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Soil Depositional Mode, Fertility Status and Suitability for Specific Crops of Physiographic-Soil Units at the Desert Belt Between El-Fayoum Depression and the Nile Valley, Egypt

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THIS STUDY is a trial to provide knowledge about the main soil factors or environmental conditions that affect soil depositional mode, profile development and its suitability for specific crops at the desert belt between El-Fayoum depression and the Nile Valley at Beni-Suef Governorate, Egypt. These items are considered of the most urgent criteria that help in planning the proper agricultural utilization of such promising areas adjacent to the desert road Cairo-Asyut. It is essential to conduct the preliminary studies for evaluating soil potentiality and favourable management practices for its sustainable cultivation on both the short and long-terms.

The main physiographic-soil units in the studied area were identified based on the visual interpretation of Landsat, which could be categorized into seven units, *i.e.*, piedmont, alluvial terraces (locally overblown sands), El-Fayoum alluvial plain (locally terraced), El-Fayoum alluvial fan, the Nile alluvial depressed plain (River bed), the Nile alluvial flat plain and rock structures. The results of the fieldwork indicated that the soil depth was 150 cm or more, except for some localities at piedmont unit where the soil depth was restricted by bedrock (45-75 cm). The studied soils have different textural grades, *i.e.*, sand, loamy sand, sandy loam, sandy clay loam, clay loam and clay. Gravels or weathered eroded lime rock-fragments were scattered distribution either on soil surface or within some desert soil profiles. Also, secondary pedogenic formations of lime and gypsum, which are ascribed to the diagnostic horizons in some soil profiles.

The calculated indices of soil profile uniformity show an evidence of partial homogeneity of soil materials developed on the desert alluvial terraces and El-Fayoum alluvial plain (*i.e.*, moderately sorted) and transported by wind and water in mixed actions of aeolian-aqueous environments. While, some of the studied soils developed on El-Fayoum alluvial plain, El-Fayoum alluvial fan and the Nile alluvial plain units gave an evidence of partial heterogeneity of the poorly and very poorly sorted soil materials, which were mainly transported and deposited in aqueous media. The C-M pattern diagram reveals that such soil deposits were transported mainly in suspension suites of uniform, graded and pelagic suspensions. On the other hand, soil deposits developed on piedmont, desert alluvial

terraces, El-Fayoum alluvial plain units were transportations in forms of rolling and rolling & suspension.

The variations in light and heavy minerals of sand fraction are mostly attributed to the nature of parent material, which could be emphasized by either the multi-origin or multi-depositional regime of soil deposits. The presence of assessable minerals in high percentages throughout soil profile layers in piedmont, desert alluvial terraces and El- Fayoum plain units; is more related with deriving high weathering values and relatively low intensity of weathering conditions, while the opposite was true in the other soil sites. Such criteria can be taken as an indication of soil profile immaturity or recent soil deposits in the first case. On the other hand, some soil profiles, particularly those developed on both El-Fayoum alluvial fan and the Nile alluvial plain units, exhibited a considerably developed phase, probably due to the occurrence of some pedogenetic features.

Soil fertility status was identified through a soil survey for total and available nutrient contents (N, P, K, Fe, Mn, Zn and Cu) as related to the main physical and chemical properties (texture, pH, ECe, organic matter, $CaCO_3$, gypsum, CEC and ESP). Such relationship gave typical models for the different studied soil sites under the prevailing environmental conditions. This was statistically confirmed from the stepwise data that was exacted by using the program of SPSS (2003). However, the nutrients status showed a wide variation depending upon the nutrients bearing minerals that are predominated soil mechanical fractions (clay, silt and sand) as well as $CaCO_3$, organic matter and soil pH. That was true, since the highest nutrient contents were associated with soils having high clay and organic matter contents.

Matching the parametric approach of land qualities with the requirements of sixteen specific corps (*i.e.*, field, oil, fodder, vegetable and fruit crops) was carried out to asses the crop-physiography adaptations as well as to define the supreme and subsequent prior potential suitability by shifting specific crop to be cultivated in the studied physiographic-soil units. Exceptional of soils developed on El- Fayoum alluvial fan and the Nile alluvial plain that are exhibited highly and moderately suitable classes, the obtained data reveal that the current suitability classes of soils developed on the different physiographic units of desert belt were generally not suitable (N), except some scattered areas which are suitable for olives, due to the relatively high values of soil salinity, gravel carbonate and gypsum, besides shallow soil depth. On the other hand, the potential suitability classes differed according to the satisfaction conditions between different properties of soils developed on the studied physiographic-soil units and plant requirements. These adaptations can be promising for rather higher output as the major land improvements that are considered for the land qualities of drainage, salinity and sodicity, to maximize the current land suitability to be potential one after re-evaluating the physiographic land considering them free of those limitations.

Keywords: Desert belt, El-Fayoum depression, Physiographic-soil units, Formation mode, Fertility stats and soil suitability for certain crops.

The highly productive land of the Nile alluvium is denaturing by flurried urbanization encroachment in El-Fayoum Governorate, which has a limited cultivated area such as in the other ones in Egypt. This phenomenon is reflecting a serious human mode, acting on a unique valued land. Such increase in urban areas on highly productive agriculture land in El-Fayoum Governorate is due to a result of overpopulation and economic growth. Egyptian National Specialized Committee (2003) expected that Egypt will lose all its old land by the year 2080 and will be mainly depend on the total new reclaimed lands. This incredible mode must create a deep dramatic impression to the pedologists, economists and the decision makers. The problem has been clearly dawned and an urgent solution has become inevitable. It is a downcast feeling being this disastrous effect, is leading to the entire loss of this valued lands within the near coming decades, meanwhile the bare areas in Egypt is a very vast for creating a new formal demographic features.

Therefore, more concern is required to prevent the urban encroachment at the expense of productive agricultural land as well as to a pay the suitable attention to exist spread of productive land outside their desert rims. It is well known that the outskirts of El-Fayoum Governorate are mainly desert areas and such have less productive desert sandy or calcareous soils are commonly known to have a poor soil structure, low water holding capacity and their limited fertility. This is due to the main mechanical constituents are the sand fraction, which is not partially capable to retain neither water nor nutrients for growing plants, and active $CaCO_3$, that affect distinctly different soil properties related to plant growth such as crusting, soil-water relations, availability of plant nutrients, etc... (Ragab, 2001). Therefore, the major policy of the Local Government aims to attain self-dependence in the natural sources of soil and water needs. To achieve this goal, efforts have been directed towards the desert belt at the southern-east desert outskirt of El-Fayoum depression for the purpose of their overall development. Such area represents a natural desert formation in landscape of alluvial terraces (locally overblown sands), and it differs from the other Western Desert ones, which is open on one or more sides, in being entirely surrounded by El- Fayoum alluvial plain and the Nile alluvial plain from the west and east directions, respectively. Evaluation of land for irrigated agriculture as well as main Cairo-Asyut desert road is the base for making an agricultural utilization.

So that, the data of the current study were created to support the local knowledge concerning soil formation mode, profile development and fertility status as affected by the prevailing environmental conditions (*i.e.*, origin and landform escape) to asses their significance as a guide to explain and correct the problems facing the future agricultural utilization projects in the area under investigation and in turn the best use of land whether be under demand for agriculture use or be planned for later on use. In addition, this work was carried out by using physiographic-soil units map obtained from the visual analysis of Enhanced Images of Landsat Thermatic Mapper 7 of the studied area (RGB, Geocover, 2005). These soil criteria represent a base for making a proper agricultural utilization and could be considered as promising items in soil potentiality and its sustainable agriculture on the long-term. For this purpose, the harmony of descriptive and processing systems, established by Sys (1991) and Sys *et al.* (1993) were considered, being are highly required in this study.

Material and Methods

Location of the studied area and the identified physiographic units

The studied area is a natural desert belt located between El-Fayoum depression and the Nile Valley at Beni-Suef Governorate (southern-east desert outskirt of El- Fayoum depression) and it comprises a total area of approximately 264 km^2. Also, it is located between latitudes 29° 24' 22.50" N to 29° 11' 56.11" N and longitudes 30° 51' 51.00" E to 31° 14' 43.19" E, in the eastern part of Western Desert of Egypt. It bounded by the Nile Valley from the Eastern, El-Fayoum depression from the western and Bahr Yousef from the southern sides (Fig.1). It comprises a total area of approximately 264 km^2, mainly occupies a landscape of alluvial terraces (locally overblown sands), in being entirely surrounded by El-Fayoum alluvial plain and the Nile alluvial plain from the west and east directions, respectively

Landsat data interpretation

Landsat data interpretation of the Enhanced Thematic Mapper 7 (ETM 7), during the year of 2005 (RGB, Geocover, 2005), with bands 2, 3 and 4 was performed to visually analyzed and delineate the different physiographic-soil units, based on the physiographic analysis as proposed by Burnigh (1960) and Gossen (1967).

