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Evaluating Soil Quality for Some Soils of South East El- Qantara

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Abstract

The governmental strategy aims tothe reclamation and cultivation of about 400.000 feddans concentrated mainly in El-Tina Plain (50.000 feddans), South East El-Qantara (75.000 feddans), Rabaa (70.000 feddans), Bir El-Abd (70.000 feddans) and El-Serw and El-Qawarir (135.000 feddans) areas.. The current study revealed the variation in soil fertility status of soils developed on various landforms in the area as the soils were having low to high in organic carbon (1.4 to 21. 5 mg kg^{-1})and having low available nitrogen (4.32 to 58.30mg kg^{-1}); low to abundant phosphorus (2.06 to 59.23mg kg^{-1}) and deficient to adequate in available K (23.50to 1360mg kg^{-1}) contents. The result showed the value of soil fertility quality index (SFQI) ranging from 0.022381to 0.665533with an average 0.310947. When fertility quality of the studied soils was examined (according to SFQI); only 27.692% of the soils has very low fertility quality, about 40.00% of the soils has Low, about 28.462% of the soils has moderate and 3.846 % has good fertility quality. The soil fertility quality index, easier to compute with fewer parameters, can be used as a quick tool to evaluate soil quality and to measure changes occurring after using different management practices. This study suggests that using soil fertility quality index to evaluate agricultural soil fertility quality can provide similar results even when different indicator methods and models have been used in the study area. In this study, SFQI determined to be the most accurate method for evaluation of soil fertility quality, because it took all soil parameters into consideration and gave the most consistent results. We suggest using the SFQI to evaluate agricultural soil fertility quality for desert soils because of its highest correlation with economic yield of desert soils.

Key Words: soil quality index, South East El- Qantara, soil chemical, physical properties

Introduction

The indicators of the soils quality are either physical or biological ones. These indicators would help to observe the modifications in the quality of the soil through estimating the changes of these indicators **(Doran and Parkin 1994).**

Soil quality/fertility index is figured out through the conversion into single value. The comparison of the changes that take place due to different land uses and affect soil health is compulsory (**Abbasi, et. al.; 2010**).

The significance of the quality of soil fertility and its role in the development of sustainable agriculture has been under extensive research and interest from either scientists or farmers. The quantification of soil fertility is difficult to accomplish through individual assessment. A range of calibrations as a set of measures is commonly used instead. However, the quality of soil fertility index (*S*) is an index that is doubtlessly and easily determinable employing lab equipment. Therefore, the index (*S*) is an estimate of soli nutrients affecting the properties of soil fertility. The anticipation is that it would be useful for the comprehensive soil quality assessment. The higher the value of the (*S*) indicator, the better the fertility quality and vice versa.

The choice of soil indicator features must base on several criteria such as:: (i) land use; (ii) soil function; (iii) reliability of measurement; (iv) spatial and temporal variability; (v) sensitivity to changes in soil management; (vi) comparability in monitoring systems; and (vii) skills required for the use and interpretation **(Nortcliff, 2002).**

Critical limits of the soil-quality indicators are the threshold values which must be maintained for normal functioning of the soil system. Within this critical range, the soil performs its specific functions in natural ecosystems. As reported by **Arshad and Martin (2002),** identification of critical limits for soil-quality indicators poses several difficult problems. For example, a critical limit of a soil indicator can be ameliorated or exacerbated by limits of other soil properties and the interactions among soil-quality indicators.

Soil quality developed as a specific concept during the decade of the 1990s, and it is an outcome of holistic approach to soil management and sustainable land use systems **(Karlen et al., 2001).** It is a necessary indicator of land management sustainability and depends on a large number of physical, chemical and biological soil properties. Characterization of soil quality requires a selection of the indicators most sensitive to changes in management practices **(Elliott, 1994). Arshad and Coen (1992)** suggested that soil depth to a root restricting layer, available water holding capacity, bulk density or penetration resistance, hydraulic conductivity, aggregate stability, soil organic matter content, nutrient availability, pH, and electrical conductivity are generally sensitive to management practices, thus they can be used as soil quality indicators.

Noellemeyer et al (2006) showed that the clay + silt contents of the rangeland soils affected the values of soil quality parameters. **Sparling and Schipper (2002)** found seven key properties (pH, total Carbon and Nitrogen, mineralize able N, Olsen P, bulk density and macro porosity) as a minimum data set to study the soil quality.

From the advent of agriculture, there has been an innate interest in soil and land quality **(Carter et al., 2004**) and understanding changes in soil fertility resulting from agricultural intensification before they severely limit crop yields. Historically, few farmers used chemicals, but maintained soil fertility by allowing long fallow periods. Nowadays, farmers have increased the use of chemical fertilizers and herbicides, and fallow cycles have decreased or disappeared, with the continuous use of the land becoming more frequent **(Zhang and Zhang, 2007).** Frequently, loss of productivity has been related to the loss of soil organic matter (SOM) and stored nutrients that result from cultivation **(Juo and Many, 1996).** Hence, an understanding of the distributions of soil properties at the field scale is important for refining agricultural management practices and assessing the effects of agriculture on environmental quality **(Cambardella et al., 1994).** Evaluating agricultural land management practices requires knowledge of soil spatial variability and understanding their relationships because of the fact that (a) spatial variability in soils occurs naturally from pedogenic factors, (b) natural variability of soil results from complex interactions between geology, topography, climate as well as soil use (**Jenny, 1980; Quine and Zahng 2007).** In addition, variability can also occur as a result of land use and management strategies, making the soil to exhibit marked spatial variability at the macro– and micro– scale **(Brejda et al., 2000; Vieira and Paz-Gonzalez, 2003).**

Materials and Methodology

Area of the investigations

South East El-Qantara is located in the northwestern corner of Sinai Peninsula between latitudes 30º 50, and 31º 05,N, and longitudes 32º 20, and 32º 40’E. It has a triangular shape with one side about 40 km long running along the Suez Canal and another side of 35 km along the cost.

The soils vary from sand to clay texture, extremely saline. Soil colour ranges from light gray to olive (dry) and grayish brown to gray (moist). Soil structure varies from single grains to strong or moderate, coarse to medium, angular to sub angular blocky. The pedological features identified within profiles depth are accumulation of gypsum crystals, common salt crystals and few lime concretions.

The soils in North Sinai will be provided with water through El-Salam Canal, which will pass below the Suez Canal.

The analysed soil samples have been collected from South East El-Qantara. The landscape is almost flat. Soil parent material is a mixture of alluvium sediments, originated from old Nile branches and lacustrine deposits, and is sometimes contaminated with aecolian sand sediments. The area is barren from plant cover. Some patches are covered with some species of Halophytes. Water table in some cases is very shallow.

Selection of Representative Soil Series

In order to study the background levels of nutrient fertility in South East El-Qantara soils, 130 representative soil samples were selected from representative 12 soil groups.

The soil samples were collected from 0 to 30 cm depth. Each soil sample, was replicated three times for everyone.

The soil samples were mixed in the field and air dried at the room temperature (about 20 to 25ºC). These air-dried samples were crushed with a wooded hammer and roller. After crushing, the soil samples were passed through a 2.0 mm sieve and mixed thoroughly in a plastic bags, and then stored in a plastic containers.

Particle size distribution was carried out according to **Piper (1950)**. The water extract components were determined in the soil paste extract, and the following determinations were carried out using the standard methods of analysis by **Jackson (1969)**. The total soluble salts were determined conduct metrically. Soil reaction (pH) was determined in the soil paste, **Richards (1954)**. Organic matter was determined by the modified Walkley and Black method, **Jackson (1973)**.

