and significant correlations with organic N (r = 0.768), salinity (r=0.725), K (r=0.742) and CEC (r=0.779), Table (4).

Iron (Fe)

Table 3 reveals that Fe content ranges between 1.7 and 8.4 µg g-1 with an average 4.2 µg g^{-1}. Also, the coarse texture has lower values in location No. 88. The highest value is detected in the heavy textured soil of site No. 75.

Values of Fe extracted from soils are classified as low (<2.5 µg g^{-1}), marginal (2.5-4.5 µg g^{-1}andadequate (> 4.5 µg g^{-1}) ,according to lindsay and Norvell (1978). Samples under investigation contain about 3.7 % within critical level of available iron, 63.6 % in marginal level and 32.7 % at adequate available iron Table 2 and Fig. 3.

Table 4. Correlations between different variables of the studied soil samples.

Items	pH	EC	CEC	Lime	OM	ON	NH_4	NO_3	P	K	Zn	Fe	Mn	Cu	B
EC	-0.5059	1.0000													
Cl	-0.4733	0.5835													
Na	-0.5567	0.8082													
CEC	-0.5927	0.8062	1.0000												
Lime	0.3785	-0.2068	-0.3117	1.0000											
OM	-0.4077	0.6183	0.7994	-0.3326	1.0000										
ON	-0.5384	0.6990	0.8144	-0.5151	0.7417	1.0000									
NH_4	-0.4141	0.3617	0.4647	-0.5529	0.3986	0.4675	1.0000								
NO_3	-0.4302	0.9153	0.6862	-0.1675	0.6081	0.6196	0.1915	1.0000							
P	-0.0411	0.1460	0.3270	0.4594	0.2903	0.0736	-0.4333	0.2127	1.0000						
K	-0.4068	0.8755	0.6939	-0.0026	0.5040	0.6078	0.2584	0.7776	0.2875	1.0000					
Zn	-0.2762	0.4652	0.5084	-0.1858	0.6503	0.5722	0.1985	0.5842	0.2151	0.3178	1.0000				
Fe	0.1797	0.0265	0.0676	0.3258	0.0182	0.0059	-0.3858	0.1270	0.5930	0.0378	0.2521	1.0000			
Mn	0.1577	0.0221	0.0864	0.1957	0.3717	0.0487	-0.1965	0.1761	0.4945	-0.0961	0.5483	0.6294	1.0000		
Cu	-0.1258	0.4308	0.4444	-0.0848	0.6043	0.3509	0.3058	0.4637	0.1811	0.3759	0.6289	0.1216	0.4237	1.0000	
B	-0.3617	0.7252	0.7793	-0.1372	0.5389	0.7678	0.3531	0.6093	0.1706	0.7422	0.4364	0.0322	-0.0732	0.4622	1.0000

These results are in harmony with Abdel Razik (1999) who stated that available Fe extracted by DTPA ranged from 0.3 to 24 µg g^{-1} in some soils of Egypt.

The obtained results reveal that statistical relationship as a simple correlation coefficient between DTPA-exractable Fe and P content is positive correlation (r = 0.593), (Table 4).

Figure 3 show fertility map of Fe, represents 204.7 faddan of low level, 3405faddanof marginal level and 327.0faddanofadequate level.

Table 3. Main statistical parameters of the studied soil samples

Items	Minimum	Maximum	Mean	Sum	Range	Median	Standard Error	Standard Deviation	Kurtosis	Skewness
pH	6.6	8.9	8.22	796.95	2.3	8.2	0.04	0.35	3.34	1
EC	1.3	89.4	7.3	708.4	88.1	4.5	1.17	11.52	32.74	5.27
Cl	80	999.1	336.5	32641	919.1	180.9	36.36	358.07	1.1	1.23
Na	0.4	29.6	2.15	208.3	29.2	1.1	0.34	3.32	49.5	6.33
CEC	7.1	65.8	16.13	1565	58.7	11.5	0.99	9.74	8.02	2.53
Lime	0.8	7.1	4.35	421.5	6.3	5.2	0.18	1.74	-0.74	-0.76
OM	0.2	1.35	0.34	33.08	1.5	0.27	0.03	0.32	0.79	1.05
ON	13.2	50	20.85	2022.4	36.8	19.9	0.74	7.32	1.79	1.27
NH_4	1.5	8	2.81	272.2	6.5	2.4	0.12	1.18	3.16	1.57
NO_3	7.5	367	26.25	2545.8	359.5	10	4.7	46.25	31.47	4.95
P	1.8	6.1	3.6	348.8	4.3	3.85	0.08	0.81	0.91	1
K	45	885	164.7	15978	840	122	11.05	108.79	20.59	3.67
Ca	5.5	31	12.02	1166	25.5	8.5	0.66	6.52	1.67	1.68
Mg	0.2	6.5	1.16	112.8	6.3	0.85	0.1	1.03	11.41	3.02
SO_4	8	999.1	269.9	26182	991.1	105	36.79	362.34	0.21	1.35
Zn	0.1	0.9	0.24	23.4	0.9	0.2	0.02	0.19	2.18	1.4
Fe	1.7	8.4	4.24	411.1	6.7	4.5	0.12	1.15	2.64	0.49
Mn	1.8	2.75	2.24	217.4	0.95	2.2	0.02	0.19	1.1	0.48
Cu	0.1	0.6	0.23	22.3	0.65	0.2	0.01	0.15	0.53	0.76
B	0.5	22.5	3.13	303.95	22	1.1	0.42	4.18	9.69	2.9

Manganese (Mn)

The available manganese varied from 1.8 to 2.7 µg g^{-1} with an average 2.2 µg g^{-1}. The minimum value is recorded in surface sample of location No. 12 which contains 7% calcium carbonate. This result is in agreement with Katyal *et.al.*(1983) and Murphy et. al. (1972). They mentioned that calcareous soils have high amounts of total Mn but available Mn is low. The maximum value of available Mn is found in site No. 75.

