IMPROVING THE HYDRO-PHYSICAL POTENTIAL OF NEW RECLAIMED SOIL USING ENVIRONMENT-FRIEND LOCAL AMENDMENTS AT EL-FAYOUM GOVERNORATE, EGYPT.

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Received on: 24/4/2008 ***Accepted: 8/6/2008***

ABSTRACT

National plans in Egypt promised to increase land reclamation potential horizontally and vertically; meanwhile, practices are looking to improve the properties of new reclaimed soils. From promises to practice, this study aimed to improve the hydro-physical properties of new reclaimed soil located in El-Fayoum Governorate, Egypt using environment-friend local amendments.

Field experiment (comprised 56 units; each 3 x 3.5 m^2, in completely randomized design) was conducted in new reclaimed soil at Kom-Osheem Village, Fayoum, Egypt, to study the improving potential of locally 3 natural soil amendments. Treatments comprised 45 ton/feddan of Taffla, 45 ton/feddan of River Nile sediments and 30 m^3/feddan of organic manure, moreover, 3 treatments of mixtures of half amount of each in combination with the other. Treatments of 4 replicates were conducted with two sets of application methods (mixed with the surface layer, 0-30 cm and a single subsurface layer at 50 cm), then, cropped with wheat followed by maize. After harvest, yield of wheat and maize were recorded and soil hydro-physical, pore size distribution and chemical properties were determined after each crop.

Results showed improvement on hydro-physical, pore size distribution and chemical properties of the soil, and on yield of wheat and maize. Addition of 45 ton/feddan of Taffla increased clay content of surface soil layer. With cropping, improvement values were increased. After maize, addition of mixture of 22.5 ton/feddan Taffla + 15 m^3/feddan organic manure improved available water by 50.7% and 70.0%; total porosity by 27.3% and 25.8%; fine capillary pores (FCP) by 96.7% and 91.8%; cation exchange capacity (CEC) by 105.0% and 123.8%; grains of wheat by 70 % and 65% and grains of maize by 76.6% and 70% higher than the control with surface and subsurface application methods, respectively. Conclusions were discussed and graphically interpreted.

***Keywords**: Taffla, River Nile Sediments, Organic Manure, Hydro-physical Properties, Available Water, Pore Size Distribution, Water Holding Pores.*

INTRODUCTION

Enhancing the agricultural potential of new reclaimed soils is essential to overcome hunger in developing countries. Sandy-textured soils are characterized by high sand contents, so, its productivity is limited due to the high infiltration rate and the low fertility level, water holding capacity and organic matter contents.

National plans in Egypt promised to increase land reclamation potential horizontally and vertically; meanwhile, continueous active practices are looking to improve the properties of new reclaimed soils especially those of sandy-textured soils. Different attempts tried to use synthetic soil conditioners to alleviate some of these constrains (Choudhary et al., 1998; Al-Omran et al., 1987; Al-Harbi et al., 1999). Due to its high costs and insufficient longevity, the use of natural amendments could be another alternative to improve the physical and chemical properties of these soils (Al-Omran et al., 2002 and 2004). It is reported that water repellency of sandy soil can be reduced by addition of small increment of clay materials (Harper and Gilkes, 1994). Reuter (1994) reported that clay-substrate application to sandy-textured soil was significantly improved soil water regime, especially percolation processes. Important consequence of clay addition caused reduction of plant nutrient losses, as addition of clay to the top of sandy soil has been reported to be highly effective in reducing water repellency and increasing crop yield (Carter et al., 1998). The use of clay deposits may increase the productivity of sandy soil, especially in the areas where these materials are naturally available in abundance and inexpensive costs (Abou-Gabal et al., 1990). Al-Omran et al. (2005) reported that application of clay amendments as a subsurface layer to sandy calcareous soils increased water contents and improved the distribution of roots in the treated layer especially with subsurface drip irrigation. Remarkable improvements in maize crop yield, water retention and water use efficiency were gained in sandy soil treated with clay (Ismail and Kiyoshi, 2007).

Natural resources of organic amendments are known to improve such soils and to correct the problematic properties especially those related to soil fertility (Kononova, 1966 and Allison, 1973). Im (1982) showed the effects of organic materials in improving soil total porosity, hydraulic conductivity, aggregation, permeability, erodability, compactibility and pF parameters in different favorable properties for plant growth. Mustafa (1982) showed the improving effects of long term application of organic materials on soil mechanical analysis, bulk density, real density, total porosity, permeability and aggregation .

Abdel-Ghaffar (1982); El-Shakweer et al (1976) and El-Shakweer et al (1997) showed that decomposition of plant residues were reflected on the

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resulted improvement of chemical and physical properties of the studied soil and, also, on yield of cultivated crops and maintainance of soil productivity.

Environmentally, some of the organic wastes are accumulated unless it is recycled to be used as organic soil amendments to realise as possible the safety standard limits of pollution prevention of the agricultural sector (EP3 project, 1996 and El-Shakweer, 2001). The country report presented by Hamdi and Alaa El-Din (1982) showed that agricultural residues, animal manure, night soil, sludge, compost of city refuse and biogas still being potential resources of increasing soil organic matter in Egypt.

This study aimed to measure the interaction effects of the type and amounts of natural local soil amendments i.e. Taffla precipitate, River Nile sediments and organic manure, that are available in the study region; to evaluate their application methods (surface or subsurface applications) on soil hydro-physical properties after two successive cropping seasons (wheat and maize) and to determine their vital role on the yield of two successive crops i.e. wheat and maize in a newly reclaimed loamy sand-textured soil at Kom Osheem village, Tamia district, El-Fayoum, Egypt.

MATERIALS AND METHODS

A field experiment was conducted in a newly reclaimed loamy sand-textured soil located at Kom Osheem village, Tamia district (about 5 km north of the Cairo-Fayoum disert road). Physical properties of this soil were analyzed according to Klute (1986) while the chemical properties were determined according to Page et al. (1982) and their data are presented in Table 1. The field experiment comprised 56 experimental units, each of which was of area of 3 x 3.5 m^2 and these units were designed and distributed in a completely randomized blocks. Treatments of the experiment comprised the following:

A- Methods of amendment application:

1- Surface application of the amendment dose at 0-30 cm depth.

2- Sub-surface application of the amendment dose as a single layer at 50 cm depth.

B-Kind of the amendment:

With each of the two methods of amendment application, the following 7 treatments were conducted, each in 4 replicates:

Treatment No.	Additions to the tested soil
1	Without addition. (Control)
2	45 ton/feddan of Taffla. (The recommended rate)
3	45 ton/feddan of River Nile Sediment (The recommended rate)
4	30 m^3/feddan Organic Manure. (The recommended rate)
5	22.5 ton/feddan of Taffla + 22.5 ton/fedan of River Nile sediments. (Mixture of half of the recommended rates).
6	22.5 ton/feddan Taffla + 15 m^3/feddan organic manure. (Mixture of half of the recommended rates).
7	22.5 ton/feddan River Nile sediments + 15 m^3/feddan organic manure. (Mixture of half of the recommended rates).

Properties of the used Taffla and River Nile Sediment are presented in Table 2; meanwhile, properties of the used organic manure are presented in Table 3.

All treatments of amendments were applied in a single dose (once) directly before cultivation. So, the experiment comprised 2 sets of amendment applications X 7 treatments of kind of amendments X 4 replicats = 56 experimental units.