Cation exchange capacity (CEC) was determined using ammonium acetate method and exchangeable sodium was determined using ammonium acetate solution as described by **Jackson, (1969)**.

Chemically available N in soil samples was extracted by 2*M* KCl solution and determined using method of **Dhank and Johson (1990).** Available P chemically extracted by 0.5 *M* $NaHCO_3$ pH 8.5 solution as described by **Olsen et.al., (1954).** Available K chemically extracted amounts by ammonium acetate pH 7.0 as described by **Jackson (1969).**

The soil samples were chemically extracted the micronutrient by DTPA solution according to **Lindsay and Norvell (1978).** The available content of these metals were analyzed by flame atomic absorption spectrophotometer.

Undisturbed soil sample, the bulk density was determined according to the core methods as described by **Klute (1986).**

Results and Discussion

The studied soil samples varied widely in their texture classes, samples represented by sand

(36.153%,47 representative soil samples), loamy sand (9.230%, 12 representative soil samples),sandy loam (15.38%, 20 representative soil samples), sandy clay loam (3.076%,4 representative soil samples), loam (2.307%,3 representative soil samples), clay loam (6.153%, 8 representative soil samples), silty loam (3.846%,5 representative soil samples), sandy clay (8.461%,11 representative soil samples), and clay (15.358%, 20 representative soil samples). These samples were represented by 12 soil groups among South East El-Qantara of north Sinai (Fig. 1).

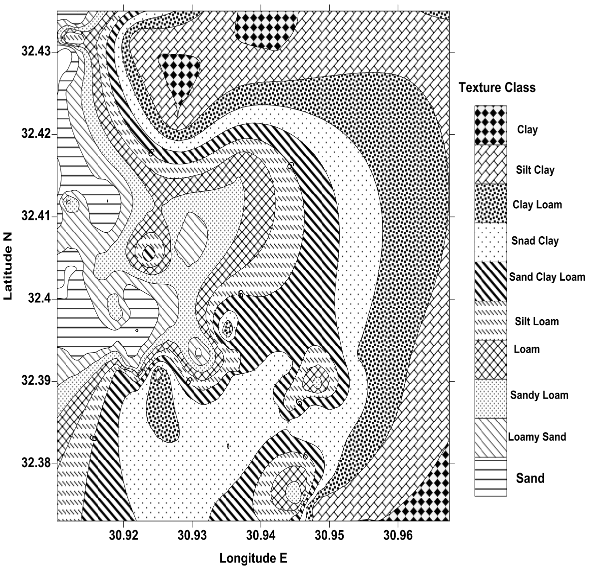

Fig. 1: Contour for texture composition of the soil data set

Soil pH

Soil pH is a significant parameter to identify the chemical nature of the soil **(Shalini et al., 2003).**It refers to the concentrations of hydrogen ion in the soil. It points out the acid or alkaline nature of the soil. The soil in South East El-Qantara has a pH ranging from 7.42 to 8.55 (Table 1).

Table 1. Measured pH of soil samples

Class No.	pH value	Range	Sample %
1	6.50 – 7.00	---	---
2	7.00 – 7.50	7.42 – 7.50	1.538
3	7.50 – 8.00	7.53 – 8.00	28.641
4	8.00 – 8.50	8.01 – 8.49	69.230
5	8.50 – 9.00	8.55	0.769

According to Ravikumar and Somashekar (2013).

This indicates the presence of a range of soils (either neutral to alkaline) (Table 1and Fig 2).

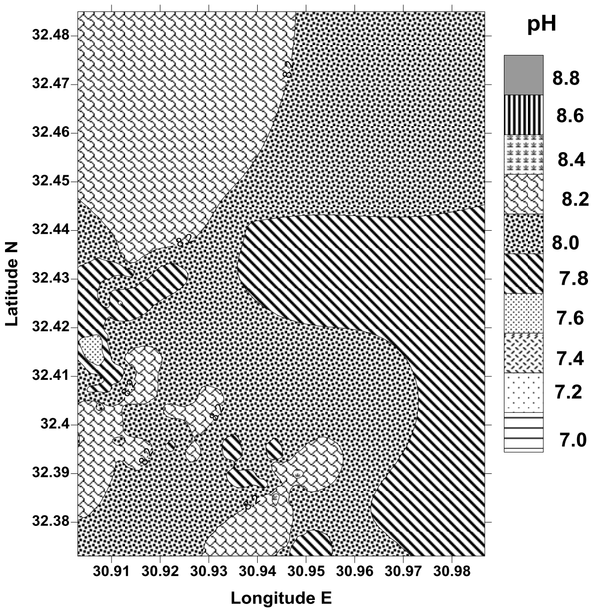

Fig.2: Contour for class of soil reaction (pH)

Electrical conductivity

The carrying capacity of the electric current is referred to as conductivity. It gives a distinct idea about how much soluble salt is present in the soil. It shows the salinity of soils. The lesser the EC value, the lower the soil salinity and vice versa. However, the conductivity of the soil is affected by several factors. For instance, high soil conductivity refers commonly to clay-rich soil, while low conductivity refers to sandy and gravelly soils. The shape and physical properties of the particles which make up the soil produce such variance in soil. The South East El-Qantara soil has EC values varying from 0.34 to 27.80 dS/m.

Soil salinity may be, then, categorized into five classes according to their Ec values. Results in Table (2) show that the issue of high soil salinity in the South East El-Qantara soils does not represent a real problem. The saline criterion is < 0.7, showing a good quality soil (Table 2 and Fig. 3). The value above 4 ds/m of soluble salts in the soil moisture causes inhibition to seed germination as well as the growth of almost all commercial crops. Consequently, the biomass production is negatively affected leading to sharp decrease in the economic yield of such crops.

Table2. Salinity condition and categories of crops tolerance in South East El-Qantara

EC (dS/m)	Category	Range	No. Sample %
<2.0	All crops	0.34 – 1.99	50.769
2.0 – 4.0	Most crops	2.02 – 3.94	27.692
4.0 – 8.0	Salt tolerant crops	4.02 – 7.95	8.461
8.0 – 16.0	Most halophytes	11.40 – 15.60	3.076
>16.0	Unsuitable for most crop	16.50 – 27.80	10

According to Ravikumar and Somashekar (2013).

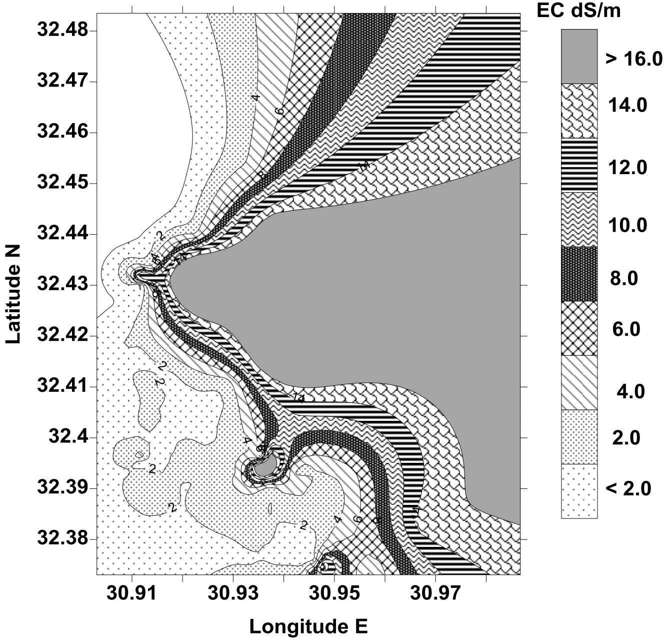

Fig. 3: Contour for class of soil salinity

Organic Carbon (OC):

Organic matter of the soil constitutes its fertility by definition. The presence of organic matter in the soil differentiates it from rocks or other types of non-fertile soils. The more the organic matter presents in the soil, the more fertile the soil. Fertility referes to how much nutrients are present in the soil. It controls the erosion and runoffs of the soils as well as water. It is also a major determinant of the structure of the soil as well as moisture and general nutrient status. Organic matter is sometimes referred to as the organic carbon. The percentage of the organic carbon ranges from 1.4 to 221.5 mg/ kg in the study area (Table 3 and figure 4).Soils are, therefore, graded as either low, medium or high according to the contents of organic carbon. Around 19.23% of the soil samples obtained from the South East El-Qantara, had low contents of organic carbon (i.e., < 0.40). Most of the soil samples (i.e., 68.46 %) had low to medium contents of organic carbon content (Table 3). To modify this status, it is imperative to add organic wastes to the soil. Organic wastes are important sources of nutrient to these agricultural fields.