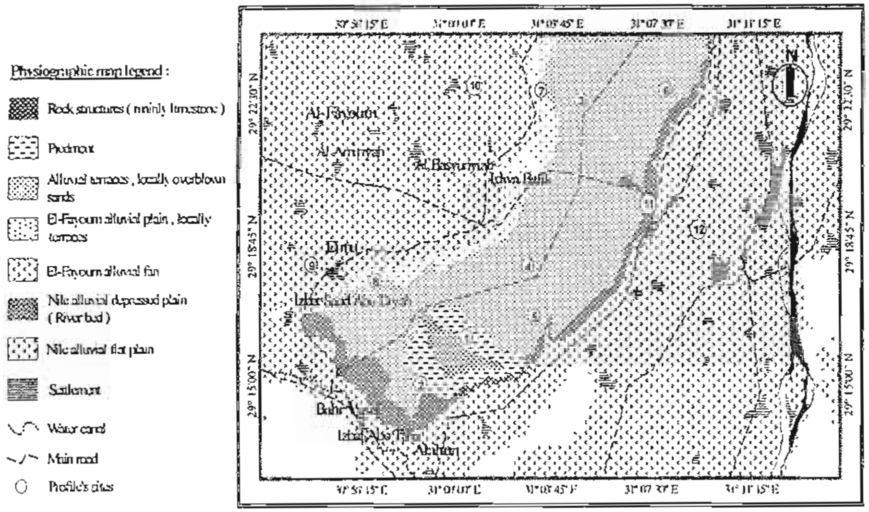

Fig. 1. Physiographic units map of the studied area.
(Scale 1 : 250 000)

This approach is to identify soil bodies on the context of dynamic processes, as the deposition types and development modes. The main physiographic units in the studied area extracted from visual interpretation and spectral classification are defined in soil map (Fig. 1) and could be categorized into seven physiographic units as follows: 1. Piedmont, 2. Alluvial terraces, locally overblown sands, 3. El-Fayoum alluvial plain, locally terraced, 4. El-Fayoum alluvial fan, 5. Nile alluvial depressed plain (River bed), 6. Nile alluvial flat plain and 7. Rock structures. Also, fieldwork was performed to describe the soils developed on these physiographic units and to collect soil samples for laboratory analyses to recognize the different soil properties, which were used as guidelines for covering the main topics of this study.

Fieldwork and sampling

Twelve representative soil profiles were chosen from the different studied physiographic-soil units (Fig. 1) *i.e.*, Piedmont (profile Nos. 1 and 2), Alluvial terraces, locally overblown sands (profile Nos. 3, 4, 5 and 6), El Fayoum alluvial plain, locally terraced (profile Nos. 7 and 8), El-Fayoum alluvial fan (profile Nos. 9 and 10), Nile alluvial depressed plain, River bed (profile No. 11) and Nile alluvial flat plain (profile No. 12). The soil profiles were dug to a depth 150 cm or to lithic contact (bedrock). Soil samples were collected according to the morphological variations throughout the soil profile layers and were described according to the nomenclature of USDA (2003) and Munsell Soil Colour Chart (1975), as shown in Table 1. The disturbed soil samples were air-dried, crushed, sieved through a 2 mm sieve, then the obtained fine earth samples (< 2 mm) were kept for laboratory analysis.

TABLE 1. Morphological description of the studied soil profiles.

Physiographic unit	Profile No.	Soil parent material	Slope gradient	Horizon	Soil depth (cm)	Soil colour	Modified texture class	Soil structure	Soil consistency
Piedmont	1	Eocene limestone	Gently undulating	Aky Cky R	0-15 15-45 45-	10YR8/4 d 10YR7/4 d	VG SL VG LS	Mas	Loose Slightly hard
						Limestone (bedrock)			
	2		Gently undulating	Aky Cky1 Cky2 R	0-20 20-45 45-75 75-	10YR7/6 d 10YR7/4 d 10YR7/4 d	G SL G SL VG SL	Mas	Slightly hard
						Limestone (bedrock)			
Alluvial terraces, locally over blown sands	3		Gently undulating	Ak Ck1 Ck2 Ck3	0-25 25-55 55-105 105-150	10YR7/6 d 10YR7/6 d 10YR7/6 d	SG SL SG SCL SG CL SG LS	Gr Gr Gr Sg	Soft Slightly hard Slightly hard Loose
	4		Gently undulating	Ak Ck Cky Ckyz	0-15 15-50 50-95 95-150	10YR7/4 d 10YR8/4 d 10YR7/4 d	G SCL G SL G LS G SCL	Gr Mas Mas Gr	Slightly hard Loose Loose Slightly hard
	5		Gently undulating	C1 C2 C3 C4	0-20 20-65 65-95 95-150	10YR7/4 m 10YR8/4 m 10YR8/4 m 10YR6/4 m	VG LS VG LS VG LS ExG S	Sg	Slightly hard Slightly hard Hard
	6	Wind blown sands	Gently undulating	C1 C2 C3	0-30 30-85 85-150	10YR7/6 d 10YR7/6 d 10YR7/6 d	S	Sg	Loose
El-Fayoum alluvial plain, locally terraced	7	Fluvio-lacustrine	Almost flat	Ak Ck Ck1 Ck2	0-35 35-75 75-110 110-150	10YR5/2 d 10YR4/2 m 10YR3/3 m 10YR3/3 m	Cl C	Mmsbk Mmsbk Cstsbk Cstsbk	Friable Friable Firm Firm
	8		Almost flat	Ap C1 C2	0-25 25-80 80-150	10YR6/6 d 10YR7/6 d 10YR7/8 d	SCL LS S	Gr Sg Sg	Slightly hard Loose Loose
El-Fayoum alluvial fan	9	Nile alluvium	Almost flat	Ap C1 C2 C3	0-25 25-80 80-120 120-150	10YR5/4 d 10YR5/2 m 10YR5/2 m 10YR5/2 m	C	Mmsbk Mmsbk Mmsbk Cstsbk	Slightly hard Hard Firm Firm
	10		Almost flat	Ap C1 C2 C3	0-20 20-60 60-100 100-150	10YR4/3 d 10YR5/3 d 10YR4/2 m 10YR5/2 m	Clay loam Clay	Mmsbk Mmsbk Cstsbk Cstsbk	Friable Slightly hard Firm Firm
Nile alluvial depressed plain (River bed)	11	Nile alluvium	Almost flat	Ap C1 C2 C3	0-15 15-50 50-100 100-150	10YR4/2 m 10YR4/3 m 10YR4/2 m 10YR4/2 m	C	Mmsbk Cstsbk Cstabk Cstabk	Firm Very firm Very firm Very firm
Nile alluvial flat plain	12		Almost flat	Ap C1 C2 C3	0-25 25-60 60-90 90-150	10YR4/2 m 10YR4/3 m 10YR4/2 m 10YR4/2 m	C	Mmsbk Mmsbk Mmsbk Cstsbk	Hard Firm Firm Firm

Gravel: SG=Slight gravelly, G=Gravelly, VG=Very gravelly and ExG=Extreme gravelly.
Fine earth: S=Sand, LS=Loamy sand, SL=Sandy loam, SCL=Sandy clay loam, CL=Clay loam and C=Clay.
Soil colour: d=Dry and m=Moist.
Soil structure: Sg=Single grain,Mas=Massive, Mmsbk=Medium moderate subangular blocky, Cstsbk=Coarse strong subangular blocky and Cstabk=Coarse strong angular blocky

Laboratory analysis

The following soil properties were determined by using via standard methods, *i.e.*, particle size distribution % was determined using the International Pipette method (Piper, 1950) and sodium hexametaphosphate as a dispersing agent (Baruah and Barthakur, 1997). $CaCO_3$ content was measured by using the Collin's Calcimeter (Black *et al.*, 1965). Soil pH in 1:2.5 soil water suspension and soil organic matter content as well as ECe in saturation soil paste extract were determined according to the methods describe by Jackson (1973). Gypsum content was determined by using the acetone method (Bower and Huss, 1948). Cation exchange capacity and the exchangeable sodium percentage (ESP) were determined according to the methods described by Richards (1954) and Tucker (1954).

Statistical size parameters

Grain size distribution of sand fraction was carried out using five sets of sieve diameters according to Dewis and Freitas (1970). Statistical size parameter of sediments such as sorting was calculated according to Folk and Ward (1957) by using the data obtained from graphically cumulative frequency curves to define the environmental media of deposition regime. Also, the transportation mechanism of the studied soil sediments was identified by the C-M pattern according to Passega (1964).

Mineralogical of sand fraction and parameters of soil uniformity and development

The heavy minerals were separated from the suitable size of sand fraction (0.125-0.063 mm) for the microscopic investigation (El-Hinnawi, 1966) using Boromoform (specific gravity 2.87). The separated heavy minerals were collected and washed with alcohol and dried and mounted by canada balsam according to the method outlined by Brewer (1964).

The systematic identification of some heavy minerals, *i.e.*, amphiboles (A), pyroxenes (P), mica biotite (B), zircon (Zr), tourmaline (T) and rutile (R) was carried out using polarizing microscope and the principles of identification reported by Kerr (1959) and Milner (1962). Calculations of percentage of such heavy minerals were made considering the non-opaque minerals as 100 %. Soil uniformity parameter was determined as a ratio of resistant minerals (*i.e.*, Zr/T, Zr/R and Zr/T+R). Also, soil profile development parameter was identified as a ratio of minerals assessable to weathering/those of resistant to weathering (*i.e.*, A/Zr+T, A+P/Zr+T and B/Zr+T).

Total and available contents of some essential plant nutrients

Total nitrogen was determined in the digested solution, which was carried out using a K_2SO_4-Salicylic as mixture accelerators using Kjeldahl methods by sodium hydroxide and boric acid according to Jackson (1973). Total macro (phosphorus and potassium) and micronutrients (iron, manganese, zinc and cooper) were determined in the digested solution, which was carried out using perchloric-hydrofluoric acids according to Hesse (1971). Total P was determined using ascorbic acid according to Houba *et al.* (1995) and the measure absorbance was carried out on Spectro-photometer at 882 nm (model 690). Total K was measured using Flame Photometer. Total Fe, Mn, Zn and Cu were measured using Atomic Absorption Spectro-photometer (model GBC 932).

