4. RESULTS AND DISCUSSION

The effect of cultivation periods on the properties of the newly reclaimed desert soils had been cleared through executing the different soil management practices as compared to the virgin soil. This work was carried out on two different soils representing the sandy and calcareous soils of El-Bustan and El-Nubariya regions, respectively. From each region, four soil profiles were selected to represent different cultivation periods, i.e., zero, 10, 20 and 30 years of cultivation..

4.1. Effect of cultivation periods on some soil physical properties:

4.1.1 Soil bulk density and total porosity:

a. Soil bulk density:

Soil bulk density is affected by different management practices such as tillage operations, crop rotation and adding of organic materials. The effect of long-term cultivation on the values of bulk density and total porosity of both the sandy and calcareous soils are presented in Tables (1 and 2) and illustrated in Figs. (1). It could be seen from these results that the soil bulk density values of the virgin soil range from 1.65 to 1.80 g/cm^3 and from 1.36 to 1.58 g/cm^3 for sandy and calcareous soils, respectively. The comparatively lower value of bulk density of El-Nubariya soil is associated with its finer soil texture as compared to that of El-Bustan coarser soil.

The data reveal that increasing cultivation periods led to improve soil bulk density, where its values tended to decrease. This was observed in both the studied sandy and calcareous soils

soil is associated with its finer soil texture as compared to that of El-Bustan coarser soil.

The data reveal that increasing cultivation periods led to improve soil bulk density where its density values tend to increase with depth. This holds true for all the soils under investigation. This pattern of increased bulk density with depth along the soil profile is mainly due to the effect of soil compaction caused by the weight of overlying layers. Also, the decrease of soil bulk density due to cultivation was more pronounced in the surface layers than in the deeper ones. The decrease in bulk density of the surface layers upon cultivation may be due to the increase in soil organic matter content and management practices.

The highest decrease in soil bulk density occurred in the soils, which cultivated for 30 years. These results are in agreement with those reported by **El-Galla (1978)**, **Moustafa (1986) and Schjonning *et al.*, (1994) who** found that soil bulk density decreased with increasing the period of soil cultivation. They attributed this decrease to the increase in soil organic matter content and management practices.

Comparison between El-Bustan and El-Nubariya areas, data show that soil bulk density values of El-Nubariya are lower than that of El- Bustan. This hold is true for both the surface and deep layers, since this variation reflects the effect of soil texture, where the texture in El- Nubariya region ranged from sandy loam to sandy clay loam, whereas the texture in El-Bustan region ranged from sand to loamy sand. Also, calcium carbonate content in El-Nubariya soil was higher than that of El- Bustan ones.

b. Total porosity:

Concerning the effect of cultivation periods on the soil porosity, data in Tables (1 and 2) and illustrated in Fig. (2) show that total porosity values increased with increasing cultivation periods for both the studied soils, i.e, cultivation practices improved soil porosity. Total porosity of the surface layer of virgin soils was 37.74% and 48.68% for sandy and calcareous soils, respectively. It increased to 44.15% and 56.27% for the 30-year cultivated sandy and calcareous soils, respectively. Also, it tends to be higher in the surface layers than in the deeper ones.

Comparing the total porosity values between El-Bustan sandy soil and El-Nubariya calcareous soil, it is quite clear that the total porosity values of El-Nubariya are higher than that of El-Bustan. This hold is true for the surface and deep layers, this variation reflects the variation in soil texture. The increase in soil total porosity is mainly related to the soil management in both regions. These results are similar to those obtained by **Eisa (1993)**, **Abdel-Razik (1995) and Ghayad (1997)** who reported that total soil porosity increased with increasing cultivation periods as a result of increasing soil organic matter content and soil management practices.

4.1.2. Hydraulic conductivity:

Generally, hydraulic conductivity is mainly affected by soil texture, depth, calcium carbonate content as well as cultivation practices **(**periods). The data of hydraulic conductivity of the soils under investigation are given in Tables (1 and 2) and illustrated in Fig. (3). The effect of soil texture on the hydraulic conductivity is distinguished by the soil at El-Nubariya region, where, the hydraulic conductivity of these soils are low in the virgin soil, but it increased with increasing the periods of cultivation.

The hydraulic conductivity of the surface layer of the calcareous virgin soil was 14.1 cm/h and increased to 16.1, 17.7 and 19.7 cm/h for the 10, 20 and 30 years cultivated soil, respectively.