Table3. Classification of soil quality based on organic carbon content in South East El-Qantara

Class No.	OC%	Rating	Range	No. Sample %
1	< 0.40	Low	0.14 – 0.39	19.231
2	0.4 - 0.75	Medium	0.42 – 0.75	49.231
3	> 0.75	High	0.76 – 2.15	31.538

According to Ravikumar and Somashekar (2013).

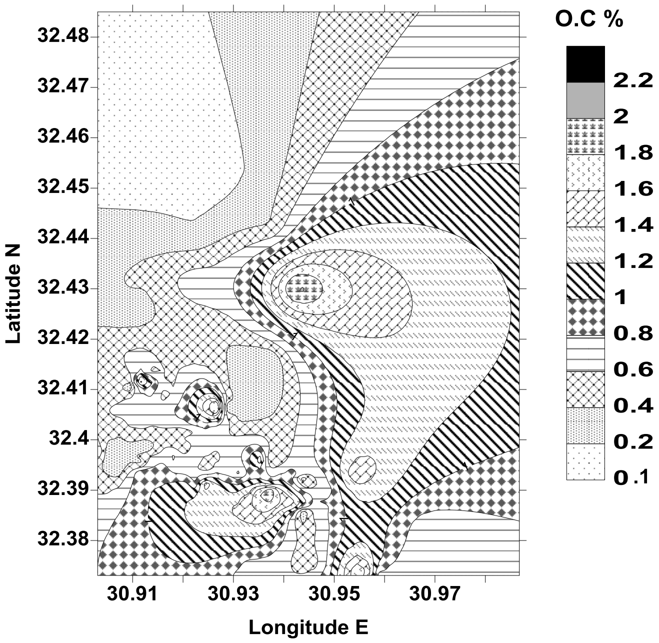

Fig. 4: Contour for organic carbon content in the soil data set

Soil Cation Exchange Capacity (CEC)

The ability to detain nutrients onto the soil and avoid leaching them beyond roots is called cation exchange capacity (CEC). The relation between CEC and soil fertility is proportional. The higher the CEC of the soil the more fertility the soil has. When combining CEC with other parameters of fertility, it represents an appreciable indicator to the quality of the soil and productivity.

Obtained values of cation exchange capacity (CEC) of the different studied soil are shown in (Fig 5) from these data, it is evident that CEC values are ranged between 2.05 and 35.15 cmol$_c$/kg soil with an average 13.31 cmol$_c$/kg. Obviously, the obtained CEC values display increasing trend with increasing clay content

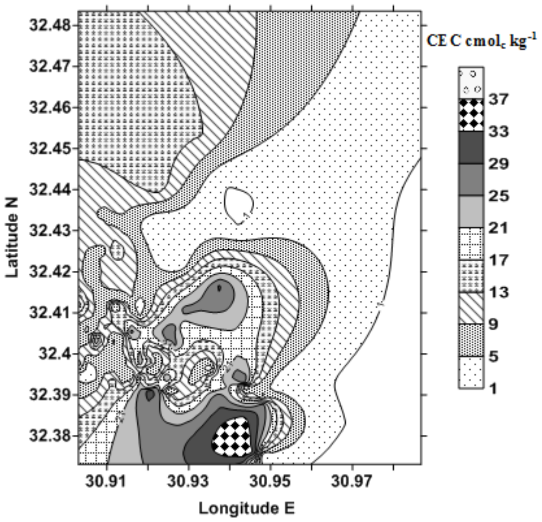

Fig. 5:Contour for CEC value in the soil data set

The values of CEC may be influenced by several factors; one of which is the soil texture. Accordingly, the lowest values of CEC are attained by the soils having the highest sand contents and the lowest clay particle contents and vice versa.

Bulk Density:

The factors that affect bulk density are the contents of organic carbon (or matter), texture, minerals and porosity. Awareness of the bulk density of soils is prerequisite to manage soils, and the knowledge of its compaction helps in the planning of modern farming techniques.

The impact of the sand content on the bulk density of soil is greater than that of other properties. Bulk density of the clay soils is usually low while porosities are higher than sandy soils.

Bulk densities of clay soil normally ranges from 1.0 to 1.6 mg/m^{3}while that of sandy soil rangesfrom1.2 to 1.8 mg/m^3. The potential root restriction occurs at $\geq$ 1.4 mg/m^3 for clay and $\geq$1.6 mg/m^3 for sand (**Aubertin and Kardos, 1965**).

Concerning the bulk density values in the studied soils ranged from 1.07 to 1.76 g/cm^3, with an average 1.44 g/cm^3 (Fig.6).

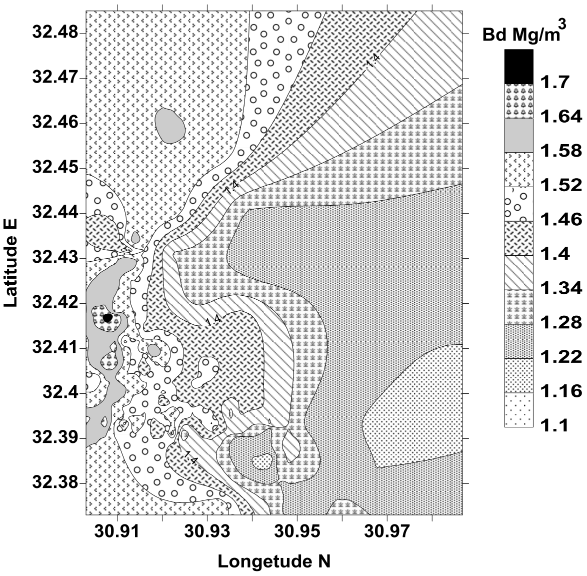

Fig. 6: Contour for bulk density value in the soil data set.

Available nitrogen

Nitrogen is a critical nutrient that limits plant growth. The nitrogen that is usually available for plants is either in the form of nitrates in aerobic conditions or ammonium in the anaerobic conditions.

Results of the current study showed that nitrogen content of soil samples is low (<272 mg/kg) (Table 4 and Fig.7), while the available nitrogen ranged from 4.32 to 58.30 mg/kg. This necessitates the essentiality of adding organic wastes to provide nutrient to the agricultural fields.

Table 4. Concentration of available nitrogen in South East El-Qantara soils

Class No.	Quantity of available N (mg/kg)	Rating	Range	No. Sample %
1	< 272	Low	4.32 – 58.30	100
2	272 to 554	Medium	---	----
3	> 554	High	---	---

According to Ravikumar and Somashekar (2013).