Available N was extracted by using 2 M KCl (Page *et al.*, 1982) and determined using Kjeldahl methods according to Jackson (1973). Available P was extracted by using 0.5 M $NaHCO_3$ at pH 8.5 according to Olsen *et al.* (1954) and was determined used ascorbic acid (Van Reeuwijk, 1993). Absorbance was detected using Spectro-photometer at 882 nm (model 690). Available K was extracted by using 1 NH_4OAC at pH 7 (Page *et al.*, 1982) and it was measured using Flame Photometer. Available Fe, Mn, Zn and Cu were extracted using 0.005 M DTPA, 0.01 M $CaCl_2$ and 0.1 M TEA at pH adjusted to 7.3 using hydrochloric acid (1:1) according to Follet and Lindsay (1971) and Lindsay & Norvell (1978) and were measured using Atomic Absorption Spectro-photometer (model GBC 932).

Land evaluation and its suitability for specific crops

The studied lands were evaluated for irrigated agriculture according to the parametric system undertaken by Sys and Verheye (1978) as well as soils under study were classified according to their suitability for certain crops using a numerical system undertaken by Sys *et al.* (1991 and 1993), which is a program developed through matching soil properties together with crop requirements. The main soil parameters used in this system are climate, soil depth, soil texture, gravel percentage, $CaCO_3$ percentage, gypsum percentage, salinity (ECe), alkalinity (ESP), slope pattern and drainage conditions. A suitability index of 21 crops for the studied soils was done according to this program.

Results and Discussion

1. A general view on the representative soil profiles

The field studies (Table 1), reveal that the topographic features of the soil profiles developed on the studied physiographic units are almost flat for the arable to gently undulating for the virgin areas that devoid scattered natural vegetation and often steep or rolling slope for the barren limestone (original structure) outcrops. The effective soil depth was 150 cm, except for some areas developed on Piedmont unit of shallow depth due to the existence of lithic contact or bedrock at a depth of 45-75 cm. Exceptional of soils developed on El-Fayoum alluvial fan and Nile alluvial plain units, which are characterized by either medium or fine textured materials, the majority of studied soils are gravelly loose sand to sandy loam. The secondary formations of $CaCO_3$ as soft and hard lime nodules or accumulations as well as gypsum segregations are found in subsoil layers of desert formations developed on Piedmont and alluvial terraces units. The orthic signs of both the prevailing environmental conditions and soil genesis played an important role for modifying soil structure types, which are found in different features of single grain, massive, weak or moderate granular, moderate medium sub-angular blocky and coarse strong angular blocky. The existence of diagnostic horizons, *i.e.*, calcic, gypsic (Piedmont, Alluvial terraces and El-Fayoum alluvial plain units) and salic horizons (Nile alluvial depressed plain as a river bed unit) can be taken as a function of the developed condition of soil profile.

Data in Table 2 indicate that the physico-chemical properties of the studied soil profiles are largely responsible for performing a closely relationship between soil origins and the prevailing environmental conditions. However, the original phase of the piedmont (soil profile No. 2), alluvial terraces (soil profile No. 6), El-Fayoum alluvial fan (soil profile No. 9), and the Nile alluvial plain (soil profile Nos. 11 and 12) units have been almost uniform texture throughout the whole profile layers, *i.e.*, sandy loam, sand, clay and clay, respectively. On the other hand, the rest soils developed on either some of these units or the other studied physiographic ones are characterized by different soil textured grades, *i.e.*, sand, loamy sand, sandy loam, sandy clay loam, clay loam and clay), besides different gravel contents (*i.e.*, slight gravelly, gravelly and very gravelly) which are randomly distributed throughout soil profiles, indicate that these soils are of multi-origins or subjected to multi-depositional environments.

In general, soil salinity tended to increase in the most of the studied soil profiles, except of some scattered soil sites developed on Alluvial terraces, El-Fayoum alluvial plain, El-Fayoum alluvial fan and Nile alluvial flat plain units, which classified as non- (ECe $<$ 4 dS/m) to slightly-saline (ECe $<$ 4-8 dS/m) probably due to either relatively coarse textured grade or well soil drainage conditions that alleviated salt accumulations or enhanced the removal of the excess salts. On the other hand, the rest of the studied soils that developed on the physiographic units under investigation are suffering from salinity (ECe $>$ 12 dS/m) and often from soil sodicity (ESP), which may be associated with the intensive of chemical weathering and dominance of soluble Na^+ that stimulated more displacement of Ca and Mg by Na on soil colloidal complexes. It is quite noticeable that the changes in the CEC value were more related to the mechanical composition of soil sediments, however, it shows a relatively low or moderate value extending parallel close to the relatively low or moderate clay contents vs a relatively high value (56.77 Cmolc kg^{-1} soil) in case of the relatively high charged silicate clay content (56.43-67.00 %). The obtained data in Table 2 showed a pronounced decrease in soil organic matter content, especially in virgin soils of desert belt. These noticeable decreases may be attributed to the hot climate desert zone, besides the absence of natural vegetation and the directly reductive of its remnants. A reversible trend was observed for both soil $CaCO_3$ and $CaSO_4.2H_2O$ contents, where their contents are generally found in relatively high contents in the majority of the studied desert localities, mostly due to the nature of lithic origin (Eocene limestone) as well as the precipitation of dissolved $Ca(HCO_3)_2$ in a form of secondary $CaCO_3$.

TABLE 2. Particle size distribution, pH, ECe, organic matter, calcium carbonate, gypsum contents, CEC and soil sodicity (ESP) of the studied soil profiles.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Particle size distribution %				Modified texture class	Soil pH (1:2.5 soil suspension)	ECe (dS/m)	Organic matter %	$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %	CEC (C mole kg^{-1} soil)	Soil sodicity (ESP)
				Coarse sand	Fine sand										
Piedmont	1	0-15	47.85	36.57	39.25	7.72	38.76	VG SL	7.72	38.76	0.17	51.65	5.95	11.38	6.10
		15-45	56.93	46.48	30.74	7.55	35.40	VG LS	7.55	35.40	0.09	56.37	7.24	8.57	5.54
		45-	Limestone bedrock												
	2	0-20	16.45	32.18	36.07	12.70	19.05	G SL	7.90	9.35	0.21	45.67	9.35	9.16	3.69
		20-45	29.89	36.94	48.84	10.25	17.75		7.85	13.72	0.16	21.93	16.84	6.15	4.02
		45-75	35.20	41.56	40.40	5.90	12.68	VG SL	7.53	20.63	0.10	32.45	10.55	5.82	5.34
		75-	Limestone bedrock												
Alluvial terraces, [illegible]ally overflown sands	3	0-25	7.50	55.69	19.64	8.75	15.92	SG SL	7.94	21.54	0.26	14.15	1.22	7.12	9.17
		25-55	9.35	32.71	23.02	16.43	27.84	SG SCL	7.98	48.12	0.17	27.90	2.90	14.08	7.35
		55-105	6.46	19.85	20.70	22.60	36.75	SG CL	8.03	36.90	0.14	21.84	4.65	15.12	11.49
		105-150	10.08	50.57	35.05	5.25	9.13	SG LS	8.15	17.83	0.08	30.50	3.00	5.87	10.82
	4	0-15	31.45	27.60	14.39	31.64	26.37	G SCL	7.81	69.75	0.17	13.98	2.85	16.54	8.66
		15-50	28.60	34.92	35.10	15.53	14.45	G SL	7.85	74.05	0.15	14.72	3.70	13.70	6.78
		50-95	26.50	26.86	55.52	7.40	10.28	G LS	7.90	113.46	0.09	25.61	5.54	16.04	9.54
		95-150	26.52	14.37	20.07	39.81	25.75	G SCL	7.92	147.25	0.07	17.50	8.43	14.65	11.52
	5	0-20	40.75	32.56	53.05	8.14	6.25	VG LS	7.76	8.71	0.28	9.97	0.52	18.93	10.91
		20-65	51.83	39.10	47.35	5.60	7.95		7.79	10.32	0.21	7.20	0.64	25.02	11.25
		65-95	45.95	35.73	53.46	4.35	6.46		7.85	13.50	0.16	8.75	0.75	20.44	9.69
		95-150	61.42	40.95	52.90	2.84	5.31	ExG S	7.89	17.84	0.12	6.84	0.83	18.90	10.30
	6	0-30	3.20	20.70	75.25	1.34	2.71	S	7.64	6.73	0.14	1.69	0.23	3.96	2.56
		30-85	1.70	77.96	12.65	2.85	6.54		7.69	5.81	0.10	1.35	0.30	4.72	3.87
		85-150	0.55	67.30	29.82	0.73	2.15		7.80	4.96	0.08	0.97	0.38	3.35	2.41
El-Fayoum alluvial plain, locally terraced	7	0-35	0.00	5.34	35.60	21.34	37.72	CL	8.13	13.85	0.67	15.75	1.86	17.70	9.20
		35-75	0.00	4.75	33.26	23.04	38.95		8.19	16.07	0.49	19.54	2.54	15.16	9.42
		75-110	0.00	2.10	20.10	26.55	51.25	C	8.24	17.69	0.32	37.82	9.75	18.75	10.48
		110-150	0.00	1.82	15.39	29.18	53.61		8.32	19.15	0.18	28.60	5.10	19.23	11.17
	8	0-25	0.00	6.45	59.15	13.22	21.18	SCL	7.91	0.79	0.35	1.23	0.54	17.89	4.45
		25-80	0.00	5.71	79.30	5.35	9.64	LS	7.96	1.16	0.21	0.75	0.37	5.05	5.20
		80-150	0.00	3.84	87.24	4.42	4.50	S	8.02	1.45	0.10	0.48	0.30	3.71	5.75
El-Fayoum alluvial fan	9	0-25	0.00	6.32	23.15	25.64	44.89	C	7.76	4.47	1.52	5.93	0.64	37.94	9.76
		25-80	0.00	8.64	16.07	29.95	45.34		7.79	3.96	0.93	4.12	0.57	36.82	10.95
		80-120	0.00	6.75	22.30	24.40	46.55		7.81	3.35	0.54	3.86	0.41	38.75	12.48
		120-150	0.00	7.81	21.96	29.78	40.45		7.86	3.10	0.27	2.45	0.29	33.61	11.97
	10	0-20	0.00	4.15	26.85	31.24	37.76	CL	7.63	2.37	1.85	4.90	0.67	31.14	6.54
		20-60	0.00	3.65	25.72	32.33	38.30		7.67	3.40	0.76	3.76	0.54	29.32	7.10
		60-100	0.00	2.93	27.10	24.45	45.52	C	7.77	3.65	0.65	2.80	0.36	38.40	8.36
		100-150	0.00	1.57	25.64	25.71	47.08		7.92	4.12	0.40	1.54	0.21	39.55	8.93
Nile alluvial depressed plain	11	0-15	0.00	2.35	26.70	1452	56.43	C	7.68	19.74	1.79	2.59	0.23	47.62	12.05
		15-50	0.00	1.84	14.11	21.90	62.15		7.76	18.91	0.95	2.21	0.57	51.35	13.67
		50-100	0.00	1.32	19.90	13.83	64.87		7.79	16.60	0.80	1.83	0.84	54.86	14.90
		100-150	0.00	1.15	17.45	14.40	67.00		7.87	15.85	0.64	1.46	0.96	56.77	14.83
Nile alluvial flat plain	12	0-25	0.00	4.85	22.34	24.56	48.25	C	7.56	2.72	2.47	3.20	0.94	40.65	8.35
		25-60	0.00	5.34	19.83	25.70	49.13		7.64	3.04	1.83	2.54	0.75	41.84	7.92
		60-90	0.00	3.71	28.26	20.19	47.84		7.71	2.51	0.92	2.05	0.61	40.53	9.84
		90-150	0.00	4.95	27.51	22.45	45.09		7.75	1.96	0.75	1.85	0.52	37.97	10.03