Within the soil profile, there was no distinct pattern in the hydraulic conductivity values with depth. These results are in good agreement with those obtained by **Eisa (1993) and El-Dawwey (1993)**, who revealed that hydraulic conductivity of El-Nubariya soils is very low in the virgin soil, whereas it sharply increased in the soils cultivated from 2 to 10 years.

Concerning the effect of cultivation periods on sandy soil, data show that increasing the period of cultivation was associated with a decrease in hydraulic conductivity, where the hydraulic conductivity of the surface layer of virgin soil was 29.84 cm/h and decreased to 25.08, 20.05 and 16.42

cm/h in the soils which cultivated for 10, 20 and 30 years of, respectively.

Within the soil profile the hydraulic conductivity tends to increase with depth in both the virgin and cultivated soils, this may be due to long-term application of clay and organic matter on the soil surface layer. The decrease in hydraulic conductivity as a result of cultivation were reported by **El-Gazzar (1982), Abdel-Naiem *et al.*, (1986)** and **El-Dawwey (1993)** who found that increasing the period of sandy soil cultivation was associated with a decrease in its hydraulic conductivity.

Comparing El-Nubariya and El-Bustan soils the hydraulic conductivity values tend to be higher in the latter. The low hydraulic conductivity values of El-Nubariya soils are most probably due to their high content of clay fraction and calcium carbonate. The improvement of hydraulic conductivity values of both soils can be attributed to the improvement of soil structure in both soils by cultivation.

4.1.3. Structure factor:

Data in Tables (1 and 2) and illustrated in Fig. (4), show the values of structure factor for both sandy and calcareous soils as affected by different cultivation periods. In general, data reveal that increasing the cultivation period improved soil structure of both the sandy and calcareous soils in all profile layers; this may be due to the little addition of fine fraction during the management practices and irrigation.

Results show that the structure factor value in the

surface layer of the virgin sandy soil was 21.40 % and increased to 24.26, 27.86 and 30.96 % for soils cultivated for 10, 20 and 30 years, respectively. Also the structure factor value in the surface layer of the virgin calcareous soil was 34.7 % and increased to 41.4, 46.7 and 54.0 % for soils cultivated for 10, 20 and 30 years, respectively. These results are in agreement with those reported by **Amer (1991)** who mentioned that the structure factor (S.F) increased gradually in paralleled trend with increasing the period of cultivation in all the studied soils.

4.1.4. Soil moisture constants:

Soil moisture contents at the field capacity and wilting point as well as the available water range are considered of the main soil characteristics that controlling the agriculture utilization in any area, moisture contents at the first two ones can be elucidate from the soil moisture characteristic curves. Data in Tables (1 and 2) and illustrated in fig. (5, 6 and 7) show the values of soil moisture contents at field capacity, wilting point and available water content at different periods of cultivation. In general, soil moisture at the available water range for sandy and calcareous soils of El-Bustan and El-Nubariya, respectively, increased with increasing the cultivation periods. This hold is true for both surface and deep layers.The results show that the improvement in soil moisture contents at the studied three parameters in El- Nubariya soils was mainly affected by the soil texture, which considerably changes by

increasing cultivation periods. The values of field capacity in the surface layer of virgin soil was 25.50 % and increased to 27.50, 30.60 and 33.25 % for soils cultivated for 10, 20 and 30 years, respectively. Similar trend was achieved for the other two moisture contents, i.e. wilting point and available water.

It is quite clear that the rate of increase in field capacity values upon cultivation was higher than that of the wilting point, which in turn resulted in an increase in the

available water content. These increases of soil moisture constants upon cultivation are mainly attributed to the increase in soil organic matter and clay content, especially in the surface layers.

As for El-Bustan soils, soils the pattern of change in soil moisture constants was similar to that of El-Nubariya soils. Within the soil profile the soil moisture constants values tend to

decrease with depth in both calcareous and sandy soils. These results are in agreement with those reported by **Faltas *et al.*, (1986), Gouda *et al.*, (1990), Omar *et al.*, (1990) and Eisa (1993)** who studied the effect of cultivation periods on soil moisture constants of sandy soils and found that cultivation was associated with an increase in field capacity, wilting point and the available moisture content. This behaviour may be due to the fact that land use leads to a considerable increase of active interactions of soil particles, and hence improve soil aggregation.

The comparison between El-Nubariya and El-Bustun soils shows that the three moisture contents are distinctly higher in the former than in the latter. This hold is true in virgin and cultivated soils in both the surface and deep layers. The increase in soil moisture content was a reflection of the increase in soil porosity and may be due to the increment in the content of colloidal materials such as clay and organic matter which characterized by high specific surface which in turn increased soil capacity for water retention.