All experimental units with its treatments were cultivated with two successive crops i.e wheat (the first crop), then, followed by maize (the second crop) and the two crops were managed as follows:

The first cropping season (Wheat crop):

At 27 th November, 2006; all treatments were cultivated with wheat (*Triticum valgarre* L., Var.Sakha 8). To each treatment, the following fertilizers were added:

Superphosphate was added prior to cultivation at a rate of 150 kg/feddan. Nitrogen was added at the rate of 120 kg/feddan in the form of ammonium nitrate in 5 equal doses during the growing season. The 5 nitrogen doses were applied consequently after 2 , 5, 8, 10 and 13 weeks of seeding. Potassium was applied at the rate of 20 kg K2O/feddan prior to cultivation. The other agricultural managements practices were applied as recommended for wheat crop in the area.

After harvesting wheat crop, representative soil samples were taken from the layers of 0-30 cm and 30-60 cm depths for physical and chemical analysis. Grains and straw weights of the wheat crop were recorded for each experimental unit.

Table 1: Initial Properties of the tested new reclaimed soil.

Soil property	Value with the depth of	
	0 – 30 cm	30 – 60 cm
Soil Physical Properties:		
Particle size distribution, %:		
Coarse sand	65.9	70.2
Fine sand	18.2	8.6
Silt	7.6	14.3
Clay	8.3	6.9
Texture	Loamy sand	Loamy sand
Bulk density, g cm^{-3}	1.65	1.70
Hydraulic conductivity, cm h^{-1}	10.50	8.20
Field capacity, %	15.00	13.50
Wilting point, %	9.50	8.48
Available water, %	5.50	5.02
Total porosity, %	35.0	32.0
Pore size distribution, %		
Quickly drainable pores	14.05	13.67
Slowly drainable pores	7.50	6.75
Volume drainable pores	21.55	20.42
Water holding pores	5.50	5.02
Fine capillary pores	7.95	6.56
Useful pores	13.00	11.77
Soil Chemical Properties		
Organic matter, %	0.05	0.02
Calcium carbonate, %	3.50	2.60
pH (in soil paste)	8.0	7.50
ECe (dS m^{-1})	2.51	3.20
Soluble ions, m.e. L^{-1}:		
Ca^{++}	12.06	17.05
Mg^{++}	8.87	9.03
Na^{+}	3.04	4.71
K^{+}	1.03	1.20
$CO_3^{=}$	-	-
HCO_3^{-}	0.97	0.98
Cl^{-}	15.0	20.0
$SO_4^{=}$	9.03	11.01
C.E.C, me/100 g soil	3.59	2.90

The Second cropping season (Maize crop):

Then, at the 7 th July 2007, all treatments were cultivated with maize (Zea maize, Hagen Fardy) Single hybrid, without additions of amendments. Superphosphate was added prior to cultivation at a rate of 150 kg/feddan.

Table 2: Properties of the used Taffla and River Nile Sediment.

Properties	Value with the used	
	Taffla	River Nile Sediment
Physical Properties		
Particle size distribution, %:		
Coarse sand	5.50	0.60
Fine sand	8.60	25.50
Silt	10.50	26.50
Clay	75.40	47.40
Texture	clay	clay
Chemical Properties		
Organic matter, %	0.05	0.65
Calcium carbonate, %	3.00	1.60
pH (in soil paste)	8.7	7.6
ECe (dS m^{-1})	6.74	1.20
Soluble ions, m.e. L^{-1}:		
Ca^{++}	23.50	4.50
Mg^{++}	14.70	3.20
Na^{+}	27.80	4.02
K^{+}	1.20	0.29
$CO_3^{=}$	-	-
HCO_3^{-}	1.50	0.50
Cl^{-}	45.50	8.70
$SO_4^{=}$	20.2	2.81
C.E.C, me/100 g soil	44.0	35.0
Gypsum content, %	1.2	-

Table 3 : Analysis of the used organic manure.

Properties	Value
pH	6.7
Organic carbon, %	20.31
Total N, %	1.52
C/N ratio	13.04
Total P, %	0.92
Total K, %	1.48
Total micronutrients:	
Fe, ppm	212
Mn, ppm	127
Zn, ppm	98

Nitrogen was added at the rate of 120 kg/feddan in the form of ammonium nitrate at 3 doses during the growing season. The first nitrogen dose was 24 kg/feddan at cultivation, the second nitrogen dose was 48 kg/feddan at the first irrigation and the third dose was 48 kg/feddan at the second irrigation. Potassium was applied at the rate of 24 kg K2O/feddan after thinning and prior to the first irrigation. The needed agricultural management practices were applied as recommended for maize crop in the area. After harvesting the maize crop, representative soil samples were taken from the layers of 0-30 cm and 30-60 cm depths, then, analysed for physical and chemical properties. Grains yield of maize crop were weighted and recorded for each treatment.

The obtained results of the experimental units and treatments after the two crops were subjected to statistical analysis according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

The obtained results are foucused on 4 aspects related to the effects of the experiment treatments on improving the hydrophysical properties of the tested soil. The changes on soil physical properties are found in Table 4; on pore size distribution are found in Table 5; on soil chemical properties are found in Table 6 and those on the yield of two successive cropping seasons (i.e.wheat and maize crops) are found in Table 7.

1- Vital role of the experiment treatments on improving the hydro-physical properties of the tested soil:

Table 4 shows the results of particle size distribution, bulk density, hydraulic conductivity, field capacity, wilting point and available water as affected by the type of soil amendments and application methods in the first and the second crop seasons.

The data of Table 4 show that slight improvement in particle size distributions (i.e. silt and clay contents) were observed with the treatment No.2 (i.e. 45 ton/feddan of Taffla (the recommended rate) either with the surface and/or with subsurface application methods; and also either after the first crop (wheat) and/or after the second crop (maize) being at its maximum with the second crop. The increase of fine fraction in sandy-textured soils referred to significant mechanical additions of clay deposits, and on the other hand, to improvement in the agriculture practices to be in easier rate. The fine materials were serving as a coating on the coarser particles to lying in the wide soil pores, meanwhile, regulating the air/water balance in the root zone and hence, increasing the water holding capacity and nutrient solubility and availability to plants.

Table 4 elucidated that with the surface and subsurface application methods of the tested treatments, values of bulk density and hydraulic conductivity were decreased as its maximum decrease was found with the surface application method in the treatment No.6 (i.e. addition of mixture of 22.5 ton/feddan Taffla + 15 m^3/feddan organic manure) after the first and second seasons in the surface layer (0-30 cm), while, with the subsurface application method, maximum decrease in bulk density and hydraulic conductivity were found with the treatment No.6 after the first and second season in the subsurface layer (50 cm).

Different levels of improvement could be indicated from Table 4 in the properties of field capacity, wilting point and available water; which reflected significant improving effects of the added soil amendments. Maximum improvement was detected with the treatment No. (6) as compared to the other treatments, being in the surface layer (0-30 cm) with the surface application method, and in the subsurface layer (30-60 cm) with the subsurface application method.

It could be concluded that the treatment No. 6 showed relatively superior effects on improving bulk density, hydraulic conductivity, field capacity, wilting point and available water in the soil layer that received the amendment. Meanwhile, treatment No.2 showed the same superior effect on improving particle size distribution through increasing the clay fraction of the soil layer that received the amendment than the other treatments. The above-mentioned conclusions are in agreement with El-Sherief and El-Hady (1988); Moussa et al. (1995);Al-Omran, et al (2002) and Al-Omran, et al (2004).