Gravel: SG=Slight gravelly, G=Gravelly, VG=Very gravelly and ExG=Extreme gravelly.
Fine earth: S=Sand, LS=Loamy sand, SL=Sandy loam, SCL=Sandy clay loam, CL=Clay loam and C=Clay.

2. Soil depositional mode

In order to study the depositional mode of the studied soil materials of the physiographic-soil units under investigation, the values of sorting, which were extracted from the graphic presentation of the soil mechanical fractions, are taken as indices of soil sediment suite, *i.e.,* either homogeneity or heterogeneity. In general, soil sediments transported by wind are well-sorted nature (uniform suite), while those transported by water are poorly-sorted nature (many or multi-suites). Accordingly, all the soils developed on the studied physiographic-soil units, except two soil sites of 6 and 8, showed three types of sorted nature, *i.e.,* poorly, very poorly and extremely poorly sorted and its values ranged between 1.34 and 4.12, indicating an evidence of multi-depositional regimes or partial heterogeneity soil materials. In addition, such soil materials exhibit a mutual relation between origin and mechanism of transportations, *i.e.,* transported by the action of water in aqueous environments.

On the other hand, the other two soil sites of 6 (Desert alluvial terraces) and 8 (El-Fayoum alluvial plain) possess one type of sorted nature, *i.e.*, moderately sorted and its values of sorting ranged 0.65-0.75, which gave an evidence of almost uniform sediments or partial homogeneity of the soil materials amongst their soil profiles and transported by wind and water in mixed actions of aeolian-aqueous environments. That means the obtained data of sorting indices for the studied soil profiles amongst the identified physiographic-soil units (Table 3), reveal that the soil sediments were mainly transported and deposited in aqueous medium by the action of water (aqueous environments) as well as locally soil sites possess moderately sorted nature and are formed by the mixed actions of wind-water (aeolian-aqueous environments).

The obtained data of the C-M pattern diagram reveal that soil deposits of both El-Fayoum alluvial fan and the Nile alluvial plain units are transported mainly in a pelagic suspension form, as a mechanism of transportation, which is more associated with the finest soil materials of the Nile sediments. In addition, some of the studied soil deposits developed on El-Fayoum alluvial plain unit (profile No. 7) are transported in suspension suites of uniform, graded and pelagic suspensions. On the other hand, the mechanism of transportation for soil deposits developed on piedmont, desert alluvial terraces, El-Fayoum alluvial plain units are represented by many mechanism of transportations, *i.e.,* rolling, rolling & suspension and uniform or pelagic suspension & rolling.

3. Soil profile uniformity and development

Some identified heavy mineral assemblages of sand separate sized 0.125-0.063 mm are used as a tool to evaluate soil profile uniformity and development, which are accomplished through the petrographical examination, *i.e.,* pyroboles (pyroxenes, and amphiboles) and ubibuitous minerals (zircon, rutile and tourmaline). The obtained data in Table 4 indicate that the noticeable variations of the studied heavy minerals distribution either throughout the profile layers or along the studied soil sites could be attributed to the representative soil profiles are characterized by either multi-origin (heterogeneous soil parent materials) or multi-depositional regimes. These findings are emphasized by the pronounced variations in the data obtained from soil uniformity ratios (ratios of resistant minerals, *i.e.,* Zr/T, Zr/R and Zr/T+R).

TABLE 3. Sorting coefficient, media of transportation or deposition and mechanism of transportation for the studied soil profiles.

Physiographic units	Profile No.	Depth (cm)	Sorting		Media of transportation and deposition	One percentile		Median		Mechanism of transportation
			Phi	Indication		Phi	Micron	Phi	Micron	
Piedmont	1	0-15	2.84	vps	Aqueous	-1.70	3400	1.80	300.0	Rolling
		15-45	2.13	vps		-1.80	3600	-1.00	2000	
	2	0-20	3.63	vps		-1.40	2800	3.00	125.0	Rolling & Suspension
		20-45	3.56	vps		-1.50	3000	2.70	162.0	
		45-75	3.48	vps		-1.60	3200	1.70	325.0	Rolling
Alluvial terraces, locally overblown sands	3	0-25	3.63	vps		-1.4	2800	3.00	125.0	Rolling & Suspension
		25-55	3.52	vps		-1.50	3000	5.00	31.2	Uniform suspension & Rolling
		55-105	2.99	vps		-1.20	2400	7.00	7.8	Pelagic suspension& Rolling
		105-150	2.56	vps		-1.50	3000	2.50	187.5	Rolling
	4	0-15	4.10	exps		-1.50	3000	3.00	125.0	Rolling & Suspension
		15-50	3.48	vps		-1.60	3200	1.70	325.0	Rolling
		50-95	2.84	vps		-1.60	3200	1.80	300.0	
		95-150	4.12	exps		-1.50	3000	3.00	125.0	Rolling & Suspension
	5	0-20	2.39	vps		-1.60	3200	1.20	450.0	Rolling
		20-65	2.13	vps		-1.80	3600	-1.00	2000	
		65-95	2.28	vps		-1.70	3400	-0.30	1300	
		95-150	1.60	ps		-1.70	3400	-1.10	2200	
	6	0-30	0.68	ms	Aeolian & Aqueous	-0.30	1300	2.70	162.5	Rolling & Suspension
		30-85	0.65	ms		0.52	697	1.70	308.0	Suspension & Rolling
		85-150	0.68	ms		-0.30	1300	1.80	300.0	Rolling
El-Fayoum alluvial plain locally terraced	7	0-35	2.93	vps	Aqueous	1.04	489	4.26	52.2	Uniform suspension
		35-75	3.34	vps		0.00	1000	2.91	133.0	Graded suspension
		75-110	3.27	vps		0.26	835	8.13	3.6	Pelagic suspension
		110-150	2.07	vps		1.26	418	9.35	1.5	
	8	0-25	3.34	vps		0.00	1000	2.91	133.0	Rolling & Suspension
		25-80	0.75	ms	Aeolian & Aqueous	0.39	763	1.48	358.0	Suspension & Rolling
		80-150	0.68	ms		0.52	697	1.70	308.0	
El-Fayoum alluvial fan	9	0-25	2.46	vps	Aqueous	1.91	266	8.87	2.1	Pelagic suspension
		25-80	3.16	vps		2.00	250	8.91	2.1	
		80-120	3.14	vps		2.35	196	8.96	2.0	
		120-150	2.69	vps		1.26	418	8.13	3.6	
	10	0-20	1.34	ps		1.65	319	9.39	1.5	
		20-60	1.97	ps		1.52	349	9.13	1.8	
		60-100	2.56	vps		1.26	418	9.04	1.9	
		100-150	2.32	vps		2.30	203	8.09	3.7	
Nile alluvial depressed plain (River bed)	11	0-15	3.14	vps		0.30	812	9.04	1.90	
		15-50	1.83	ps		2.00	250	9.22	1.70	
		50-100	1.41	ps		2.74	150	9.35	1.50	
		100-150	1.39	ps		2.91	133	9.52	1.40	
Nile alluvial flat plain	12	0-25	3.14	vps		0.30	812	9.22	1.70	
		25-60	3.01	vps		0.43	742	9.09	1.80	
		60-90	3.21	vps		0.26	835	8.96	2.00	
		90-150	3.16	vps		0.35	785	8.91	2.10	

Aqueous=soil materials transported by water, *i.e.*, exps=extremely poorly sorted (>4.0), vps=very poorly sorted (4.0-2.0) and ps=poorly sorted (2.0-1.0) vs Aeolian=soil materials transported by wind and water, *i.e.*, ms=moderately sorted (1.0-0.5).