4.1.5. Soil texture:

The effect of cultivation periods on soil texture are presented in Tables (3 and 4) and illustrated in Figs. (8, 9, 10 and 11). Results show that the virgin sandy soil characterized by its high contents of coarse and fine sand particles and low contents of silt or clay particles. Clay contents of the virgin sandy soil were 2.80 and 2.10 % in the surface and sub-surface layers, respectively and increased to 3.2, 5.4 and 8.8 % in the surface layers, and to 3.7, 4.9 and 8.0 % the subsurface layers upon soil cultivation for 10, 20 and 30 years, respectively. Generally, the textural class changed from sand to loamy sand through 30 years of cultivation. These results are in agreement with those reported by **Abdel- Aal (1990), El-Barbary (1993), El-Dawwey (1993), Eisa (1993) Ghayad (1997)** who reported that percentage of clay increased with increasing cultivation periods; they attributed this increase to the little addition of fine fraction during the management practices.

Concerning the calcareous soil, results show that the texture of the virgin soil was a sandy loam and changed to sandy clay loam after 30 years of soil cultivation; where clay content of the virgin soil was 17.3 and 21.4 % in its surface and subsurface layers, respectively and increased to 21.0, 24.0 and 27.8 %, and to 23.2, 26.8 and 29.6 % in the surface and subsurface layers of the soils which cultivated for 10, 20 and 30 years, respectively.

These results are in agreement with those reported by **El-Dawwey (1993), Gao and Chang (1996), Eisa (1993) and Ghayad (1997)**.

4.2. Effect of cultivation periods on soil chemical properties:

4.2.1. Electrical conductivity:

Data in Tables (5 and 6) and illustrated in Fig. (12) Show the values of electrical conductivity (EC) at different cultivation periods of both the sandy and calcareous soils. As for the sandy soil, results show that the EC of the virgin sandy soil was 3.1dSm^{-1} (as a mean value), then it decreased with increasing the cultivation periods, to reach 0.68 dS/m upon soil cultivation for 30 years. This is true for both surface and subsurface layers.

Concerning the calcareous soil, results show that the pattern of change in soil salinity is similar to that of the sandy soils, where the EC of the virgin soil was 5.45 dS/m and decreased to 3.19 dS/m with increasing cultivation period for 30 years. This indicates that such soils are under adequate irrigation and drainage, therefore salinity was reduced by cultivation.

4.2.2. Soluble ctions and anions:

The data of distribution of soluble cations and anions in both the sandy and calcareous soils are presented in Tables (5 and 6). Results show that the soluble cations (Ca^{++}, Mg^{++}, Na^{+}, and K^{+}) have the same trend of EC, where, the virgin sandy and calcareous soils have the higher values, but the 30 years cultivated soils have the lower ones; soluble calcium was the dominant cation in both soils.

Concerning the distribution of soluble anions, results show that soluble sulfate decreased with increasing cultivation periods, however, it still the dominant anion in all layers of virgin and cultivated calcareous soils. Anion concentrations in the calcareous soils were in the following a descending order of $SO_4 > Cl > HCO_3$.

On other hand, no specific pattern was shown regarding anions concentrations in the sandy soils.

4.2.3. Soil pH

The effect of long-term cultivation on the pH of both sandy and calcareous soils is presented in Tables (5 and 6). Results show that there is a decrease in the pH values of both the sandy and calcareous soils due to their cultivation for different periods. The pH of the virgin sandy soil was 7.81 and decreased to 7.7 after 30 years of soil cultivation.

Concerning the calcareous soil, the pH of the virgin soil was 8.13 and decreased to 7.92 upon soil cultivation for 30 years. The decrease of pH with cultivation may be

attributed to the decomposition of organic matter and the activities of microorganisms which produce organic acids causing a decrease of soil pH. These results are in agreement with those reported by **Kumar and Yadav (1993), Sarooshi *et al.*, (1994) Abd el- Razik (1995) and Naidu *et al.*, (1996).**

4.2.4. Cation exchange capacity (CEC) and exchangeable cations:

Tables (7 and 8) and illustrated in fig. (13) show the effect of cultivation period on the (CEC) and exchangeable cations in both the sandy and calcareous soils. In general, increasing cultivation periods increased the CEC and in turn the exchangeable cations in both studied soils.