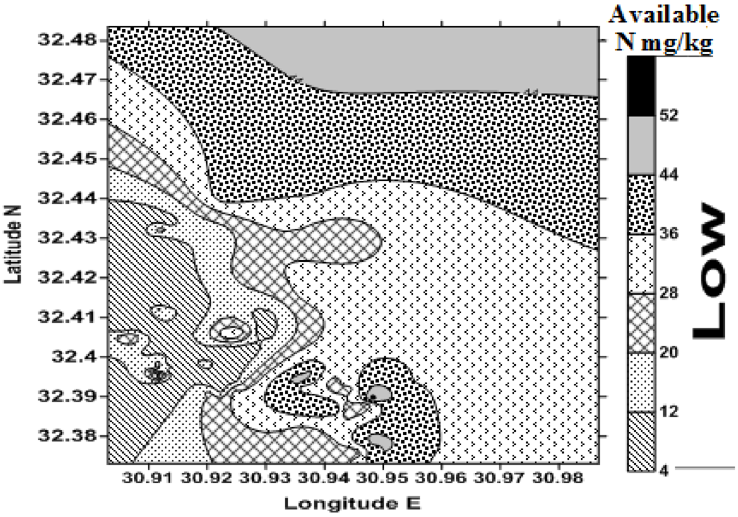

Fig. 7: Contour for distribution of available N in the study soils

Available phosphorus

Phosphorus is an essential macro-nutrient and ranks second after nitrogen. It comprises more than 1% of the organic matter on dry weight basis. It is the second most plant growth limiting nutrient. It is present in the soil in either organic or inorganic manners.

The available contents of phosphorus in the South East El-Qantara area ranges from 2,06 to 59.23 mg/kg and 66.92 % of the soil samples showed low to 13.85% intermediate amount of available phosphorus, while the rest (19.23%) had adequate to abundant amount of the available phosphorus (Table 5 and Fig. 8). Therefore, phosphorous rich fertilizers must be applied to soils having low to medium phosphorus content (such as those of the study area).

Table 5. Measured concentration of available phosphorus in South East El-Qantara soils

Class No.	Grade	Concentration P (mg/kg)	Range	No. **Sample %**
1	Low phosphorus	< 15	2.06 – 14.63	66.92
2	Medium phosphorus	15 - 22	15.83 – 21.50	13.85
3	Adequate phosphorus	22 - 30	22.20 – 28.84	10.77
4	Abundant phosphorus	> 30	30.84 – 59.23	8.46

According to Ravikumar and Somashekar (2013).

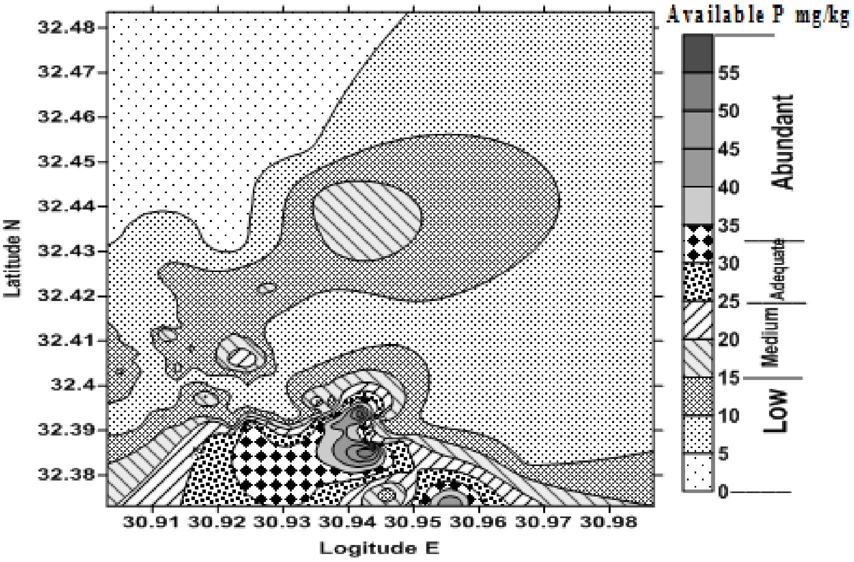

Fig. 8: Contour for distribution of available P in the study soils

Available potassium (K)

The values of the available K varied from 23.5 to 1360 mg/kg in the South East El-Qantara. Majority of the soil samples in the South East El-Qantara had deficient (54.62 %), doubtful (13.85%) supply of potassium and adequate (31.54%) resource of potassium (Table 6 and Fig. 9**)**. Enriched compost with potassium of about 0.48% K_2O or vinasse of about 8% K_2O must be supplied to soils deficient in potassium.

Table 6: Measured concentration of available K in South East El-Qantara soils

Class No.	Supply of available K	Quantity (mg/kg)	Range	No. Sample %
1	Deficient supply of K	<113	23.50 - 110	54.62
2	Doubtful supply of K	113 to 280	113 – 255	13.85
3	Adequate supply of K	> 280	306 -1360	31.54

According to Ravikumar and Somashekar (2013).

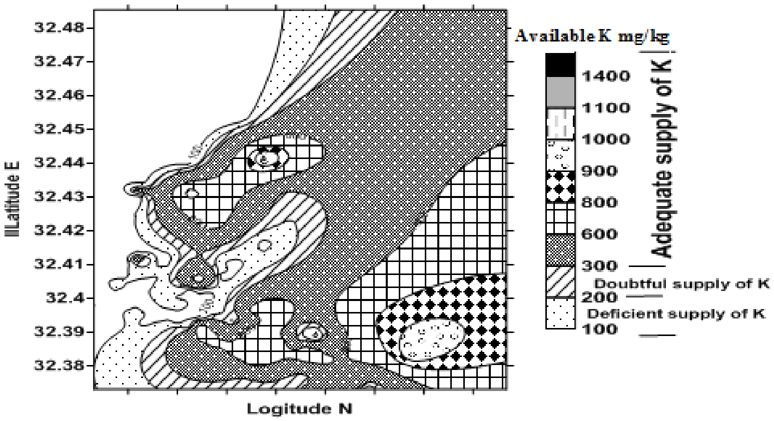

Fig.9: Contour for distribution of available K in the study soils.

Available iron

In the South East El-Qantara, the available iron content ranged between 2.03and 36.60 mg/kg. According to the critical levels reported by **Lindsay and Norvell (1978)** the data in (Table 7 and Fig 10) of DTPA-available Fe levels showed that 33.85 % of the tested soils (44 samples) are deficient (<4 mg/kg), while the31.54% of the tested soils (41 samples) are within the margin, 34.61% (45 samples) are adequate. The margin soils are those sandy in texture. The amount of available Fe extracted by DTPA solution increased with increasing clay or silt content in soils.

Table 7: Measured concentration of available iron in South East El-Qantara soils

Class No.	Grade	Concentration Fe (mg/kg)	Range	No. Sample %
1	Very low	0 - 2	---	--
2	Low	2-4	2.03 -4.00	33.85
3	Medium	4- 6	4.01 – 6.00	31.54
4	High	6 - 10	6.06 – 9.86	16.15
5	Very High	>10	10.08 – 36.6	18.46

According to Ravikumar and Somashekar (2013).