TABLE 4. Frequency of some heavy minerals (pyrobole, ubibuitous and biotite), uniformity ratios and weathering values of some representative soil profiles.

Physiographic units	Profile No.	Depth (cm)	Pyroboles %		Ubibuitous minerals %			Biotite % (B)	Uniformity ratios			Weathering values		
			Amphiboles (A)	Pyroxenes (P)	Zircon (Z0	Tourmaline (T)	Rutile (R)		Z/T	Z/R	Z/T+R	Wr_1 (A/Z+T)	Wr^2 (A+P/Z+T)	Wr_3 (B?Z+T)
Piedmont	2	0-20	21.45	26.07	12.51	4.40	6.55	10.80	2.84	1.91	1.14	1.27	**2.81**	**0.64**
		20-45	22.61	23.23	10.40	4.00	7.70	7.75	2.60	1.35	0.89	1.57	**3.18**	**0.54**
		45-75	24.25	25.46	13.70	3.80	6.11	8.60	3.60	2.24	1.38	1.39	2.78	**0.49**
Alluvial terraces, locally overblown sands	3	0-25	25.70	29.57	8.91	2.90	7.60	5.84	3.07	1.17	0.85	**2.18**	**4.68**	**0.49**
		25-55	23.53	27.20	11.64	2.65	8.79	7.22	4.39	1.32	1.02	1.65	3.55	**0.51**
		55-105	25.15	28.41	9.05	3.00	6.35	5.95	3.02	1.42	0.97	2.09	4.44	**0.49**
		105-150	24.47	25.90	7.25	2.70	7.56	6.70	2.69	0.96	0.71	2.46	5.06	**0.67**
	6	0-30	18.02	20.62	5.85	3.76	2.38	1.45	1.56	2.46	0.95	**1.87**	**4.02**	**0.15**
		30-85	17.14	19.25	6.14	4.09	2.47	1.20	1.50	2.49	0.93	**1.68**	**3.58**	**0.12**
		85-150	16.67	15.10	6.78	4.20	2.85	1.31	1.61	2.38	0.97	1.52	2.89	**0.12**
El-Fayoum alluvial plain, locally terraced	7	0-35	19.56	22.40	9.47	4.90	5.45	4.20	1.93	1.74	0.91	**1.36**	**2.92**	**0.29**
		35-75	20.32	23.70	10.00	5.25	3.30	3.34	1.90	3.03	1.17	1.33	**2.89**	**0.22**
		75-110	21.07	24.61	9.85	7.10	4.75	4.15	1.39	2.07	**0.83**	**1.24**	**2.69**	**0.24**
		110-150	22.95	25.82	7.92	6.05	3.20	2.98	1.31	2.47	**0.86**	**1.64**	**3.49**	**0.21**
El-Fayoum alluvial fan	9	0-25	17.63	11.08	5.97	3.74	1.89	0.85	1.60	3.16	1.06	1.82	2.95	**0.19**
		25-80	16.25	13.72	6.36	3.95	2.05	0.64	1.61	3.10	1.06	**1.58**	**2.89**	**0.06**
		80-120	14.81	12.60	6.78	4.10	2.16	0.56	1.65	3.19	1.08	1.36	2.52	**0.05**
		120-150	12.40	9.55	7.12	4.47	2.34	0.48	1.59	3:04	1.05	**1.07**	**1.89**	**0.04**
Nile alluvial depressed plain (River bed)	11	0-15	13.45	14.35	8.32	3.45	2.05	0.72	2.41	4.06	**1.51**	**1.14**	**2.36**	**0.06**
		15-50	10.90	11.79	7.89	3.67	1.91	0.55	2.15	4.13	**1.41**	**0.94**	**1.96**	**0.05**
		50-100	8.05	9.85	8.21	3.50	1.83	0.42	2.16	**4.48**	**1.54**	**0.69**	**1.53**	**0.04**
		100-150	7.81	8.64	7.95	3.92	1.77	0.37	2.34	4.49	**1.40**	**0.65**	**1.38**	**0.03**
Nile alluvial flat plain	12	0-25	15.75	13.31	7.48	2.97	2.25	1.35	2.52	3.32	1.46	1.51	2.78	**0.13**
		25-60	13.63	14.80	7.65	3.10	2.39	1.10	2.47	**3.20**	**1.39**	**1.27**	**2.64**	**0.10**
		60-90	10.56	11.72	7.76	3.24	2.45	1.29	2.39	3.16	1.36	**0.96**	**2.03**	**0.12**
		90-150	9.82	8.95	7.93	3.56	2.15	1.30	2.23	3.67	1.38	**0.85**	**1.63**	**0.11**

In general, the obtained values of uniformity indices for the resistance minerals are rather unlikely without any specific trend either amongst profile layers or soil sites developed on piedmont, desert alluvial terraces (except soil site No. 6), El-Fayoum alluvial plain units, indicating the stratification of parent materials as well as the multi-depositional regimes, which may result within different geochemical weathering conditions. Whereas, the deposits of each soil profile developed on both El-Fayoum alluvial fan and the Nile alluvial plain units besides soil site No. 6 of desert alluvial terraces poses an almost uniform parent material as well as depositional regime.

It is well known that pyroboles (pyroxenes, and amphiboles) and mica biotite are relatively low resistable or assessable minerals; hence their ratios to the relatively high resistance ones (zircon, rutile and tourmaline) are quite helpful in assessing weathering conditions, consequently soil profile development. Data in Table 4 show that the presence of assessable minerals in high percentages; either along the studied soil sites or throughout the profile layers in piedmont, desert alluvial terraces and El-Fayoum plain units; is more related with deriving high weathering values and relatively low intensity of weathering conditions. Such criteria can be taken as an indication of the immature soil conditions or recent soil deposits. On the other hand, some soil profiles, particularly those developed on both El-Fayoum alluvial fan and the Nile alluvial plain units, exhibited a considerably developed phase, probably due to the occurrence of some pedogenetic features.

4. Soil fertility as expressed by essential nutrients status

Soil fertility status is generally judged by its capacity to supply plant nutrients which being governed by several factors, *i.e.,* nature of the studied soil sediments. Judging from the previous item, a great attention should be focused upon the different soil morphological features and physio-chemical properties as related to the aspects of soil fertility, especially those affected positive or negative influence on releasing the nutritive elements from the prevailing mineral resources as well as their availability for plants. Data of total and available contents of the studied macro and micronutrients for the different soil sites under consideration (Table 5), reveal that the studied soil characteristics give typical models to define the relation between soil fertility aspects and the nature of soil sediments as well as influence of the prevailing soil characteristics and environmental conditions. In general, soil texture of as a remnant characteristic is not only affects the distribution pattern of nutrient-bearing minerals throughout the different soil mechanical fractions, but also affects plant roots penetration capability and nutrients status; in terms of released rate, distribution and available content. That was true, since this study showed that both silt and clay fractions, to a large extent, provided a clear indication about the capacity of soil to adsorb or release nutrients for plant roots.

Visualizing soil chemical properties under study, data give a clear picture about a close relationship between the origin of soil sediments and soil variables such as soil pH, salinity (ECe) and/or alkalinity (ESP) conditions, cation exchange capacity, organic matter, $CaCO_3$ and gypsum contents, which could shed some lights on the availability and behavior of plant nutrients, especially phosphorus and micronutrients. The data obtained confirmed the aforementioned trends, neverthiles, the unsuitable conditions of relatively high values of soil pH, salinity (ECe), alkalinity (ESP) and calcareous in nature ($CaCO_3$ content) have pronounced adverse effects on nutrients availability due to their inhibitive conditions on biological activity nutrients availability in roots zone. In adition, releasing the plant nutrients from the nutrients bearing minerals is more influenced by several factors such as the intensive conditions of chemical weathering, agricultural cropping system and agro-management practices.

Another aspect of nutrients status is that related to nutrients bound with organic matter, which plays an important role in the soil fertility condition, however, it is greatly affect the soil physio-chemical properties through the behaviour of active charged surface of the humus materials. In addition, organic matter is considered as a storehouse source for the essential plant nutrients, especially micronutrients. In general, soil organic matter content is relatively high in the surface layer of soil profile as well as such condition is most likely attributed to the differences in soil agro-management practices in the arable lands, land use periods in agricultural utilization, nature of soil sediments and the prevailing local environmental conditions.

TABLE 5. Total and available contents of some nutrients in some representative soil profiles.