To elucidate the above-mentioned conclusions, Figures 1 and 2 show the relative percentages values of increases higher than the control (the control is relatively 100%) for the properties of clay contents and available water while Figures 3 and 4 show the decrease less than the control (the control is relatively 100%) for bulk density and hydraulic conductivity with the tested treatments.

Clay deposits additions may increase the productivity of sandy-textured soil, especially in the areas where these materials are naturally available in abundance and inexpensive costs (Abou-Gabal et al., 1990). Application of clay amendments as a subsurface layer to sandy calcareous soils increased water contents and improved roots distribution in the treated layer especially with subsurface drip irrigation (Al-Omran et al., 2005); and also improved water retention and water use efficiency in sandy soil (Ismail and Kiyoshi Ozawa, 2007).

2- Vital role of the experiment treatments on improving pore size distribution of the tested soil:

The results of Table 5 show the effects of the experiment treatment on total porosity (T.P.), quickly drainable pores (Q.D.P.), slowly drainable pores (S.D.P.), volume drainable pores (V.D.P.), water-holding pores (W.H.P.), fine capillary pores (F.C.P.) and useful pores (U.P.).

It could be observed that amendments treatments and application methods were clearly affected the total porosity and consequently all of the pore size distribution properties, especially those of S.D.P, W.H.P and F.C.P. as compared with the control. Treatment No. 6 (i.e. addition of 22.5 ton/feddan Taffla +15 m^3/feddan organic manure) showed superior improving effect on total porosity than the other treatment being 14.1% and 13.5% higher than the control with the surface and subsurface application methods at the first crop (wheat), while being 27.3% and 25.8% at the second crop (maize), respectively. Also, treatment No.6 showed different levels of improvements after the second crop (maize) as the improvements in the treated layer of the surface and subsurface application methods were with the S.D.P.17.3% and 15.6%; with the W.H.P. 50.7% and 70%; with the F.C.P.96.7% and 91.8% higher than the control, respectively. It is clear that maximum improvement was found after the second crop (maize) with the fine capillary pores (F.C.P.) in the treated soil layer either with the surface or subsurface application methods.

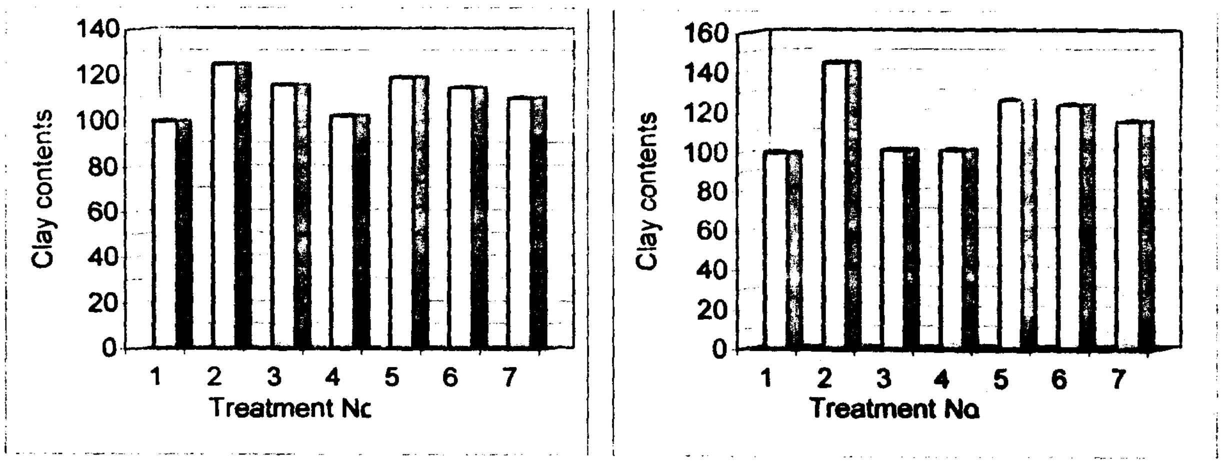
Table (4): Effect of the tested experiment treatments on soil hydrophysical properties.

Treatment	Depth, Cm	Particle size distribution,%				Bulk density, g/cm^3	Hydraulic conductivity, cm/h	Field capacity %	Wilting point,%	Available water,%
		C.S	F.S	Silt	Clay					
I - After the first season (after wheat crop)										
A- Surface application of treatments (Mixed with the 0 – 30 cm soil layer)										
1	0 -30	65.5	18.0	7.61	8.89	1.62	9.97	16.50	9.90	6.60
	30 - 60	70.2	8.61	14.1	7.09	1.69	8.00	13.70	8.60	5.10
2	0 -30	62.5	18.2	8.2	11.1	1.57	8.40	18.75	10.60	8.15
	30 - 60	70.1	8.63	14.2	7.15	1.68	7.38	13.80	8.60	5.20
3	0 -30	61.6	19.3	8.8	10.3	1.58	8.90	17.70	10.40	7.30
	30 - 60	70.2	8.62	14.0	7.1	1.64	7.46	13.70	8.60	5.10
4	0 -30	64.8	17.9	8.2	9.1	1.60	9.24	18.00	10.50	7.50
	30 - 60	69.6	8.71	14.2	7.15	1.68	7.60	13.80	8.61	5.19
5	0 -30	63.2	18.3	8.0	10.6	1.59	9.14	19.20	10.80	8.40
	30 - 60	70.2	18.6	14.1	7.11	1.69	7.70	13.80	8.61	5.19
6	0 -30	63.1	18.6	8.1	10.2	1.53	7.87	19.50	10.90	8.60
	30 - 60	69.7	8.75	14.4	7.12	1.67	7.30	14.04	8.65	5.39
7	0 -30	62.9	18.8	8.5	9.8	1.57	9.03	18.30	10.50	7.80
	30 - 60	69.7	8.72	14.5	7.09	1.68	7.50	14.00	8.69	5.31
B- Subsurface application of treatments (A single layer at the 50 cm depth)										
1	0 -30	65.5	18.0	7.61	8.89	1.64	10.08	15.30	9.60	5.70
	30 - 60	70.2	8.61	14.1	7.09	1.66	7.87	14.20	8.70	5.50
2	0 -30	65.4	18.1	7.63	8.9	1.63	8.90	15.60	9.69	5.91
	30 - 60	65.3	9.61	14.8	10.3	1.64	6.72	16.60	9.50	7.10
3	0 -30	65.4	18.1	7.62	8.91	1.62	9.5	15.45	9.64	5.81
	30 - 60	71.6	9.62	9.8	7.2	1.64	7.13	15.5	9.10	6.40
4	0 -30	65.3	18.1	7.64	8.91	1.62	9.60	15.53	9.64	5.89
	30 - 60	70.0	8.6	14.2	7.2	1.65	7.38	16.10	9.20	6.9
5	0 -30	65.4	18.1	7.62	8.9	1.61	9.70	15.68	9.69	5.99
	30 - 60	66.5	9.4	15.1	8.97	1.64	7.30	17.01	9.60	7.41
6	0 -30	65.3	18.1	7.65	8.92	1.60	8.61	15.90	9.74	6.16
	30 - 60	67.4	9.0	14.8	8.8	1.61	6.40	17.10	9.70	7.40
7	0 -30	65.4	18.1	7.64	8.91	1.62	9.70	15.75	9.79	5.96
	30 - 60	67.4	9.3	15.1	8.2	1.63	7.20	16.20	9.30	6.90
II- After the second season (after maize crop)										
C- Surface application of treatments (Mixed with the 0 – 30 cm soil layer)										
1	0 -30	65.2	18.2	7.66	8.96	1.58	9.45	18.00	10.50	7.50
	30 - 60	70.3	8.6	14.0	7.15	1.68	7.9	13.90	8.65	5.25
2	0 -30	60.6	19.1	8.6	11.7	1.49	6.30	22.50	11.90	10.60
	30 - 60	70.0	8.7	14.2	7.1	1.66	6.10	14.04	8.65	5.39
3	0 -30	60.1	20.0	9.2	10.7	1.52	7.35	20.40	11.20	9.20
	30 - 60	69.9	8.7	14.2	7.2	1.68	6.70	13.90	8.65	5.25
4	0 -30	64.3	18.2	8.3	9.2	1.55	7.98	21.00	11.40	9.60
	30 - 60	69.7	8.8	14.3	7.22	1.66	7.10	14.04	8.73	5.31
5	0 -30	61.4	19.1	8.4	11.13	1.53	7.77	23.25	12.10	11.15
	30 - 60	69.9	8.7	14.2	7.2	1.67	7.20	14.18	8.73	5.45
6	0 -30	61.7	19.3	8.4	10.6	1.42	5.56	23.70	12.4	11.30
	30 - 60	69.5	8.8	14.5	7.2	1.65	6.40	14.58	8.82	5.76
7	0 -30	62.0	19.3	8.7	10.0	1.50	7.66	21.6	11.60	10.00
	30 - 60	69.5	8.8	14.6	7.1	1.67	6.90	14.45	8.90	5.55
D- Subsurface application of treatments (A single layer at the 50 cm depth)										
1	0 -30	65.2	18.2	7.68	8.97	1.62	9.7	15.6	9.69	5.91
	30 - 60	69.9	8.7	14.2	7.16	1.63	7.54	14.9	8.9	6.00
2	0 -30	63.0	19.0	8.3	9.7	1.62	7.35	16.2	9.88	6.32
	30 - 60	65.0	9.7	14.9	10.4	1.55	5.49	19.7	10.3	9.40
3	0 -30	63.5	18.9	8.2	9.5	1.61	8.4	15.9	9.79	6.11
	30 - 60	71.3	9.7	9.9	9.12	1.58	6.23	17.6	9.7	7.9
4	0 -30	64.2	18.7	7.9	9.2	1.6	8.61	16.05	9.79	7.9
	30 - 60	69.7	8.7	14.3	7.3	1.61	6.15	18.60	10.00	8.6
5	0 -30	63.3	19.2	8.1	9.4	1.59	8.82	16.35	9.88	6.47
	30 - 60	66.1	9.5	15.3	9.1	1.60	6.31	20.5	10.7	9.8
6	0 -30	63.0	19.3	8.2	9.5	1.58	6.72	16.80	9.98	6.82
	30 - 60	67.1	9.09	14.9	8.88	1.50	4.75	21.1	10.90	10.20
7	0 -30	63.4	19.1	8.1	9.4	1.6	8.71	16.50	10.07	6.43
	30 - 60	67.0	9.4	15.3	8.3	1.56	6.40	18.90	10.20	8.70