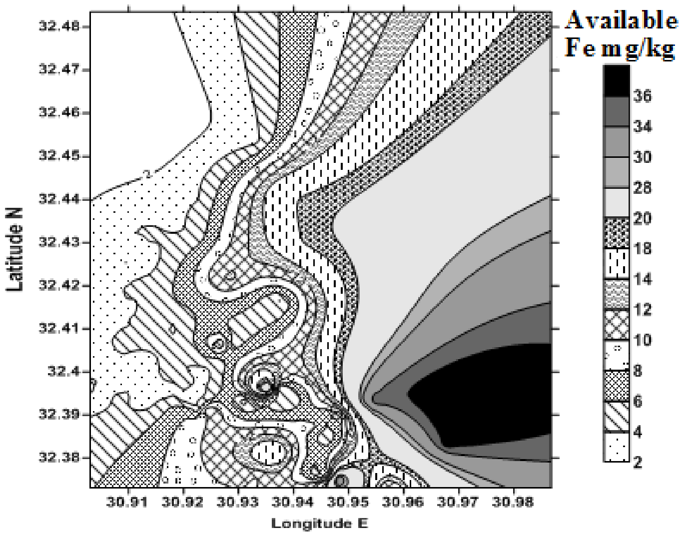

Fig.10: Contour for distribution of available Fe in the study soils

Available Manganese

Vales of DTPA extractable-Mn varied from 1.18 to 12.38mg/kg, with an average of 3.663mg/kg. The values of Mn were mostly greater in soil having high clay or silt content than that characterized by light textures ones.

According to the critical levels reported by **Lindsay and Norvell (1978)** the data in (Table 8 and Fig.11) of DTPA-available Mn levels showed that 13.40 % of the tested soils (13rep. soil samples) are moderate, and the remaining 86.60% of soil contained high amounts of available Mn.

Table 8. Measured concentration of available manganese in South East El-Qantara soils

Class No.	Grade	Concentration Mn (mg/kg)	Range	No. Sample %
1	Very low	0 –0.5	---	--
2	Low	0.5 1.2	1.18 – 1.20	2.308
3	Medium	1.2 – 3.5	1.25 – 3.48	63.080
4	High	3.5 – 6.0	3.63 – 5.68	16.920
5	Very High	> 6.0	6.06 - 12.38	17.69

According to Ravikumar and Somashekar (2013).

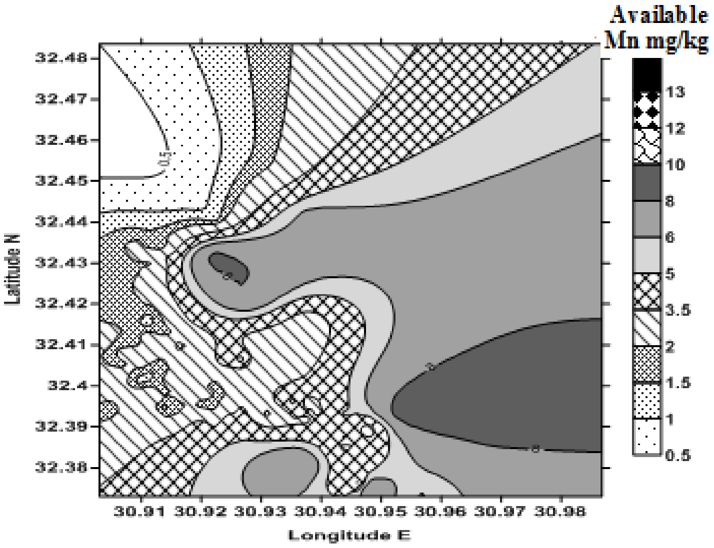

Fig. 11: Contour for distribution of available Mn in the study soils

Available Zinc

Values of DTPA extractable Zn in the studied soils ranged from 0.32 to 3.14 mg/kg, with an average of 0.9177 mg/kg. About 70.77% of the soil samples were Zn deficient (< 1.0 mg/kg), 28.46% contained moderate amount of available Zn (1.0 – 3.0 mg/kg), and 0.769% contended high amount of available Zn (3.0 – 5.0 mg/kg), (Table 9and Fig 12).

Table 9. Measured concentration of available zinc in South East El-Qantara soils

Class No.	Grade	Concentration Zn (mg/kg)	Range	No. Sample %
1	Very low	< 0.50	0.32 - 0.48	24.620
2	low	0.50 – 1.0	0.50- 0.98	46.150
3	Medium	1.0 - 3.0	1.01 -2.98	28.460
4	High	3.0 – 5.0	3.14	0.769
5	Very High	> 5.0	--	--

According to Ravikumar and Somashekar (2013).

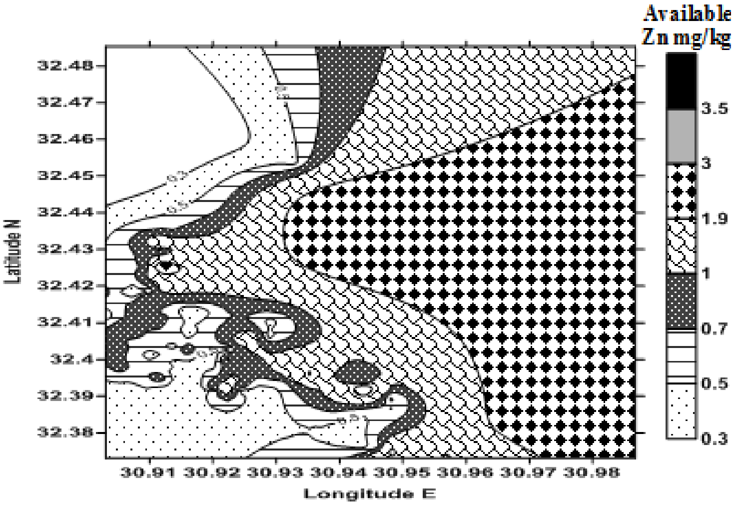

Fig. 12: Contour for distribution of available Zn in the study soils

Available Copper

The value of the extractable Cu from soils ranged from 0.20 to 1.90mg/kg, with an average of 0.50mg/kg. About 18.46% of the soils were low available Cu, 66.92% contained moderate amount of available Cu, and the remaining 14.62% of soils contained high amounts of available Cu (Table 10 and Fig13).

Table 10: Measured concentration of available copper in South East El-Qantara soils

Class No.	Grade	Concentration Cu (mg/kg)	Range	No. Sample %
1	Very low	< 0.10	--	--
2	Low	0.10 - 0.30	0.2 - 0.28	18.46
3	Medium	0.30 – 0.80	0.30 – 0.79	66.92
4	High	0.80 – 3.0	0.80 – 1.90	14.62
5	Very High	> 3.0	--	--

According to Ravikumar and Somashekar (2013).

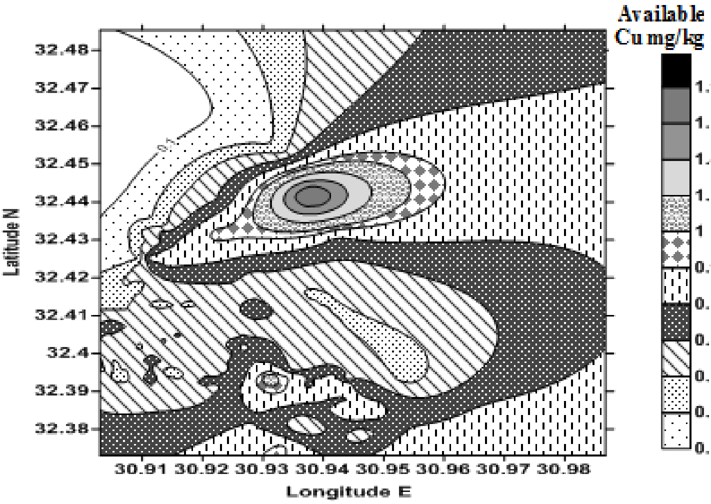

Fig. 13: Contour for distribution of available Cu in the study soils

Available Boron:

The value of the extractable B from soils ranged from 0.11 to 2.34 mg/kg, with an average of 0.74 mg/kg. About 60.77% of the soils were low available B, 30.00% contained moderate amount of available B, and the remaining 9.23% of soils contained high amounts of available B (Table 11 and Fig 14).