Profile No.	Depth (cm)	Nutrients status	Macronutrients (mg/kg)			Micronutrients (mg/kg)			
			N	P	K	Fe	Mn	Zn	Cu
Piedmont									
2	0-20	Total	66.47	203.18	5295.64	9278.35	75.91	20.17	15.36
		Available	21.34	3.18	142.75	4.42	0.87	0.65	0.43
	20-45	Total	21.42	182.53	4864.25	8167.79	68.45	17.63	13.92
		Available	9.85	2.76	125.84	3.34	0.69	0.51	0.37
Alluvial terraces, locally overblown sands									
3	0-25	Total	121.40	189.35	5736.72	13769.40	78.65	24.51	19.87
		Available	23.45	4.98	145.60	3.89	0.97	0.76	0.70
	25-55	Total	92.57	245.90	7351.95	24543.05	117.32	38.40	25.93
		Available	16.42	5.02	254.12	4.96	0.85	0.68	0.62
6	0-30	Total	55.36	73.75	2216.90	6534.85	53.40	17.25	14.70
		Available	23.15	3.97	46.87	3.25	0.83	0.73	0.42
	30-85	Total	46.71	98.48	3483.55	7024.64	62.78	19.75	15.68
		Available	16.54	4.05	75.40	2.86	0.56	0.64	0.39
El Fayoum alluvial plain, locally terraced									
7	0-35	Total	420.71	397.35	9105.84	32570.30	218.45	71.15	69.02
		Available	36.08	4.78	405.63	5.12	1.05	0.97	0.81
	35-75	Total	395.35	423.10	10154.75	34273.54	227.03	64.65	57.40
		Available	27.75	3.94	358.05	4.96	0.80	0.78	0.65
El Fayoum alluvial fan									
9	0-25	Total	1095.25	684.90	9862.47	43594.90	306.55	87.62	75.12
		Available	63.10	12.50	512.80	11.47	4.30	3.02	1.76
	25-80	Total	1022.48	643.25	1074.63	44760.35	293.46	81.57	71.90
		Available	57.45	10.67	484.95	10.20	3.15	2.34	1.48
Nile alluvial depressed plain (River bed)									
11	0-15	Total	1170.50	798.45	17145.04	54439.10	375.95	110.65	87.63
		Available	54.75	12.93	536.84	13.65	3.48	2.36	1.95
	15-50	Total	978.80	695.94	16876.36	55437.62	341.50	102.20	81.44
		Available	43.96	10.85	495.07	9.98	2.15	1.84	1.32
Nile alluvial flat plain									
12	0-25	Total	1210.46	805.70	14352.65	47165.90	349.65	105.34	81.67
		Available	62.54	15.97	587.46	16.20	4.70	3.95	2.15
	25-60	Total	1042.65	773.94	15055.73	50112.05	315.25	92.45	76.82
		Available	56.30	13.35	542.85	13.54	3.62	2.13	1.67

Data presented in Table 5 show that higher contents of total N, P and K in the studied soils are more associated with soil sediments rich in the clay and silt fractions as well as soil organic matter component, *i.e.,* El-Fayoum alluvial fan and the Nile alluvial soils of soil profile Nos. 9, 11 and 12, particularly at surface layers. The reverse was true for the virgin soils characterized by either calcareous or siliceous in nature such as profile Nos. 1-6. These results are emphasized by the statistical data of simple correlation coefficients and the contribution percentages of soil constituents (Tables 6 and 7). However, the total N, P and K showed a highly significant and positive correlation with each of clay and organic matter vs a negative correlation with total $CaCO_3$, which sometime exhibited a degree of significance with any of these nutrients. It is noteworthy to mention that the total N and P contents in the different studied soil sediments were, in general, relatively high in the surface layers of the studied soil sites where the organic materials are relatively abundant. This denotes to its role as a nutrient-source. This was true, since their contents tended to lessen with increasing the soil depth, which was contemporary associated with a decrease in soil organic matter content.

TABLE 6. Simple correlation coefficients between some soil characteristics and both total and available nutrient contents.

Soil characteristics	Macronutrients in mg kg^{-1}			Macronutrients in mg kg^{-1}			
	N	P	K	Fe	Mn	Zn	Cu
Total contents							
Clay %	0.894**	0.944**	0.798**	0.983**	0.962**	0.960**	0.948**
Silt %	0.376	0.389	0.460	0.412	0.412	0.410	0.471
Sand %	-0.885**	-0.931**	-0.710**	-0.967**	-0.946**	-0.943**	-0.945**
Total $CaCO_3$%	-0.582*	-0.592*	-0.316	-0.502	-0.502	-0.509	-0.508
$CaSO_4.2H_2O$ %	-0.476	-0.399	-0.279	-0.485	-0.461	-0.488	-0.493
Organic matter%	0.921**	0.916**	0.729**	0.879**	0.879**	0.879**	0.847**
ECe (dS m^{-1})	-0.339	-0.283	-0.075	-0.008	-0.217	-0.183	-0.225
Available contents							
Clay %	0.802**	0.792**	0.956**	0.812**	0.726	0.712**	0.825**
Silt %	0.290	0.336	0.313	0.389	0.296	0.237	0.419
Sand %	-0.835**	-0.783**	-0.966**	-0.798**	-0.736**	-0.725**	-0.816**
Total $CaCO_3$%	-0.560*	-0.597*	-0.416	-0.549*	-0.560*	-0.551*	-0.548*
$CaSO_4.2H_2O$ %	-0.535*	-0.486	-0.422	-0.418	-0.395	-0.417	-0.466
Organic matter%	0.910**	0.954**	0.884**	0.975**	0.948**	0.938**	0.965**
ECe (dS m^{-1})	-0.435	-0.312	-0.174	-0.318	-0.407	-0.407	-0.289
pH (1:2.5)	-0.444	-0.610*	-0.202	-0.577*	-0.584*	-0.569*	-0.590*
CEC (C molc kg^{-1} soil)	0.888**	0.918**	0.929**	0.913**	0.850**	0.826**	0.915**
Soil sodicity (ESP)	-0.650*	-0.608*	-0.789**	-0.580*	-0.516	-0.521	-0.662**

**Correlation is significant at the 0.01 level and * Correlation is significant at the 0.05 level.

As for the distribution available N, P and K fractions, data obtained indicate that the greatest values are more related to the fine fractions, *i.e.,* clay followed by silt in exchangeable forms, as well as organic matter component. The maximum values of their available contents were more associated with the fine texture soil of the Nile alluvial sediments, while a relatively smaller proportion of the total store of NPK is potentially available for mineralization in the soils with higher clay content (Tables 2 and 7). Such effects are often ascribed to the different physical properties, which are mainly associated with the soil texture. This may be affecting the substrate availability to microorganisms and thus the mineralization rates (Jensen, 1994). The obtained data showed a highly significant positive correlation was detected between the studied available nutrient contents and each of clay content, organic matter content and cation exchange capacity. Whereas, a significant negative correlation between the studied available nutrient contents and each of total $CaCO_3$, soil pH and sodicity was observed.

TABLE 7. Contribution percentages of some soil variables constituents* on both the studied total and available nutrients.

Nutrient	Parameter	Constant	Soil variables %					Total %	
			Clay	Sand	Organic matter	$CaSO_4.2H_2O$	$CaCO_3$	R^2	Residual
Total contents									
N	B	-77.733	17.960	---	242.515	---	---	96.0	4.0
	R^2	---	21.9	---	74.1	---	---		
P	B	366.988	5.483	-3.332	135.575	8.888	-28.136	98.9	1.1
	R^2	---	30.8	2.3	15.9	2.1	47.8		
K	B	1026.118	228.935	208.202	---	---	---	77.7	22.3
	R^2	---	60.7	17.0	---	---	---		
Fe	B	328.333	909.047	---	---	-470.471	-148.760	99.0	1.0
	R^2	---	95.4	---	---	2.9	0.7		
Mn	B	26.426	4.763	---	41.345	---	-1.307	98.3	1.7
	R^2	---	91.9	---	4.9	---	1.5		
Zn	B	7.636	1.324	---	14.088	-1.133	---	98.4	1.6
	R^2	---	91.4	---	5.1	1.9	---		
Cu	B	8.794	1.418	---	---	---	-0.516	93.3	6.7
	R^2	---	89.0	---	---	---	4.3		
Available contents									
Nutrient	Parameter	Constant	Soil variables					Total %	
			Clay	Sand	Organic matter	CEC	pH	R^2	Residual
N	B	17.898	---	---	22.422	---	---	81.3	18.7
	R^2	---	---	---	81.3	---	---		
P	B	3.404	-0.119	---	3.439	0.231	---	97.3	2.7
	R^2	---	2.8	---	90.2	4.3	---		
K	B	508.186	---	-4.931	90.909	---	---	98.6	1.4
	R^2	---	---	92.8	5.8	---	---		
Fe	B	21.611	---	---	3.808	0.081	-2.422	98.2	1.8
	R^2	---	---	---	94.8	2.7	0.7		
Mn	B	0.457	---	---	1.850	---	---	89.1	10.9
	R^2	---	---	---	89.1	---	---		
Zn	B	0.432	---	---	1.310	---	---	87.0	13
	R^2	---	---	---	87.0	---	---		
Cu	B	0.287	---	---	0.555	0.013	---	95.9	4.1
	R^2	---	---	---	92.5	3.4	---		

Using the program of SPSS (2003).

Data in Table 7 showed that the contribution of organic P sources to soil fertility was directly related to the amount of organic matter in the soil (Deenik & Yost, 2006). The content of total P may also reduce presumably due to its adsorption on the surface of $CaCO_3$ particles and/or precipitation due the reaction with soluble Ca, besides the relatively high soil pH. The lowest available P amount was detected in a virgin soils developed the Eocene limestone (soil profile Nos. 1, 2, 3, 4 and 7), probably due to the relatively high content of $CaCO_3$. The relatively high amounts of available K in the surface layer of the Nile alluvial sediments (El-Fayoum alluvial fan and the Nile alluvial plain) could be mainly attributed to the relatively high content of bounded K-organic and K-exchangeable fractions. An interesting observation on the content of available K in relation to soil texture was noticed as the clay fraction showed substantially higher concentrations of adsorbed potassium than the sandy soils (Pal *et al.*, 1999). These authors claimed that potassium introduced into the soil is subjected to fixation by the finest fraction of the solid phase. Such relationships are emphasized by the statistical data, Tables (6 and7), which exhibited a significant positive correlation between each of clay and organic matter on one hand and the available potassium on the other hand.

Data in Table 5 showed that the amounts of micronutrients under study represent very small fractions of the detected total amounts. In addition, the relatively high amounts of available forms are mainly attributed to the relatively high contents of the nutrient-bearing minerals, which are predominated in the different soil mechanical fractions as recorded in the Nile alluvial sediments. While, the lowest available amounts are associated with the soils characterized by either calcareous or siliceous in nature, may be attributed to the predominant of $CaCO_3$ and quartz, which are poorer in nutrient contents. The later are dominated in the relatively coarse texture soils developed on both piedmont and desertic alluvial terraces of skeletal nature being of a very poor ability for micronutrients retention. In this connection, Obrador *et al.* (2007) pointed out those micronutrients availability may be limited by the amounts of both clay and $CaCO_3$ present in soils as well as associated high soil pH, which inversely affect micronutrients availability.