Clay contents

1-After the first crop (wheat)

A-Surface Application method B-Subsurface Application method



2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method

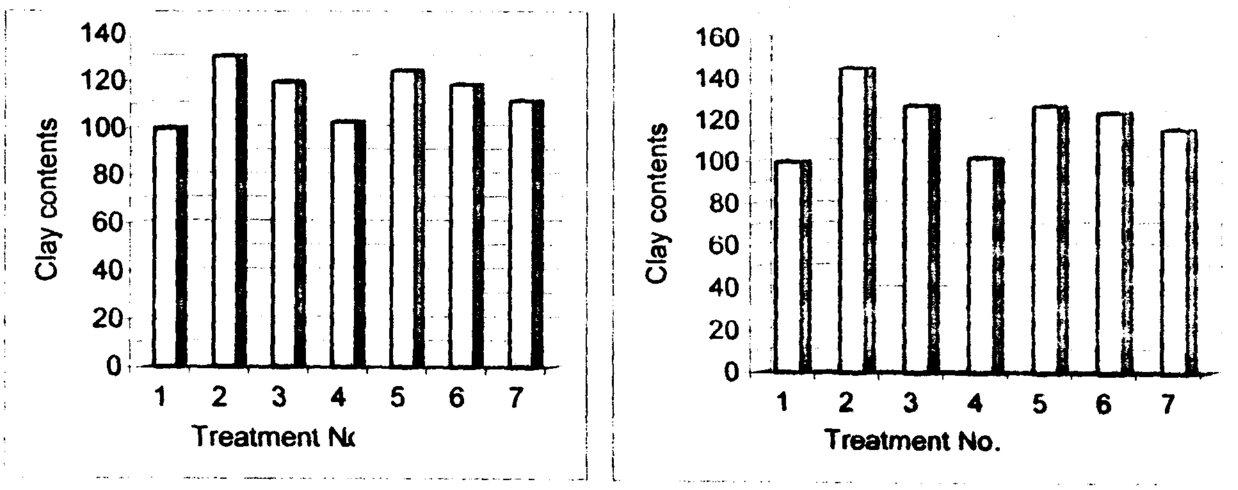
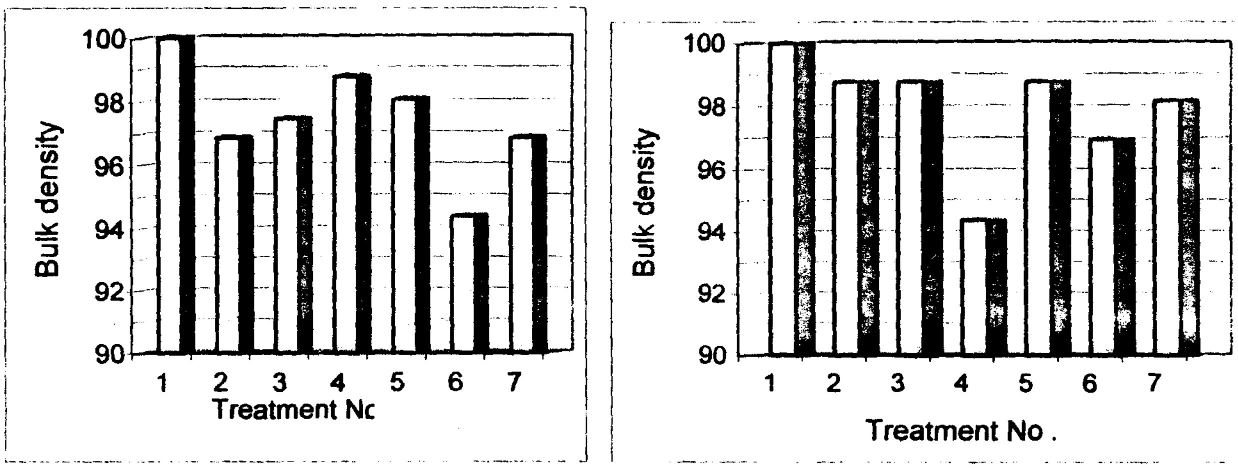


Figure 1: Relative percentage values of the clay contents with the tested treatments
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Bulk density