Concerning the sandy soil, results show that the cation exchange capacity of the virgin soil was 1.28 $cmol_c$ /kg soil and increased to 4.79 $cmol_c$ / kg soil and after 30 years of soil cultivation; the increase was more pronounced in the surface layers than in the deeper one.

Concerning the distribution of the exchangeable cations in the sandy soil, results show it could be arranged in the following descending order: Ca > Na > Mg > K

Respect to the calcareous soil, results show that the cation exchange capacity (CEC) gradually increased by increasing the cultivation periods. In the virgin soil the CEC was 8.22 $cmol_c$ / kg soil and increased to 12.78 $cmol_c$ / kg soil upon soil cultivation for 30 years. As for the distribution

of the exchangeable cations in the calcareous soil, results show the following descending order: Ca> Mg> Na> K

In general, the increase in the CEC of both the sandy and calcareous soils may be a direct outcome of the increase in the colloidal particles of soils including clay and organic colloids. These results are confirmed by the findings obtained by **Fathi *et al. (*1971); El-Galla (1978); Schjonning *et al. (*1994) and Gao and Change (1996)** who reported that addition of organic manures as well as clayey materials was most certainly, a common practice during reclamation of these soils.

4.2.5. Organic matter content:

Data in Tables (3 and 4) and illustrated in fig. (14) Show that soil organic matter content of both the sandy and calcareous soils increased as cultivation periods increased; the increase may be due to the accumulation of organic residues from the harvested crops as well as the added organic manure during the soil management. In the virgin sandy soil, organic matter content was very low (0.02 %) and tended to increase with increasing the cultivation periods, where it reached 0.30 % after 30 years of soil cultivation.

Concerning the calcareous soils, organic matter content in the virgin soil was 0.03 % and increased with increasing cultivation period, where it reached to 0.67 % after 30 years of soil cultivation. These results are in agreement with those reported by **El-Barary (1993), Eisa (1993) and Ghayed (1997)**.The relatively high organic matter content in the calcareous soil as compared to the sandy one may be explained on the bases of the decomposition rate of organic matter tends to

be faster in sandy soils as compared to the calcareous one, where the free calcium (soluble Ca^{+2}) in the latter soil leads to accumulate the organic materials in form of coagulated calcium humus.

4.2.6. Soil calcium carbonate:

Data in Tables (3 and 4) and illustrated in fig. (15) Show the effect of increasing cultivation period on calcium carbonate contents of both the sandy and calcareous soils. Results show that calcium carbonate contents of both soils decreased with increasing cultivation period.

Concerning the sandy soil, results show that calcium carbonate content of the virgin soil was 6.43 % and decreased to 5.61 % after 30 years of soil cultivation. With respect to the calcareous soil, calcium carbonate content was 38.23 % in the virgin soil and decreased with increasing cultivation period reached to 29.28 % after 30 years of soil cultivation. The decrease in soil calcium carbonate content after 30 years of soil cultivation, may be attributed to the invigoration of biological activities which produces acidic substances that caused a decrease in $CaCO_3$ (carbonation process), as shown in the following:

$$\underset{\text{Solid}}{CaCO_3} + CO_2 + H_2O \text{ ------------- } \underset{\text{Soluble}}{Ca(HCO_3)_2}$$

This is in agreement with those reported by **Omar *et al.*, (1990), El-Dawwey (1993), El-Barbary (1993), Abdel-Razik (1995), Hassan (1995) and Ghayad (1997).**

4.3. Soil fertility as affected by cultivation periods:

4.3.1. Macronutrients in soil:-

4.3.1.1. Available N:

The effect of cultivation periods on the availability of N in the sandy and calcareous soils is presented in Tables (9 and 10) and illustrated in fig. (16). In general, results show that increasing cultivation period was associated with an increase in available N contents in both soils; the increase was more pronounced in the surface layer than in the deeper ones. Concerning the sandy soil, results show that available N content in the virgin soil was 13.11 mg kg $^{-1}$N soil and increased to 36.70 mg kg $^{-1}$N soil after 30 years of soil cultivation. Also, results show that the percentage of available N increases in were 67.5, 149,6 and 179.9 % in the soils which cultivated for 10, 20 and 30 years, respectively, as compared with the virgin soil. Comparing the effect of the three periods of cultivation on the soil available N content, results show that the rate of increase in available N content after 20 years of cultivation was higher than that after 10 and 30 years of soil cultivation, where it was 32.5, 82.1 and 30.3 % at the three studied periods, respectively. Undoubtedly, the relatively N increase in the second period of cultivation may be attributed to an environmental case concerned with the in situ condition.