Table 11. Measured concentration of available boron in South East El-Qantara soils

Class No.	**Grade**	**Concentration B (mg/kg)**	**Range**	**No. Sample %**
1	Very low	< 0.20	0.11 – 0.19	10.00
2	Low	0.20 - 0.80	0.21 – 0.78	50.77
3	Medium	0.90 – 1.5	0.80 – 1.49	30.00
4	High	1.6 – 3.0	1.51 – 2.34	9.23
5	Very High	> 3.0	---	--

According to Ravikumar and Somashekar (2013).

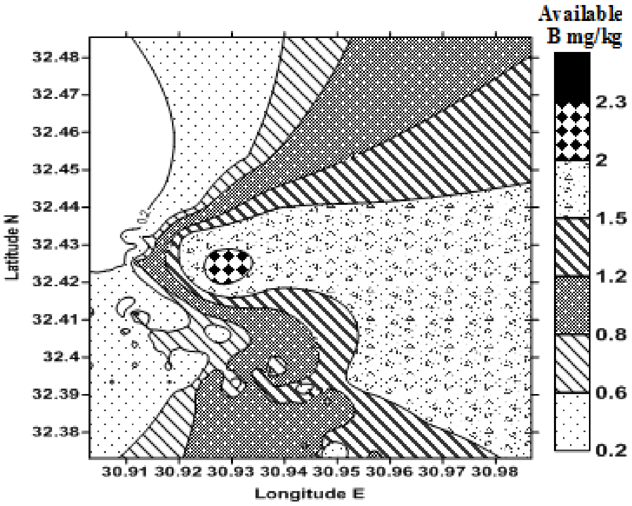

Fig. 14: Contour for distribution of available B in the study soils

Soil Fertility Quality Index(SFQI):

The choice of indicators along with minimum data set:

Soil nutrient quality was measured through analyzing dynamic soil fertility (N, P, K, Fe, Mn, Zn, Cu, and B) and soil properties such as BD, EC, pH, OM, clay, and CEC on the basis of land use.

The minimum data set (MDS) must be selected from the values of dynamic soil fertility and soil properties among land uses which show significantly different ($p<0.05$).

To decrease mult-collinearity of the MDS to the minimum, variable with high correlation ($r \geq 0.75$) should be excluded while the high factor loading variables were selected through principle component analysis (PCA) (Fig.15).

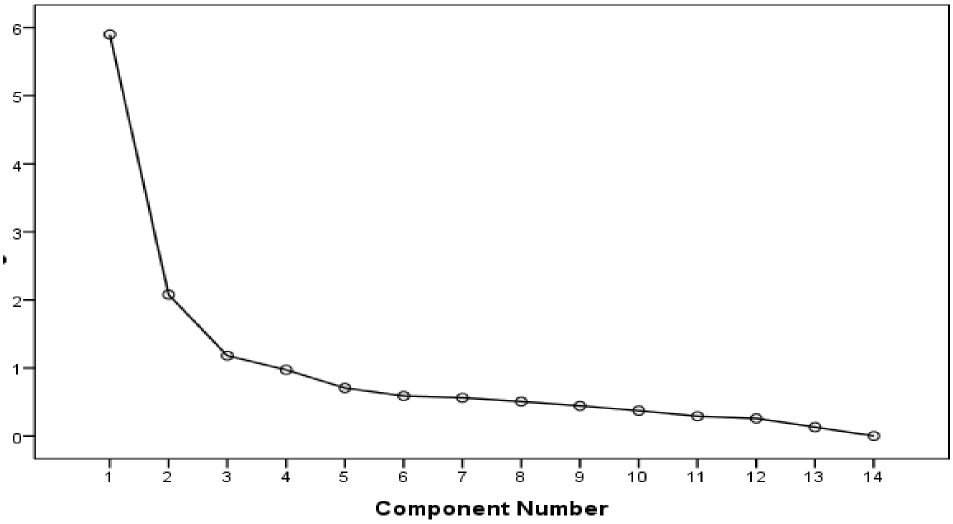

Fig.15: Screed plot of component analysis of nutrient and soil properties in studied soils

The general approach of the soil fertility nutrient quality index (SFQI) was employed to evaluate the quality of soil fertility. This involves functions that have scores (i.e. scoring functions) for each soil property. The definition of the scoring functions is the simple nonlinear polynomial framework.

Each soil property (pH, EC, OC, CEC, Clay and BD) and soil fertility (N, P, K, Fe, Mn, Zn, Cu, and B) were transformed. This has been done through the conversion into a unit less score (0 to 1) to represent the associated level of function in that system. This way, the scores might be combined to form a single value(Fig.16).The Gaussian function **(Moasto, et al. 2008) was employed to assess the distributed soil variables.PCA was used to interpret** scoring function and integrate it into an index **(Moasto, et al. 2008).** The index values ranged from 0 to 1; low values indicated poor soil nutrient quality, while high values indicated good soil nutrient quality.

The equation used to determine the value of soil fertility quality index (SFQI) is as follows:

$$\mathbf{SFQI} = \sum_{i}^{n} SiWi$$

Where $\mathbf{S_i}$ is score of the soil fertility quality indicators(Table 12)and $\mathbf{W_i}$ is the weight index of each soil nutrient quality indicators(Table 12). S_i and W_i standardized value from 0 to 1 and therefore SFQI values were also calculated with a range of values from 0 to 1. The method of weighting of each parameter adjusted to the importance of the function in supporting living of aquaculture organisms.

Table 12: Weight and score indicator for soil fertility in studied soils of South East El-Qantara.

Soil indicator	Weight indicator	Scoring functions
pH	0.04000000	(X /0.21000046) –1.640164219
EC	0.08000000	0.0599780 – (X /15.9363079)
OC	0.10666667	(X/1.7178) -0.11909544
BD	0.06666667	0.01353814 – (X / 0.6095583)
Clay	0.10666667	(X / 123.792) – 0.00643
CEC	0.12000000	(X /47.206118) – 0.0418603
N	0.12000000	(X / 65.810215) – 0.04955728
P	0.10666667	(X /41.310684) –0.0723197
K	0.09333333	(X /1376.679) – 0.01308
Fe	0.05333333	(X /20.614979) – 0.0699734
Mn	0.04000000	(X /8.8068606) – 0.1063966
Zn	0.02666667	(X /2.424) – 0.0996617
Cu	0.01333333	0.018779 - (X /0.91316)
B	0.02666667	(X /2.4096) - 1.05530471