1-After the first crop (wheat)

A-Surface Application method B-Subsurface Application method



2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method

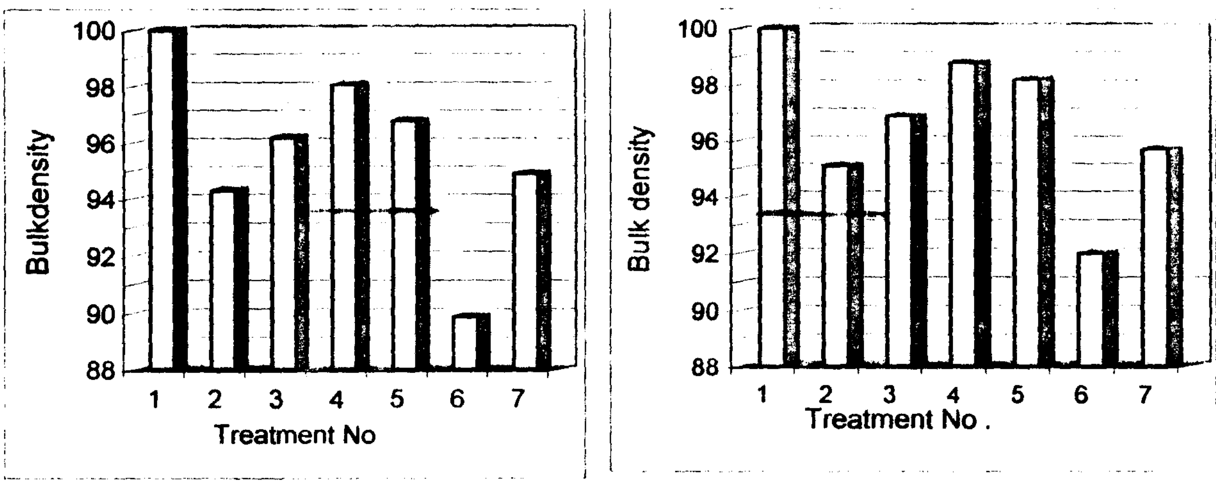
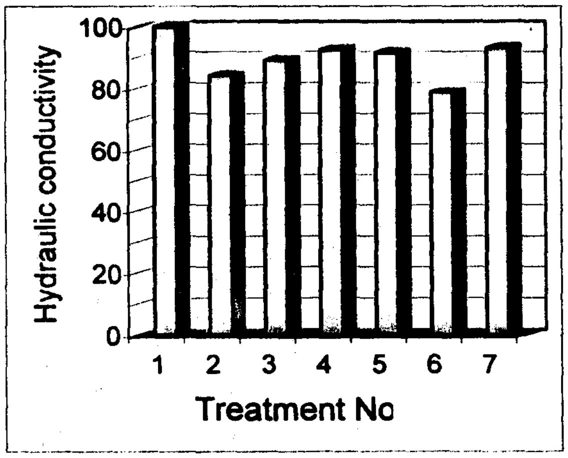


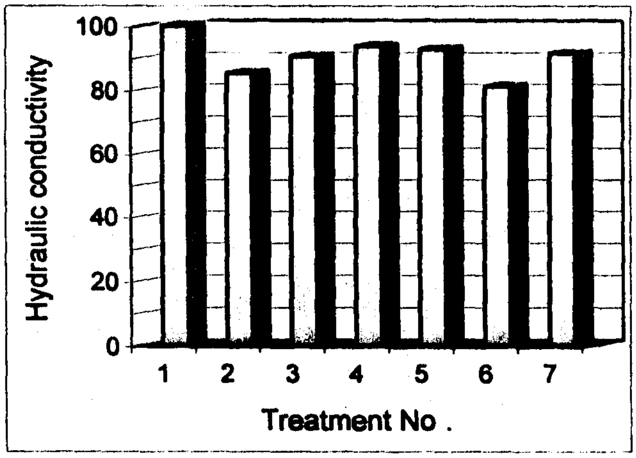
Figure 2: Relative percentage values of soil bulk density with the tested treatments,
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Hydraulic conductivity

1-After the first crop (wheat)

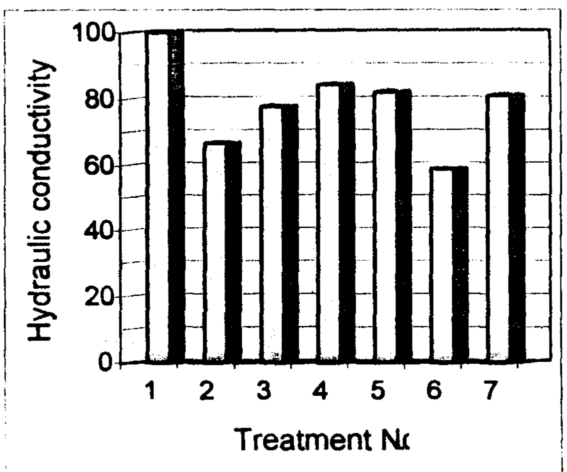
A-Surface Application method B-Subsurface Application method





2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method



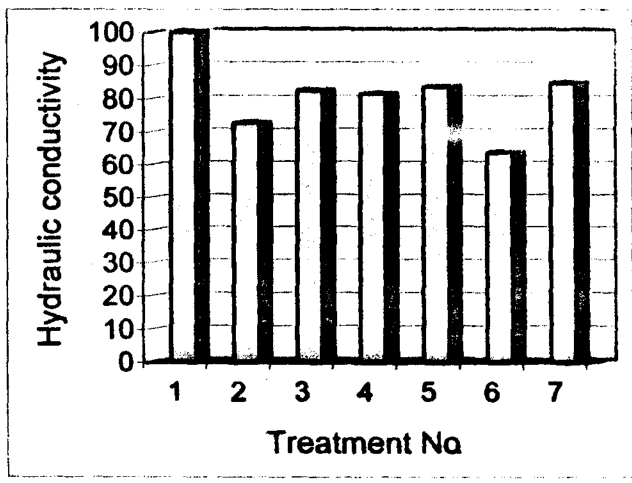
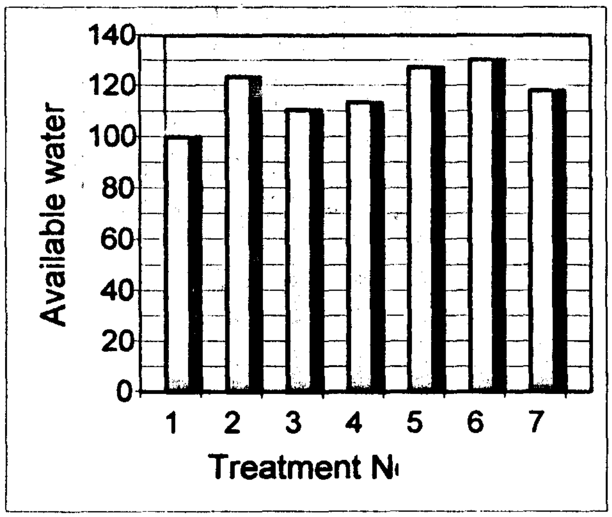