As for the calcareous soil, results in Table (10) show that available N content of the virgin soil was 15.97 mg kg $^{-1}$N soil and increased to 41.23 mg kg $^{-1}$N soil after 30 years of soil cultivation. The relative increases in available N

content were 49.2, 73.5 and 158.2 % in the soils, which cultivated for 10, 20 and 30 years, respectively, as compared with the virgin soil. Comparing the effect of the three periods of cultivation on the soil available N content, results show that the rate of increase in available N content after 30 years of cultivation was higher than that after 10 and 20 years of soil cultivation, where it was 50.8, 24.3 and 84.8 % at 10, 20 and 30 years cultivation periods, respectively. These results are in accordance with those obtained by **Ghayad (1997)** who reported that cultivated soils contained more available N, particularly those with increased cultivation periods. The increase in available N content due to increasing cultivation periods may be due to the repeated seasonal additions of manures and fertilizers. Also, **Beshay and Sallam (2001)** reported that fertility status of N in virgin sandy soil is very poor and increased to 0.039, 0.06 and 0.07 % when the soil cultivated for 10, 20 and 30 years, respectively.

Data in Tables (9 and 10) also show that the changes of distribution pattern in the successive layers of different soils cultivated for different periods. The obtained results show that there was a gradually decrease in available N_in the second and third layers of different soils. The increase in the available N content of the surface layer compared with the subsurface one, mainly attributed to the relatively high accumulation of organic matter in the upper zone of soil profile. In this connection, **Sharpley and Smith (1995)** reported that where additions of organic matter occurred to the soils there was an increase in available N.

The calcareous soils took the previous trend, however, N values exhibited gradually increases as a result of increasing periods of cultivation, where with increasing period of cultivation from 10 to 30 years was associated with an increase of available N. This is true for all the studied soils (sandy and calcareous). The maximum values of available N were obtained after 30 years of cultivation for sandy and calcareous soils, where it reached 40.3 and 50.9 mg/kg soil for the surface (0-15 cm) of sandy and calcareous soils, respectively.

These results are in accordance with that obtained by **Ghayad (1997)** who reported that cultivated soils contained more available N, particularly those with increased cultivation periods. Soils under cultivation gave the maximum figure of available N with cultivation periods, presumably due to the repeated seasonal additions of manures and fertilizers as well as increasing the management of soil. Also, **Beshay and Sallam (2001)** reported that fertility status of N in virgin sandy soil is very poor and increased to 0.039, 0.06 and 0.07% when the soil cultivated for 10, 20 and 30 years, respectively.

4.3.1.2. Available P:

Data in Tables (9 and 10) and graphically illustrated in Fig. (17). Show the effect of cultivation periods on the available P content in both the sandy and calcareous soils. In general,

results show that an almost similar trend to that of N occurred in both soils, where increasing cultivation period was associated with a gradual increase in available P content of both soils; the increase was more pronounced in the surface layer than in the deeper one.

As for the sandy soil, results show that available P content in the virgin soil was 2.46 mg P / kg soil and increased to 5.43, 9.59 and 11.51 mg P / kg soil after 10, 20 and 30 years of soil cultivation respectively. Also, results show that P content of the cultivated soils decreased with soil depth, but still higher than that of the virgin one.

Concerning the calcareous soil, results in Table (10) show that available P content of the virgin soil was 1.03 mg P / kg soil and increased to 8.39, 10.23 and 11.49 mg P / kg soil after 10, 20 and 30 years of soil cultivation respectively. Also, P content of the cultivated soils tended to decrease with soil depth, as compared with the surface layer, but still higher than that of the virgin soil. These results agree with those reported by **Johuston and Poulton (1992) and Abdel-Razik (1995)** who observed an increase in available P with increasing the period of cultivation.

Decreasing the mobility of P throughout the profiles seem to be related to soil physico-chemical properties as well as microbial activities. Accumulation of organic matter in the soil surface as a result of increasing the period of cultivation leads to increase the available P content in surface layers. In this concern. **Ghayad (1997)** found that the highest available P content in sandy soil under cultivation was obtained in the top (0-15 cm) layer of the 10 years cultivated soil. Also, **Beshay and Sallam (2001)** reported that fertility status of P in virgin sandy soil is very poor and increased to 18, 21 and 20 mg/kg upon soil cultivation for 10, 20 and 30 years, respectively. Like as in the most of the studied soils **Johuston and Poulton (1992) and Abdel-Razik (1995)** observed an increase in available P with increasing period of cultivation. Data show also that there were relative decreases in available P in the second (15-60 cm) and third layers (60-90 cm), this was true for all the investigated soils.