Considering 1.0 and 2.0 µg g^{-1}as critical limit and marginal range for Mn deficiency, according to Lindsay and Norvell, (1978), all the values of soil Mn in the surface layers are considered sufficient.. Similar results are reported by Abdel Razik (1999) and Khalil (2014). who stated that available Mn extracted by DTPA varied from 0.8 to 30 µg g^{-1}. Available Mn has positive correlations with soil Fe (r=0.629). As for soil fertility map of Mn, the areas percentages of Mn levels are 488 faddan for marginal level, 3448 faddan for sufficient level (Fig 3).

Zinc (Zn)

Data in Table 3 show available Zn content in the studied soil samples ranged from 0.05 to 0.9 µg $g^{-1}$with an average 0.24 µg g^{-1}. According to Lindsay and Nowell, (1978), the index values for Zn extracted from soils by DTPA are Low (<0.5 µg g^{-1}, marginal (0.5-1 µg g^{-1}) and adequate (> 1 µg g^{-1}). The surface layers in the studied soils contain 98.2 % as low and 1.8 % adequate. All values of available Zn in the studied surface layers are considered not sufficient for plants. The maximum values (0.8, 0.9 and 0.9 µg g^{-1}) are found in soils which have medium and fine texture i.e. sandy clay loam, clay loam and clayey soils respectively. These results are in harmony with Khalil (2014)

The total area of soil fertility map for Zn is 3430Faddan, include 3386faddanlow Zn level and 61.7faddan marginal Zn level. Fig. (3).The obtained values of simple coefficients indicate positive significant correlation between available Zn and OM (r=0.650).

Copper (Cu)

The critical values of Cu in the studied surface layers reached 61.8 %. The obtained values of DTPA-extractable Cu in Table 3 reveal that available Cu content varied from 0.05 to 0.6µg g^{-1}, with an average 0.2 µg g^{-1}. According to Lindsay and Norvell, (1978), the index value used for Cu extracted from soils by DTPA method are critical (<0.2 µg g^{-1}), marginal (0.2-0.4 µg g^{-1}) and high (> 0.4 µg g^{-1}).

Soil fertility map for Cu, Fig 3 show levels of Cu (low and medium). The corresponding areas of these levels are 3.6, and 10.8 km^2 respectively. These results are in harmony with Khalil (2014).

The obtained values of simple coefficients indicate positive significant correlation between available Cu and both of OM (r=0.604) and Zn (R=0.629).

CONCLUSION

The agricultural management practices e.g. leaching requirements for salt soils, fertigation, addition of organic matter, cropping patterns and precision agriculture improving nutritive elements status and crop production under investigation area.

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انتاج خرائط خصوبة التربة باستخدام تكنيك GIS لبعض أراضي واحة الفرافرة ـ مصر

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يهدف البحث إلى إنتاج خرائط خصوبة التربة باستخدام تكنيك نظم المعلومات الجغرافية GISودراسة ملوحة التربة والمادة العضوية وبعض العناصر المغذية الصغرى والكبرى مثل النتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك والنحاس والبورون فى بعض أراضى منطقة واحة الفرافرة، ومدى تأثير هذه العناصر ببعض خواص الأرض موضع الدراسة. ولتحقيق ذلك تم اختيار ١٠٦ عينة تربة سطحية تمثل اراضي منطقة الدراسة، وكانت النتائج المتحصل عليها كالتالى: - أظهرت خرائط التربة أن قيم نسب التوصيل الكهربائي كانت كالأتي :ـ منخفضة بنسبة ١٧.٥% ، متوسطة بنسبة ٥٣.٨%، مرتفعة بنسبة ١٩.٩%، مرتفعة جداً ٣.٨ % ، وقد تراوحت قيم ملوحة التربة من ١.٣ حتي ٨٩.٤ ميكروجرام/جرام بمتوسط ٧.٣ ميكروجرام/جرام - كانت قيم كل من الماده العضوية والفوسفور والزنك ذات محتوي منخفض وذلك في منطقة الدراسة.- نسبة النيتروجين المعدني (الامونيا و النترات) كانت ٧٥ % ، ٢٥ % تمثل تركيزات منخفضة ومتوسط علي التوالي . فضلاً عن تراوح قيم النيتروجين المعدني من ٩. إلي ٣٦٩.٢ ميكرو جرام/ جرام .- كانت مستويات عنصر البوتاسيوم في المنطقة المدروسة منخفضة وهامشية وتمثل النسب ٦٠% ، ٤٠% مع التوالي .- تراوحت قيم عنصر البورن من ٥. إلي ٢٢.٥ ميكرو جرام/ جرام بمتوسط ٣.١ ميكرو جرام/ جرام .- كانت نسب عنصر الحديد ١٣.٧ ، ٦٢.٦ ، ٢٣.٧ ميكرو جرام/ جرام وتمثل مستويات منخفضة وهامشية وكافية علي التوالي .- كل المساحة المدروسة لعنصر الزنك احتوت علي قيم ذات مستوي مرتفع.- احتوت قيم عنصر النحاس علي نسبة ٢٥% من إجمالي منطقة الدراسة وتمثل الحد الحرج للعنصر.- أظهر التحليل الإحصائي وجود علاقة قوية بين العناصر المدروسة وبعض خواص التربة، فضلاً عن وجود ارتباط بين بعض العناصر وبعضها.