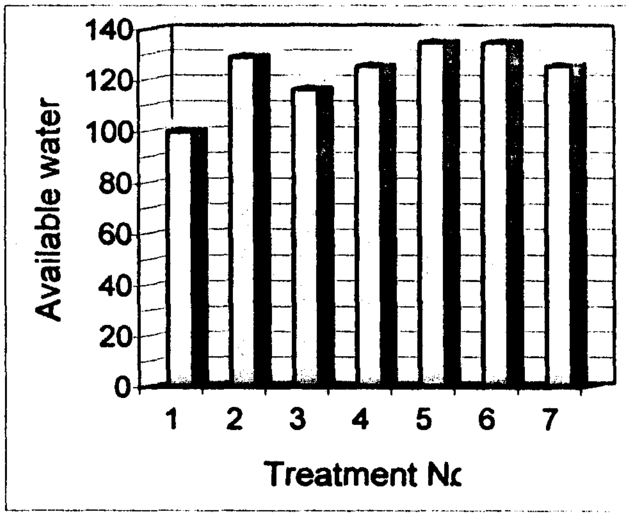
Figure 3: Relative percentage values of soil hydraulic conductivity with the tested Treatments.
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Available water

1-After the first crop (wheat)

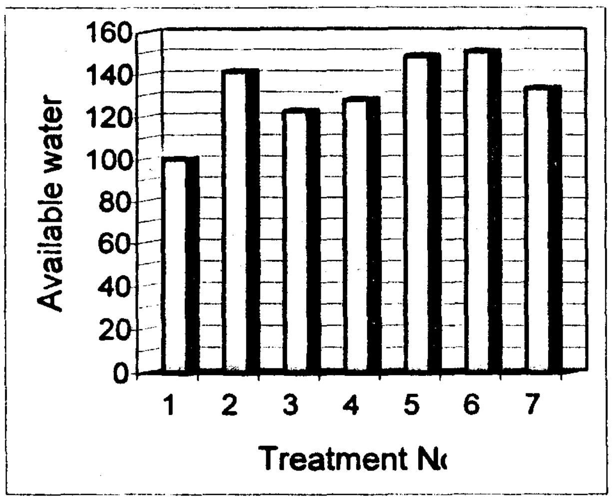
A-Surface Application method B-Subsurface Application method





2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method



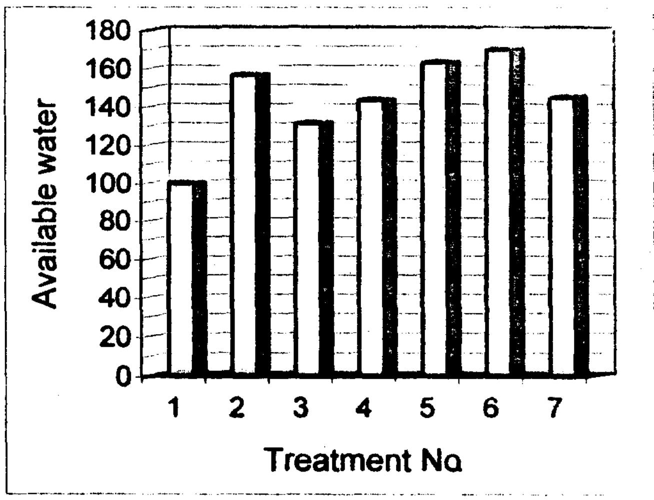


Figure 4: Relative percentage values of soil available water with the tested treatments.
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Table (5): Effect of the tested experiment treatments on pore size distribution.

Treatment	Depth, cm	Pore size distribution, % of volume basis						Total porosity, % (T.P.)
		Q.D.P	S.D.P	V.D.P	W.H.P	F.C.P	U..P	
I - After the first season (after wheat crop)								
A- Surface application of treatments (Mixed with the 0 – 30 cm soil layer)								
1	0 -30	13.35	7.95	21.30	6.60	8.90	14.55	36.8
	30 - 60	13.53	6.89	20.42	5.10	6.80	11.99	32.32
2	0 -30	11.24	9.08	20.32	8.15	11.78	17.23	40.25
	30 - 60	13.26	6.99	20.25	5.20	7.51	14.50	32.96
3	0 -30	11.94	8.70	20.64	7.30	10.96	16.00	38.90
	30 - 60	13.40	6.92	20.32	5.10	7.19	12.02	32.64
4	0 -30	11.80	8.78	20.58	7.50	11.12	16.28	39.20
	30 - 60	13.26	7.02	20.28	5.19	7.49	14.51	32.96
5	0 -30	11.52	8.93	20.45	8.40	12.45	17.33	41.30
	30 - 60	13.12	7.05	20.17	5.19	7.92	14.97	33.28
6	0 -30	11.10	9.15	20.25	6.60	15.15	15.75	42.00
	30 - 60	12.99	7.16	20.15	5.39	8.06	12.55	33.60
7	0 -30	11.38	9.00	20.38	7.80	12.42	16.80	40.60
	30 - 60	12.92	7.19	20.11	5.31	8.34	12.50	33.76
B- Subsurface application of treatments (A single layer at the 50 cm depth)								
1	0 -30	13.77	7.80	21.57	5.70	8.43	13.50	35.70
	30 - 60	13.26	7.09	20.35	5.50	7.45	12.59	33.30
2	0 -30	13.35	8.03	21.38	5.91	9.46	13.94	36.75
	30 - 60	11.20	8.10	19.30	7.10	10.10	15.20	36.50
3	0 -30	13.63	7.88	21.51	5.81	8.73	13.69	36.05
	30 - 60	11.89	7.76	19.65	6.40	8.85	14.16	34.90
4	0 -30	13.49	7.95	21.44	5.89	9.07	13.84	36.40
	30 - 60	11.76	7.70	19.46	6.90	9.14	16.84	35.50
5	0 -30	13.07	8.18	21.25	5.99	10.21	14.17	37.45
	30 - 60	11.48	7.83	19.31	7.41	10.40	15.24	37.12
6	0 -30	12.93	8.25	21.18	6.16	10.46	14.41	37.80
	30 - 60	11.07	8.17	19.24	7.40	11.16	15.57	37.80
7	0 -30	13.21	8.10	21.31	5.96	9.83	14.06	37.10
	30 - 60	11.35	7.97	19.32	6.90	10.58	14.87	36.80
II- After the second season (after maize crop)								
C- Surface application of treatments (Mixed with the 0 – 30 cm soil layer)								
1	0 -30	12.65	8.25	20.90	7.50	10.10	15.75	38.50
	30 - 60	13.40	6.95	20.35	5.25	7.04	12.20	32.64
2	0 -30	8.43	9.60	18.03	10.60	16.87	20.20	45.50
	30 - 60	13.05	7.09	20.14	5.39	7.91	12.48	33.44
3	0 -30	9.84	9.15	18.99	9.20	15.91	18.35	44.10
	30 - 60	12.99	7.16	20.15	5.25	8.20	12.41	33.60
4	0 -30	9.55	9.30	18.85	9.60	14.95	18.90	43.40
	30 - 60	12.85	7.19	20.04	5.31	8.57	12.50	33.92
5	0 -30	8.99	9.45	18.44	11.15	18.01	20.60	47.60
	30 - 60	12.58	7.36	19.94	5.45	9.17	12.81	34.56
6	0 -30	8.15	9.68	17.83	11.30	19.87	20.98	49.00
	30 - 60	12.37	7.43	19.80	5.76	9.48	16.91	35.04
7	0 -30	8.71	9.53	18.24	10.00	17.96	19.53	46.20
	30 - 60	12.71	7.29	20.00	5.55	8.69	12.84	34.24
D- Subsurface application of treatments (A single layer at the 50 cm depth)								
1	0 -30	13.63	7.88	21.51	5.91	8.63	13.79	36.05
	30 - 60	12.58	7.36	19.94	6.00	8.66	13.36	34.60
2	0 -30	13.21	8.03	21.24	6.32	9.54	14.35	37.10
	30 - 60	8.61	8.64	17.25	9.40	14.31	18.04	40.96
3	0 -30	13.35	7.99	21.34	6.11	9.30	14.10	36.75
	30 - 60	9.98	8.10	18.08	7.90	11.82	16.00	37.80
4	0 -30	13.14	8.20	21.34	7.90	8.04	16.10	37.28
	30 - 60	9.57	8.24	17.81	8.60	12.63	16.84	39.04
5	0 -30	12.93	8.10	21.03	6.47	10.30	14.57	37.80
	30 - 60	9.02	8.37	17.39	9.80	15.05	18.17	42.24
6	0 -30	12.79	8.18	20.97	6.82	10.36	15.00	38.15
	30 - 60	8.20	8.51	16.71	10.20	16.61	18.71	43.52
7	0 -30	13.07	8.33	21.40	6.43	9.62	14.76	37.45
	30 - 60	8.75	8.44	17.19	8.70	15.71	17.14	41.60