X is the observation value of variables

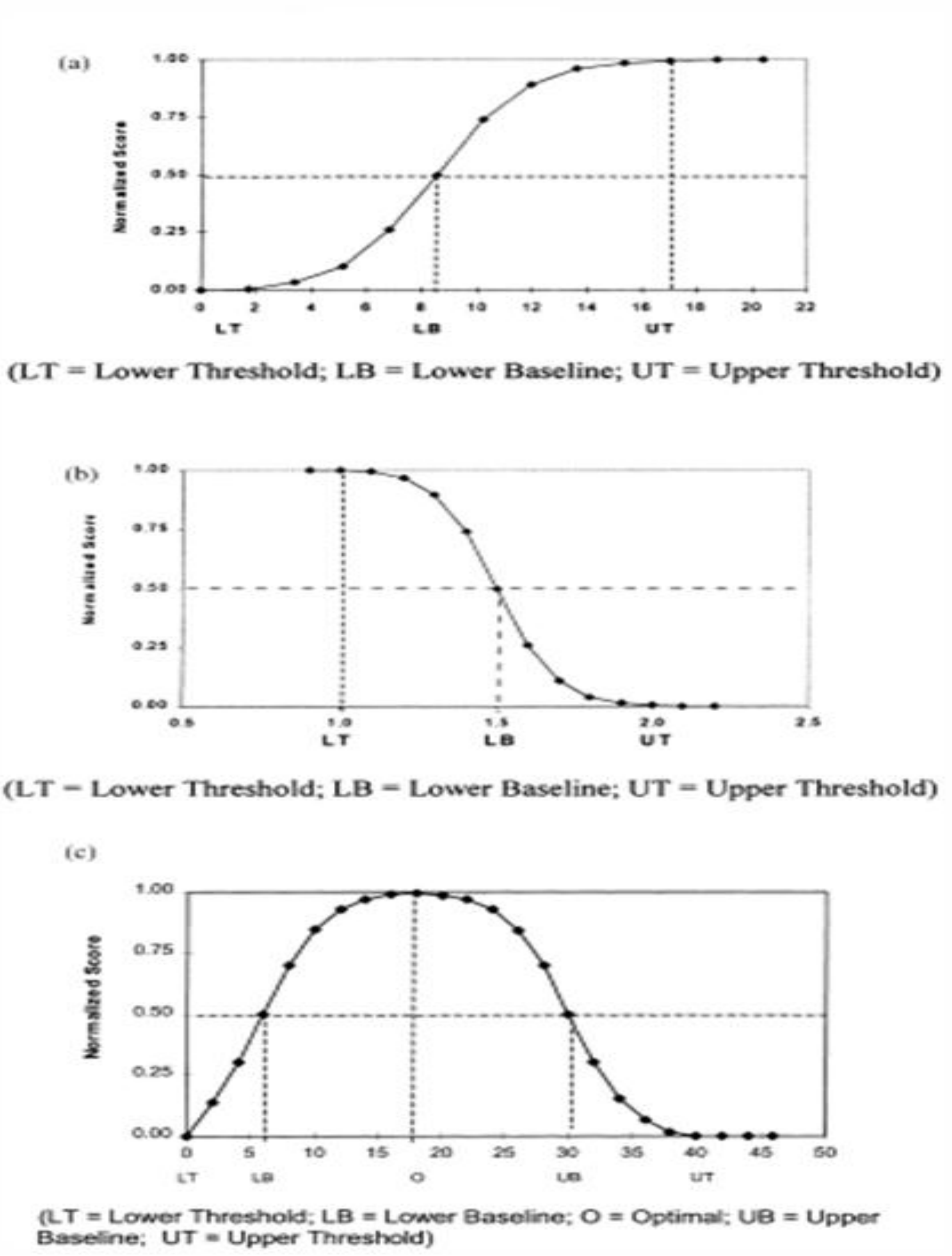

Fig. 16: Three types of scoring curves used for the interpretation of measured values of fertility quality indicators; (a) More is better, (b) Less is better and (c) Optimum (adapted from **Gugino *et al.* 2009)**

The resultant weight of soil nutrient quality, in addition to standard values of (0-1_ of the quality of soil fertility are brought into a specific weight. Thereafter, they were joined to a simple value called SFQI.The total values of the weight of all indicators are 1. Consequently, SFQI values varied from 0 to 1. The weighting factors were developed from the PCA outcomes. When not correlated indicators within a PC, weighting factors equaled to the percent of total variance explained by the PC standardized to unity. As for the correlated indicators, the percent of the total variance explained by the PC was divided among these and then standardized to unity.

Soil fertility quality status assessment criteria conducted based on soil nutrient quality index as shown in Table 13.

Table13.Criteria for fertility quality based on soil fertility quality index (SFQI) values (adapted from **Anggoro ,*et al.* 2016)**

Class No.	Class of SOCQI values	Criteria of SOCQ
1	0.80 – 1.00	**Very Good**
2	0.60 – 0.79	**Good**
3	0.40 – 0.59	**Moderate**
4	0.20 – 0.39	**Low**
5	0.00 – 0.19	**Very low**

Soil fertility quality index are simple values that indicate the alteration of soil fertility under different management systems and the changing trends of soil properties.

The results showed the value of soil fertility quality index (SFQI) ranging from 0.022381to 0.665533with an average 0.310947as can be seen in(Table 14 and Fig. 17).Based SFQI, the status of the soil fertility quality in the South East El-Qantara area included in the quality criteria for very low to good.

When fertility quality of the studied soils was examined (according SFQI, Table:28 and Fig. 32); only 27.692% of the soils has very low fertility quality, about 40.00% of the soils has Low, about 28.462% of the soils has moderate and 3.846 % has good fertility quality.

Table 14. The values of soil fertility quality index and class of SFQI studied soils.

Sample No.	SFQI	Class	Sample No.	SFQI	Class
1	0.29300	**L**	34	0.12266	**VL**
2	0.26652	**L**	35	0.21123	**L**
3	0.23279	**L**	36	0.15630	**VL**
4	0.20908	**L**	37	0.15357	**VL**
5	0.19456	**VL**	38	0.18041	**VL**
6	0.17827	**VL**	39	0.17654	**VL**
7	0.22184	**L**	40	0.22540	**L**
8	0.22097	**L**	41	0.17601	**VL**
9	0.22782	**L**	42	0.25823	**L**
10	0.16530	**VL**	43	0.24017	**L**
11	0.25758	**L**	44	0.24774	**L**
12	0.18259	**VL**	45	0.26627	**L**
13	0.28303	**L**	46	0.31697	**L**
14	0.19257	**VL**	47	0.21397	**L**
15	0.21147	**L**	48	0.20891	**VL**
16	0.16046	**VL**	49	0.18328	**VL**
17	0.19969	**VL**	50	0.29521	**L**
18	0.20774	**L**	51	0.24426	**L**
19	0.24453	**L**	52	0.18109	**VL**
20	0.23115	**L**	53	0.25976	**L**
21	0.20795	**L**	54	0.20926	**VL**
22	0.19315	**Vl**	55	0.23884	**L**
23	0.14553	**VL**	56	0.25833	**L**
24	0.09670	**VL**	57	0.26076	**L**
25	0.13840	**VL**	58	0.27294	**L**
26	0.18626	**VL**	59	0.15020	**VL**
27	0.19164	**VL**	60	0.34483	**L**
28	0.02238	**VL**	61	0.41665	**M**
29	0.13866	**VL**	62	0.28164	**L**
30	0.05165	**VL**	63	0.27139	**L**
31	0.17947	**VL**	64	0.22130	**L**
32	0.18200	**VL**	65	0.24498	**L**
33	0.11410	**VL**	66	0.36490	**L**

VL : Very Low, L: Low, M: Moderate, G: Good

SFQI**:** Soil Fertility Quality Index

Table 14 Cont.