It is quite clear that the studied total and available micronutrient contents of Fe, Mn, Zn and Cu were more bounded with the exchangeable form on both the inorganic colloids and organic matter fractions. This is true, since the statistical results in Tables 6 and 7 showed a significant positive correlation between the studied both total and available micronutrients and each of clay and organic matter contents. The statistical data indicated that there are significant positive correlations between the studied available micronutrient contents and both of clay and organic matter contents, but there was a significant negative correlation between available micronutrient contents manganese and both of soil pH and total $CaCO_3$.

5. Land suitability for certain crops

The physiographic-soil map was used as a base for presenting land suitability classes. The simple approach that proposed by Sys (1991) was selected for land suitability evaluation of the studied area, since it is valid for irrigation purposes in arid and semi arid regions. By this approach, the classification was processed according to the framework of FAO (1976), at the level of subclasses. Ratings, attributed to land qualities, were matched with each crop requirements. The land qualities are drainage (d), soil texture (x), stoniness (g, gravel %), soil depth (p), calcium carbonate % (c), salinity (s, ECe), sodicity (n, ESP) and fertility (f). Fertility ratings attributed to soil reaction (pH), cation exchange capacity (CEC) and sum of basic cations (exchangeable Ca, Mg and K). Suitability subclasses in Tables 8 and 9 reflect the kind of limitations as indicated in symbols, using lower-case letters synonymous with those limitations when any of them is moderate. Severe or very severe limitation in the case of slight limitation, it is expressed as minor limitation (m) what ever they are.

Land suitability for agricultural irrigated soils is the appraisal of specific areas of land from a general point of view without mentioning the specific kind of use. So, some soils may be suitable for a specific crop and unsuitable for another. The ideal approach for land evaluation is based on evaluating the land for utilization types which used as guides for the most beneficial use for a specific productivity by replacing a less adapted land utilization type by another promising one, and was applied in this study according to Sys (1991). The evaluation indices of land characteristics are done by rating them and specifying their limitations for certain crops by matching the calculated rating with the crop requirements in different suitability levels as proposed by Sys *et al.* (1993).

a. Current land suitability classification (Cs)

In the studied area, without major land improvements, the crop requirements were matched with the present land qualities for processing the current land suitability of the different land units. This approach enables management of different alternatives for specific utilizations that are adapted to the existing limitations to give maximum output. The current land suitability classification of different physiographic units for the different specific utilizations are shown in Tables 8 and 9.

b. Potential land suitability classification (Ps)

As for this purpose, the land utilization is applicable after executing specified major land improvements as proposed in the current study according to their necessity

Potential land suitability classification can be established if the main improvements for the studied area are considered regarding land qualities of drainage, salinity and sodicity. The potential land suitability classification of different physiographic units for the different specific utilizations are shown in Tables 8 and 9 for the studied area. The obtained potential land suitability subclasses were sorted in two productive levels. These two levels were designed to be guide charts for the best land utilization alternatives giving a possible maximum output. The two potential land suitability levels are as follows:

TABLE 8. Current and potential suitability of the soils developed on the identified physiographic units for field, oil and fodder crops.

Physiographic unit	Profile No.	Field crops								Oil crops				Fodder crops			
		Wheat		Barley		Maize		Cotton		Sesame		Sunflower		Alfalfa		Sorghum	
		CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS
Piedmont	1	N2g s	S3xgc	N2gs	S3xgc	N2gcs	N2c	N2gcs	N2gc	N2s	S3gp	N2gcs	N2gpc	N2gs	N2gc	N2gs	S3gxc
	2	N2s	S3xy	S3xys	S3xy	N2s	S3cy	S3cys	S3xy	N2s	S2x	N2s	S3cy	N2s	S3cy	S3s	S3y
Alluvial terraces, locally overblown sands	3	N2s	S3x	N2s	S2m	N2s	S2xc	N2s	S2c	N2s	S2m	N2s	S2c	N2s	S2m	N2s	S2m
	4	N2s	S2m	N2s	S2m	N2s	S2c	N2s	S2m	N2s	S2m	N2s	S2cy	N2s	S2m	N2s	S1m
	5	N2s	S3x	S3x	S3x	N1s	S3x	S3xs	S3x	N2s	S3g	N2s	S3xg	N1s	S3x	S3x s	S3x
	6	N2x	N2x	N2x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x	S3x
El-Fayoum alluvial plain, locally terraced	7	N2s	S3s	S3s	S1m	N2s	S3c	N1s	S2m	N2s	S1m	N1s	S2m	N2s	S2m	N1s	S2m
	8	S3x	S3x	S1m	S1	S2m	S2m	S3x	S3x	S2x	S2x	S2x	S2x	S2x	S2x	S3x	S3x
El-Fayoum alluvial fan	9	S1m	S1	S1m	S1	S1m	S1	S1m	S1	S2x	S2x	S1m	S1	S1m	S1	S1m	S1
	10	S1m	S1	S1m	S1	S1m	S1	S1m	S1	S1m	S1m	S1m	S1	S1m	S1	S1m	S1
Nile alluvial depressed plain	11	N2s	S1	S3s	S1	N1s	S1	N1s	S1	N1s	S3x	N1s	S1m	N2s	S1	N2s	S1m
Nile alluvial flat plain	12	S1	S1	S1	S1	S1	S1	S1	S1	S2x	S2x	S1	S1	S1	S1	S1	S1

TABLE 9. Current and potential suitability of soils developed on the identified physiographic units for vegetable crops and fruit trees.

Physiographic unit	Profile No.	Vegetable crops				Fruit trees											
		Onion		Tomato		Banana		Citrus		Guava		Mango		Oil palm		Olive	
		CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS
Piedmont	1	N2gcys	N2gcy	N2pcys	N2gpcy	N2gpcs	N2gpc	N2pcys	N2gpcy	N2s	S2m	N2pcys	N2gpcy	N2cys	N2cy	N2p s	N2p
	2	N2cys	N2cy	N2cys	N2cy	N2cys	N2cy	N2cys	N2cy	N2s	S2m	N2cys	N2cy	N2cys	N2cy	N2p	N2p
Alluvial terraces, locally overblown sands	3	N2cs	N2c	N2s	S3c	N2cs	N2c	N2cs	S3c	N2s	S2m	N2s	N2c	N2cs	N2c	N2s	S1y
	4	N2s	S3c	N2s	S3cy	N2cs	N2c	N2s	S3cy	N2s	S2m	N2s	S3cy	N2cys	N2cy	N2s	S1m
	5	N1s	S2c	N2s	S3x	N2s	S3x	N2s	S2x	N2s	S3x	N2s	S2m	N2s	S3xc	S2s	S1m
	6	S3x	S3x	S3x	S3x	N2x	N2x	S2x	S2x	S3x	S3x	S3x	S3x	N2x	N2x	S3x	S3x
El-Fayoum alluvial plain, locally terraced	7	N2cs	N2c	N2s	S3c	N2c	N2c	N2s	S3cy	N2s	S2m	N2s	S3cy	N2cys	N2cy	S3s	S2m
	8	S2x	S2x	S3x	S3x	S3x	S3x	S2m	S2m	S2m	S2m	S2x	S2x	S3x	S3x	S1m	S1m
El-Fayoum alluvial fan	9	S2x	S2x	S1m	S1	S3n	S1m	S2m	S2m	S2m	S2m	S2x	S2x	S2c	S2c	S2m	S2m
	10	S2x	S2x	S1	S1	S2n	S1m	S2m	S2m	S2m	S2m	S2x	S2x	S2c	S2c	S2m	S2m
Nile alluvial depressed plain	11	N2s	S3x	N2s	S1m	N2sn	S1m	N2s	S2m	N2s	S2m	N2s	S2x	N2s	S2c	S3s	S2m
Nile alluvial flat plain	12	S1m	S1	S2m	S1	S3n	S1m	S2m	S2m	S1m	S1m	S2x	S2x	S2c	S2c	S1m	S1

CS=Current suitability, PS=Potential suitability, S1=Highly suitable, S2=Moderately suitable, S3=Marginally suitable, N1=Currently not suitable, N2=Potentially not suitable

[Soil limitations: d=drainage, x=texture, g=gravel%, p=soil depth, c=calcium carbonate %, y=gypsum %, s=salinity (EC), n=ESP, m= accumulation of minor limitations].

Supreme potential suitability for specific utilizations

Matching charts for the supreme potential suitability for specific utilizations with the different physiographic units of the current study are shown in Tables 6 and 7. The resultant adaptations are as follows:

Highly suitable (S1) adaptations

a. Some soil sites of the alluvial terraces, locally overblown sands unit are suitable for sorghum and olives.

b. Some soil sites of El-Fayoum alluvial plain, locally terraced unit are suitable for barley, sesame and olives.

c. Some soil sites of El-Fayoum alluvial fan unit are suitable for wheat, barley, maize, cotton, sesame, sunflower, alfalfa, sorghum, tomato and banana.

d. Some soil sites of the Nile alluvial depressed plain unit are suitable for wheat, barley, maize, cotton, sunflower, alfalfa, sorghum, tomato and banana.

e. Some soil sites of the Nile alluvial flat plain unit are suitable for wheat, barley, maize, cotton, sunflower, alfalfa, sorghum, onion, tomato, banana, guava and olives.

Moderately suitable (S2) adaptations

a. Soils of the piedmont unit are suitable for sesame and guava.