Thus, icreasing total porosity (T.P.) and fine capillary pores (F.C.P.) are actually results of changing in particle size distribution to the side of increasing fine fractions in the soil i.e. clay particles and also, results of increasing the formation of organic-clay complexes. Moreover, after the second crop (maize), maximum effects are mainly as a result of the biochemical reactions functioning and acted by the root hairs and soil microorganisms in the rizoshpere zone. As a result of these actions, more roots exudates are formed and accumulated due to the systematic and gradual modifications in the soil system, meanwhile, reflect on its chemical and consequently hydro-physical properties. It could be stated that the employment of some particles and processes to create favourable soil structure is of prime importance to maintain optimum air/water balance in soil. On the other hand, El-Damaty and Moubarak (1992) reported that cropping effect is of importance on improving hydrophysical properties of new reclaimed sandy soil in Tahreer Province. Figures 5 and 6 show relative percentages values of the increases higher than the control (the control is relatively 100%) of the properties of total porosity and fine capillary pores (F.C.P.) with the tested treatments.

3- Vital role of the experiment treatments on improving soil chemical properties of the tested soil:

Data of Table 6 show the values of pH, ECe, soluble ions, organic matter, calcium carbonates and cation exchange capacity with all of the experiment treatments.

The values of pH, ECe and soluble ions showed more or less changes with the applied treatments and application methods.

Total calcium carbonates contents of the tested soil were decreased being at maximum decrease with the treatment No. (6) after the second season with the surface application of the amendment as compared with its subsurface application treatment. Accordingly, it is expected that all of root respiration of the cultivated crops, the continuous biological activities and the active decomposition of organic manure that released CO2 lead to increase the partial pressure of CO2 in soil media which enhanced the solubility of more CaCO3 in the soil.

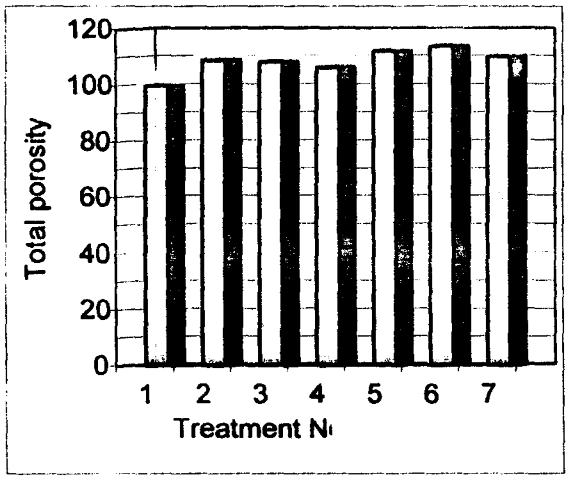
Soil organic matter contents showed remarkable increases with the treatments No. 4 (30 m^3/feddan Organic Manure), No. 5 (22.5 ton/fedan of Taffla+22.5 ton/fedan of River Nile sediments), No.6 (22.5 ton/feddan Taffla+15 m^3/feddan organic manure) and No.7 (22.5 ton/feddan River Nile sediments +15 m^3/feddan organic manure). in the second crop season with the surface application method while organic matter contents showed relatively less changes with the other treatments. Extreme of the increase in organic matter contents was found in the 0 – 30 cm soil layer (71.4% higher than the control) with the treatment No. (4) of the surface application of amendment at the second crop season than subsurface application as compared with the tratments No. 6 and 7 as each showed increase by 57.1% higher than the control with its treatment of surface application method at the second crop season.

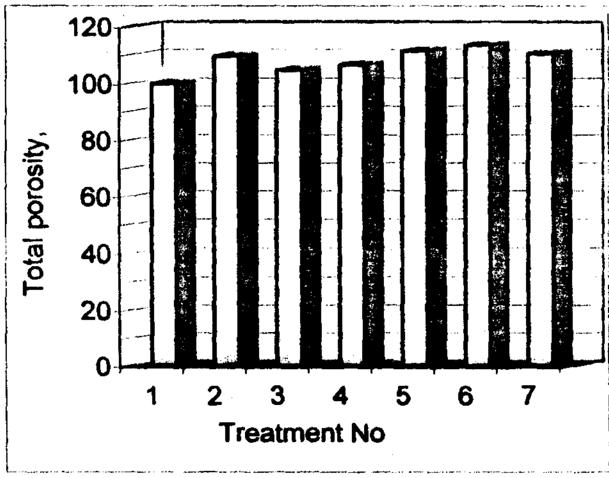
The components of clay contents and organic colloidal particles are known to play an important role in increasing the C.E.C, which are sources for supplying plant nutrients.

Total porosity

1-After the first crop (wheat)

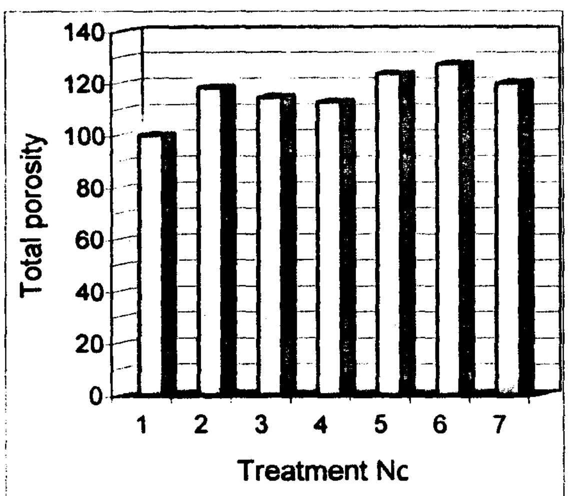
A-Surface Application method B-Subsurface Application method