4.3.1.3. Available K:

Data presented in Tables (9 and 10) and illustrated in fig. (18). Show the effect of cultivation periods on available K content in both the sandy and calcareous soils. In general, the effect is similar to that obtained in the case of available N and P contents. Thus, soil cultivation for any period increased available K content in all the studied soils, and the increase being dependent on the period of cultivation and soil management practices. Soil cultivation for 10, 20 and 30 years increased the available K content in the surface layer of both studied soils by 63.4, 11.52 and 128.7 % for the sandy soil, and by 8.4, 18.9 and 30.2 % for the calcareous one, respectively, over the virgin soil. These results are in agreement with those obtained by **Yadav and Singh (1995)** who found that available K content in soils

increased with increasing cultivation period. Also, **Beshay and Sallam (2001)** reported that fertility status of K in virgin sandy soil is very poor and increased to 120, 115 and 132 mg/kg upon the soil cultivation for 10, 20 and 30 years, respectively.

Also, results show that available K content of the sandy soil was relatively higher than that of the calcareous one. This may be due to the effect of physico-chemical features, where the excess of oxygen in sandy soil leads to a rapid rate of organic manures mineralization and hence the release of K in available form. In this connection, **Prasad *et al.*, (1982)** reported that farmyard manure increases available K in sandy gravel soil.

Concerning the distribution of available K as a function of soil depth, results of Tables (9 and 10) show that the surface layers have a relatively high content of available K as compared with the deeper ones. This was holds true for both the sandy and calcareous soils along the three cultivation periods. The decrease of available K content in subsurface layers as compared to that of the surface ones seems to be related to the association of K with soil organic matter. It is noteworthy to mention that K tended to decrease with increasing soil, but the values were still higher than that of virgin soil. This was true for all the studied soils (sandy and calcareous).

3.3.2. Micronutrients in soil:

Data tabulated in Tables (9 and 10) and graphically illustrated in Figs. (19, 20, 21 and 22) represent the effect of different cultivation periods on the availabl**e** Fe, Mn, Zn and Cu contents in the studied soils. Results show that the available micronutrient components dependent on the periods of cultivation and soil type under consideration.

Results show that increasing the periods of cultivation up to 30 years increased the contents of available Fe, Mn, Zn and Cu in the studied soils. This is true in the surface and subsurface soil layers. Similar results were obtained by **Ghayad (1997)** who reported that available Zn, in the soils increased with increasing the period of cultivation.

Also, results reveal that sandy soil cultivation for 10 years increased the available Fe, Mn, Zn and Cu contents in the surface layer by 75, 77, 76 and 20 % relative to virgin soil, respectively. The corresponding values at the same period for the calcareous soil were 33, 133, 440 and 25% in the same order. However, when the soil cultivated for 20 years, the increase in the available Fe, Mn, Zn and Cu contents reached to 105, 95, 108 and 46 % relative to the virgin sandy soil and to 70, 209, 457 and 100 % relative to the virgin calcareous soil, respectively. These increases were 170, 181, 179 and 133% for Fe, Mn, Zn and Cu in sandy soil cultivated for 30 years, respectively; while they were 80, 251, 571 and 150 % for Fe, Mn, Zn and Cu in calcareous soil at the same period of cultivation, respectively.

These results indicate that the relative increase in available micronutrients, except Fe, were higher in the calcareous soil than in the sandy one. However, the relative increase in the available Fe content was higher in the sandy soil than in the calcareous one.

These variations are mainly dependent on the concerned soil as well as several interacting factors of soil physico-chemical properties and soil management practices. In fact chemical behavior of micronutrients should expected to be related to soil texture, clay mineral and the presence of $CaCO_3$.

Concerning the distribution of available Fe, Mn, Zn and Cu contents through the different layers of the soil profile, results in Tables (9 and 10) show that increasing the cultivation period gradually increased Fe, Mn, Zn and Cu contents in the different soil layers as compared with virgin soils; the increase was more pronounced in the surface layer (0-15 cm) of both the studied soils than in the deeper ones (15-60 cm and 60-90 cm). The low content of micronutrients in the subsurface layers of the cultivated soils, compared with the surface ones, may be due to the low mobility of all micronutrients.