Subsequent prior potential suitability for specific utilizations

Moderately suitable (S2) adaptations

a. Some soil sites of the alluvial terraces, locally overblown sands are suitable for wheat, barley, maize, cotton, sesame, sunflower, alfalfa, sorghum, onion, citrus, guava, mango and oil palm.

b. Some soil sites of El-Fayoum alluvial plain, locally terraced unit are suitable for maize, cotton, sunflower, alfalfa, sorghum, onion, citrus, guava, mango and olives.

c. Some soil sites of El-Fayoum alluvial fan unit are suitable for onion, citrus, guava, mango, oil palm and olives.

d. Some soil sites of the Nile alluvial depressed plain unit are suitable for citrus, guava, mango, oil palm and olives.

e. Some soil sites of the Nile alluvial flat plain unit are suitable for sesame, citrus, mango and oil palm.

Marginally suitable (S3) adaptations

a. Some soil sites of the piedmont unit are suitable for wheat, barley, maize, cotton, sesame, sunflower, alfalfa and sorghum.

b. Some soil sites of the alluvial terraces, locally overblown sands are suitable for wheat, barley, maize, cotton, sesame, sunflower, alfalfa, sorghum, onion, tomato, banana, citrus, guava, mango and oil palm and olives.

c. Some soil sites of El-Fayoum alluvial plain, locally terraced unit are suitable for wheat, maize, cotton, sesame, sorghum, tomato, banana, citrus, mango and oil palm.

d. Some soil sites of the Nile alluvial depressed plain unit are suitable for sesame and onion.

Finally, it can be concluded that the data of this study are created to update and support the local knowledge, particularly the best use of land whether be under demand for agriculture use or be planned for later on use. That means the obtained results represent the best adaptation between certain land units with specific soil properties to give the maximum outputs from the agricultural utilization projects. Also, identifying the physiographic-soil features of a unique area in the desert belt between El-Fayoum depression and the Nile Valley at Beni-Suef Governorate by mapping them to be a model is in a harmony of physiographic and soil data set, serving the extrapolation approach when other areas will be under study

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نمط الترسيب، الحالة الخصوبية و الصلاحية للزراعة بمحاصيل معينة لأراضى الوحدات الفيزيوجرافية فى النطاق الصحراوى بين منخفض الفيوم ووادى نهر النيل - مصر

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تعتبر هذه الدراسة محاولة لإعطاء معلومة عن عوامل التربة والظروف البيئية المؤثرة على نمط ترسيب مادة التربة وتطور قطاعها الأرضى ومدى صلاحيتها للزراعة بمحاصيل معينة فى منطقة النطاق الصحراوى بين منخفض الفيوم ووادى نهر النيل عند محافظة بنى سويف - مصر. حيث تمثل هذه الدراسات أركانا رئيسية للمعايير الهامة التى تساعد فى التخطيط لبرامج التنمية الزراعية الحالية والمستقبلية لمثل هذه الأراضى الصحراوية الواعدة والمتاخمة للطريق الصحراى القاهرة - أسيوط ومن الضرورة إعداد هذه الدراسات الأولية لتقييم القدرة الكامنة للتربة وتحديد أفضل عمليات الخدمة لصيانتها وتعزيز إستدامتها فى مجال الزراعة على المدى القصير والطويل.

وقد تم تحديد الوحدات الفيزيوجرافية فى منطقة الدراسة باستخدام التفسير المرئى لصور الأقمار الفضائية Landsat TM band 742، والتى يمكن حصرها فى سبعة وحدات رئيسية هى:

1. Piedmont, 2. Alluvial terraces (locally overblown sands), 3. El-Fayoum alluvial plain (locally terraced), 4. El-Fayoum alluvial fan, 5. Nile alluvial depressed plain (River bed), 6. Nile alluvial flat plain and 7. Rock structures.

وتشير نتائج الدراسة الحقلية إلى أن العمق الفعال للتربة وصل إلى ١٥٠ سم فأكثر، فيما عدا بعض المواقع المحددة بتواجد الصخر الأصلى على بعد ٤٥-٧٥ سم، كما وأن الأراضى موضع الدراسة تتميز بدرجات متباينة من قوام التربة (رملى، رملى طميى، طميى رملى، طميى طينى رملى، طميى طينى، طينى) مع تواجد الحصى والفتات الصخرية الناتجة من تجوية الصخر الجيرى والمنتشرة على سطح التربة أو داخل بعض قطاعات التربة الصحراوية وأيضا توجد التكوينات الجيرية والجبسية البيدوجينية الثانوية التكوين والتى تميز الآفاق التشخيصية فى بعض القطاعات الأرضية.

وتوضح نتائج قيم أدلة تجانس القطاع الأرضى المحسوبة أن هناك تجانس جزئى لمادة التربة فى بعض مواقع التربة المتكونة على وحدات Desert alluvial terraces and El-Fayoum alluvial plain والمنقولة تحت تأثير عاملى المياه والرياح، بينما أعطت رسوبيات بعض الأراضى المتكونة على El-Fayoum alluvial plain, El-Fayoum alluvial Fan and the Nile alluvial plain units دلالة على عدم تجانس ورداءة تصنيف مادة التربة، والتى تشير إلى أنه تم نقلها وترسيبها من خلال بيئات مائية. كما وأن C-M pattern diagram يوضح أن مثل هذه الرسوبيات قد تم نقلها فى صورة مادة معلقة متجانسة الحبيبات، متدرجة فى الحجم. بينما تلك المتكونة على وحدتى Piedmont, desert alluvial terraces بالإضافة إلى وحدة El-Fayoum alluvial plain فان رسوبياتها تم نقلها فى صورة زاحفة أو متدحرجة أو صورة مشتركة (متدحرجة- معلقة).

وغالبا ما ترجع الإختلافات فى المعادن الخفيفة والثقيلة لمكون الرمل إلى طبيعة مادة أصل التربة التى تكونت منها والتى يمكن تأكيدها من خلال تعدد مواد الأصل أو تباين فى بيئة ترسيب مادة التربة. وكذلك فان الإرتفاع النسبى فى قيم المعادن القابلة للتجوية خلال طبقات القطاع فى الأراضى المتكونة على وحدات Piedmont, desert alluvial terraces and El-Fayoum plain والمصاحب بارتفاع فى قيم التجوية وإنخفاض فى شدة التجوية يمكن أن يكون دلالة على حالة عدم نضج الأراضى، والعكس صحيح بالنسبة لمواقع أرضية أخرى. بينما بعض القطاعات الأرضية خاصة تلك المتكونة على الوحدات الفيزيوجرافية El-Fayoum alluvial fan and the Nile alluvial plain تظهر حالة من التقدم الملحوظ لتواجد بعض المظاهر البيدوجينية.

وتحدد حالة خصوبة التربة من خلال تقدير المحتوى الكلى والميسر من المغذيات النباتية فى التربة (N, P, K, Fe, Mn, Zn and Cu) وعلاقته بخصائص التربة الطبيعية والكيميائية (القوام، الرقم الهيدروجينى، الملوحة، المادة العضوية، الكربونات، الجبس، السعة التبادلية الكاتيونية، النسبة المئوية للصوديوم المتبادل). ومثل هذه العلاقة أعطت أنماط واضحة لمختلف المواقع الأرضية تحت الظروف البيئية السائدة، وقد تأكد ذلك إحصائيا من النتائج المتحصل عليها من نتائج الـ Stepwise والتى تم تحقيقها باستخدام برنامج SPSS (1997). وتظهر حالة المغذيات تباينا كبيرا معتمدا على المعادن الحاملة للمغذيات السائدة فى مجموعات التربة الحجمية (الطين، السلت، الرمل)، كذا المحتوى من $CaCO_3$ والمادة العضوية وقيم pH التربة. ويعتبر هذا صحيحا لأن المحتوى المرتفع من المغذيات كان مصاحبا للأراضى ذات المحتوى المرتفع من الطين والمادة العضوية.

وقد تم عمل توافق بين التقييم الكمى للتربة وإحتياجات ستة عشر محصولا معينا (حاصلات حقلية، زيتية، أعلاف، خضر، فاكهة) لتحديد المواءمات الحالية لإمكانية زراعتها باراضى الوحدات الفيزيوجرافية تحت الدراسة، وكذا المستقبلية (الكامنة بعد معالجة المعوقات التى يمكن التعامل معها) طبقا لأفضلية الحاصلات والتالية لها من حيث الأهمية باستثناء الأراضى المتكونة على El-Fayoum alluvial fan وكذا Nile alluvial plain والتى تظهر درجات صلاحية عالية ومتوسطة، فان النتائج تشير إلى أن الأراضى المتكونة على الوحدات الفيزيوجرافية للنطاق الصحراوى غالبا غير صالحة بصورتها الحالية لزراعتها بالحاصلات المختارة فيما عدا الزيتون فى بعض المناطق المتفرقة ، وذلك يرجع أساسا إلى إرتفاع محتواها من الملوحة، الحصى، الكربونات، الجبس بجانب ضحالة عمق التربة، وعلى الجانب الأخر فان القدرة الكامنة للأراضى (الصلاحية المستقبلية) تتوقف على مدى التأقلم المستقبلى ما بين خصائص التربة وإحتياجات الحاصلات المختارة وهذا التأقلم المستقبلى بلا شك لتعظيم العائد من خلال تحسين حالة التربة خاصة فيما يتعلق بالصرف، مستويات الملوحة والصودية لتعزيز القدرة الكامنة للأراضى وإعادة تقييم أراضى مختلفة الوحدات الفيزيوجرافية تحت الدراسة بعد خلوها من تلك العوامل المعوقة للإنتاجية.