Sample No.	SFQI	Class	Sample No.	SFQI	Class
67	0.26457	**L**	100	0.48905	**M**
68	0.29301	**L**	101	0.43581	**M**
69	0.20374	**VL**	102	0.52450	**M**
70	0.21440	**L**	103	0.45598	**M**
71	0.22788	**L**	104	0.55960	**M**
72	0.19861	**VL**	105	0.53603	**M**
73	0.26896	**L**	106	0.61568	**G**
74	0.29332	**L**	107	0.41134	**M**
75	0.32338	**L**	108	0.42565	**M**
76	0.30634	**L**	109	0.61669	**G**
77	0.29933	**L**	110	0.41319	**M**
78	0.21296	**L**	111	0.43646	**M**
79	0.23930	**L**	112	0.57077	**M**
80	0.29964	**L**	113	0.51843	**M**
81	0.46714	**M**	114	0.36674	**L**
82	0.17181	**VL**	115	0.41931	**M**
83	0.47291	**M**	116	0.43055	**M**
84	0.49199	**M**	117	0.25093	**L**
85	0.29884	**L**	118	0.43785	**M**
86	0.50716	**M**	119	0.21175	**L**
87	0.43241	**M**	120	0.59845	**M**
88	0.27430	**L**	121	0.66553	**G**
89	0.28995	**L**	122	0.48026	**M**
90	0.26453	**L**	123	0.44725	**M**
91	0.43858	**M**	124	0.54231	**M**
92	0.38889	**L**	125	0.45451	**M**
93	0.41826	**M**	126	0.46946	**M**
94	0.58360	**M**	127	0.48209	**M**
95	0.53574	**M**	128	0.44801	**M**
96	0.40395	**M**	129	0.59148	**M**
97	0.52921	**M**	130	0.60408	**G**
98	0.40148	**M**			
99	0.46429	**M**			

VL : Very Low, L: Low, M: Moderate, G: Good
SFQI: Soil Fertility Quality Index

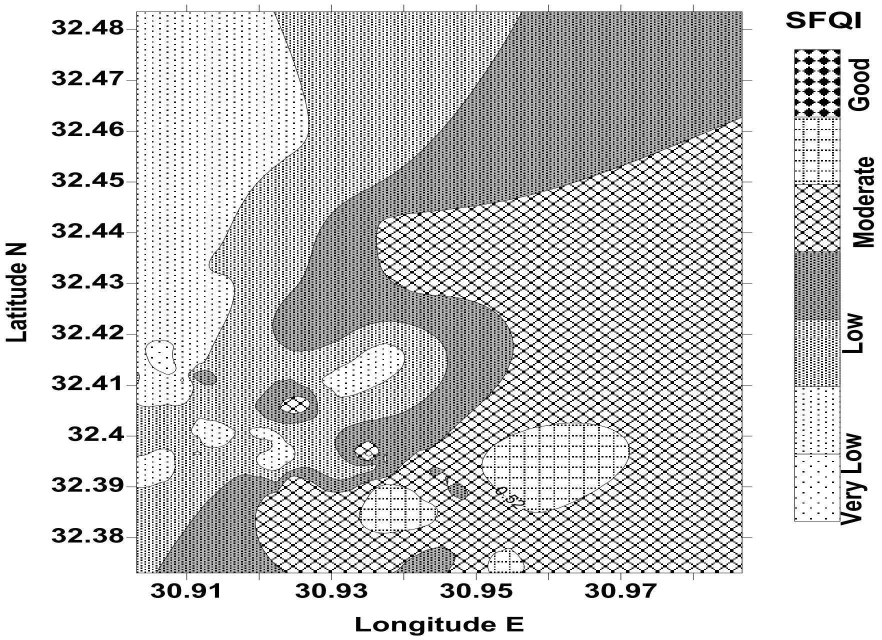

Fig. 17: Contour for class of SFQI composition of the soil data set

The soil fertility quality index (SFQI) method used to assess fertility quality, is relatively simplistic and crude. This model provides a simplified representation of soil fertility quality in an arid soils.

The current study proposes that the use of soil fertility quality indices to assess agricultural soil fertility quality may afford comparable results even when different indicator methods and models are used. Also, SFQI was determined to be the most accurate way to assess soil fertility quality. That is because it takes all of the soil parameters into application and gives the most consistent results. We suggest using the SFQI to evaluate agricultural soil quality for desert soils because of its highest correlation with economic yield of desert soils.

Correlation analysis of the 14 soil attributes representing soil physical, chemical, and nutrient parameters resulted in a significant correlation of the 130 studies soil Table 15

The SFQI focuses on the variations among inner soil properties. They have implications not only on soil productivity, but also on other soil fertility. Also, the soil fertility quality index which is, easier to compute using fewer parameters, may be employed as a quick tool to evaluate soil quality and to measure changes occurring after different management practices.

Table 15: Correlation matrix of soil fertility quality indicators in studies soil.

	pH	**EC**	**OC**	**CEC**	**Clay**	**BD**	**N**	**P**	**K**	**Fe**	**Mn**	**Zn**	**Cu**	**B**
SFQI	0.04	0.16	0.68**	0.32**	0.49**	-0.79**	0.62**	0.70**	0.76**	0.69**	0.69**	0.42**	0.41**	0.70**
B	-0.21*	0.51**	0.36**	079**	0.79**	0.73**	0.54**	0.37**	0.68**	0.68**	0.77**	0.60**	0.45**	
Cu	-0.01	0.36**	0.17	0.49**	0.46**	-0.44**	0.40**	0.36**	0.46**	0.23**	0.33**	0.42**		
Zn	-0.43**	0.55**	0.25**	0.62**	0.65**	-0.50**	0.40**	0.06	0.59**	0.62**	0.64**			
Mn	-0.33**	0.47**	0.45**	0.77**	0.77**	-0.71**	0.46**	0.29**	0.73**	0.85**				
Fe	-0.26**	0.36**	0.44**	0.69**	0.70**	-0.64**	0.43**	0.25**	0.67**					
K	-0.33**	0.49**	0.50**	0.51**	0.81**	-0.69**	0.59**	0.45**						
P	-0.01	-0.06	0.49**	0.51**	0.46**	-0.48**	0.31**							
N	-0.12	0.44**	0.29**	0.58**	0.56**	-0.56**								
BD	0.12	-0.45**	0.46**	-0.80**	-0.80**									
Clay	-0.33**	0.52**	0.48**	0.98**										
CEC	-0.31**	0.50**	0.51**											
OC	-0.21*	-0.01												
EC	-0.32**													

* : significant at 5% level of probability.

** : significant at 1% level of probability.

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تقييم جوده التربة لبعض أراضى جنوب القنطرة شرق

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تهدف خطة الحكومة إلى إستصلاح الأراضي الصحراوية و زراعة حوالي 400.000 فدان تتركز أساسا في سهل الطينة (50,000 فدان) وجنوب القنطرة شرق (75,000 فدان) ورابعة (70,000 فدان) و بئر العبد (70,000 فدان) و السرو والقوارير (135,000 فدان). وكشفت هذه الدراسة أنه ليس هناك تباين في حالة خصوبة التربة التي وضعت على مختلف التضاريس في المنطقة وقد وجد ان محتوى التربة من الكربون العضوي يتراوح بين منخفض إلى نسبة مرتفعة (0,14 إلى 2,50%) و محتوى التربة من النيتروجين الميسر منخفضة (4,32 إلى 58,30 جزء في المليون) ومحتواها من الفوسفور الميسر يتراوح بين منخفض إلى مرتفع (2,06 إلى 59,23 جزء في المليون) وكانت التربة تتراوح من حد الفقر إلى الكافي في محتواها من البوتاسيوم الميسر (23,50 إلى1360 جزء في المليون).

وكانت قيمة مؤشر دليل جودة خصوبة التربة (SFQI) تتراوح بين 0,022381 0,665533 بمتوسط 0,343957 ، وقد وجد أن 27,692 ٪ فقط من التربة تحت الدراسة منخفض جدا في جودة خصوبة التربة(طبقا لـ SFQI) و 40,00 ٪ من التربة منخفضة في جودة خصوبة التربة و حوالي 28,462 ٪ من التربة معتدلة الخصوبة و 3,846 ٪ من التربة جيدة في خصوبة التربة. و يمكن استخدام دليل جودة خصوبة التربة بوصفه أداة سريعة لتقييم نوعية العناصر الغذائية في التربة وقياس التغيرات التي تحدث بعد ممارسات الإدارة المختلفة، كما أن استخدام مؤشرات دليل جودة خصوبة التربة لتقييم جودة العناصر الغذائية للتربة تراعي جميع الخواص، ونقترح إستخدام مؤشر (SFQI) لتقييم خصوبة التربة الزراعية خاصة التربة الصحراوية.