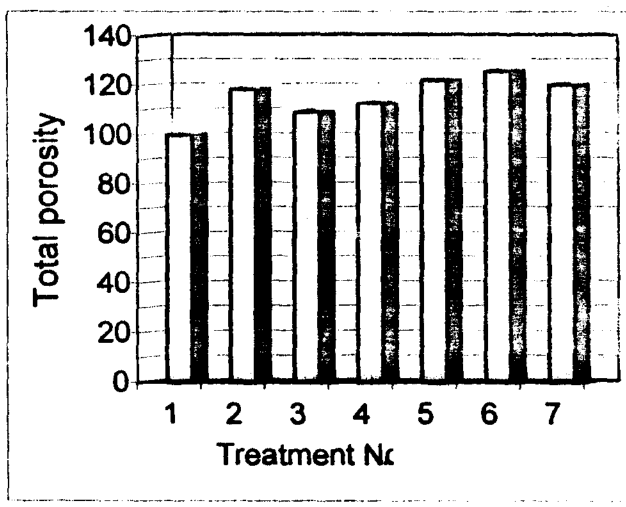




2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method



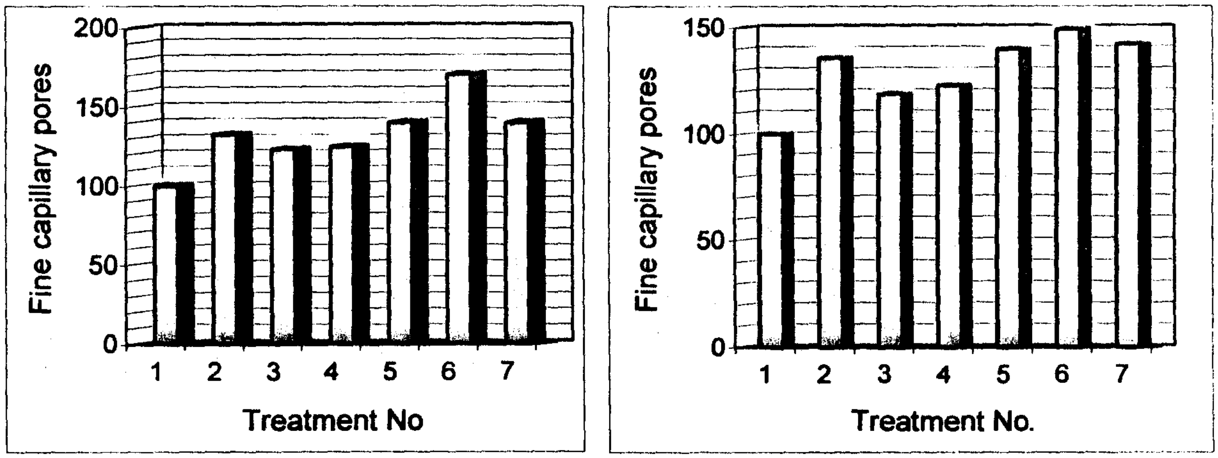


Figures 5: Relative percentage values of soil total porosity with the tested treatments .
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Fine capillary pores (F.C.P.)

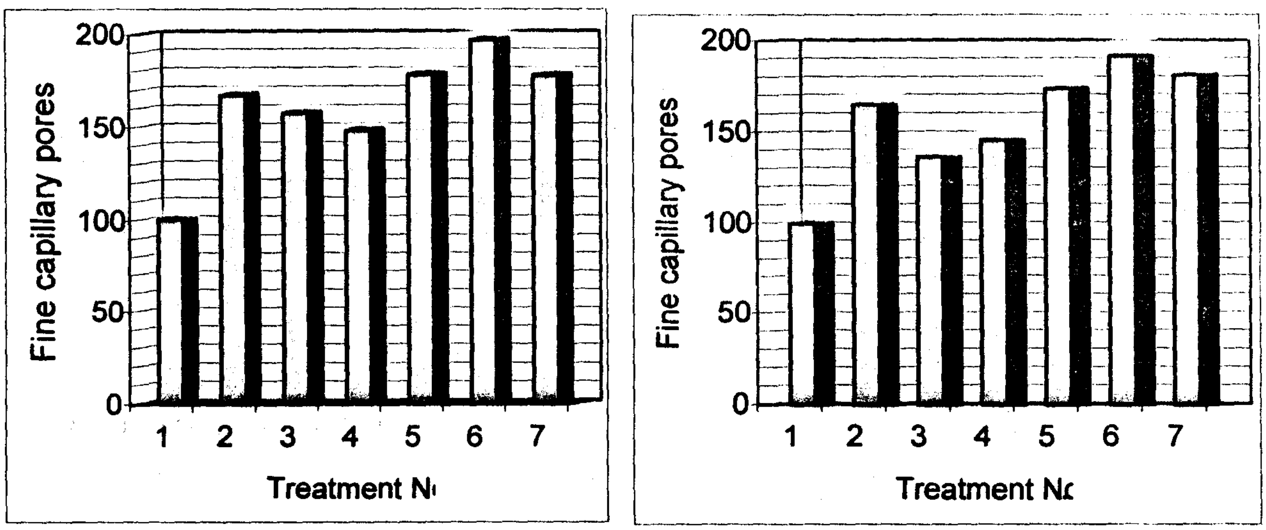
1-After the first crop (wheat)

A-Surface Application method B-Subsurface Application method



2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method



Figures 6: Relative percentages values of fine capillary pores (F.C.P.) with the tested treatments.
*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

Table (6): Effect of the tested experiment treatments on soil chemical properties.

Treatment	Depth, cm	pH*	ECe dS/m	Soluble cations, me/l Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Soluble anions, me/l HCO3-	Cl-	SO4--	O.M %	$CaCO_3$ %	C.E.C me/100g
I - After the first season (after wheat crop)													
A- Surface placement of treatments (Mixed with the 0 – 30 cm layer)													
1	0 -30	7.96	2.64	12.74	9.37	3.21	1.09	0.81	16.00	9.60	0.06	3.33	3.95
	30 - 60	7.48	3.39	18.07	9.57	4.99	1.26	1.04	21.19	11.66	0.02	2.57	2.93
2	0 -30	7.93	2.67	13.31	9.79	3.37	1.14	0.86	16.70	10.05	0.07	3.15	6.10
	30 - 60	7.47	3.55	18.92	10.03	5.23	1.33	1.09	22.20	12.22	0.02	2.55	2.96
3	0 -30	7.94	2.71	13.07	9.62	3.30	1.12	0.84	16.40	9.87	0.07	3.19	5.39
	30 - 60	7.46	3.49	18.61	9.85	5.14	1.31	1.07	21.83	12.01	0.02	2.56	2.94
4	0 -30	7.84	2.61	12.60	9.27	3.18	1.08	1.01	15.68	9.44	0.09	3.12	5.92
	30 - 60	7.46	3.36	17.91	9.49	4.95	1.26	1.03	21.01	11.57	0.02	2.52	2.97
5	0 -30	7.94	2.69	12.84	9.44	3.24	1.10	1.03	15.97	9.62	0.07	3.17	5.74
	30 - 60	7.47	3.46	18.45	9.77	5.10	1.30	1.06	21.64	11.92	0.02	2.55	2.96
6	0 -30	7.92	2.66	12.84	9.44	3.24	1.10	1.03	15.97	9.62	0.08	3.08	6.28
	30 - 60	7.46	3.42	18.24	9.66	5.04	1.28	1.05	21.39	11.78	0.02	2.54	2.99
7	0 -30	7.92	2.65	12.79	9.41	3.22	1.09	1.03	15.91	9.57	0.08	3.13	6.21
	30 - 60	7.46	3.41	18.19	9.63	5.02	1.28	1.05	21.33	11.74	0.02	2.55	2.97
B- Subsurface placement of treatments (A single layer at 50 cm depth)													
1	0 -30	7.98	2.61	12.60	9.27	3.18	1.08	1.01	15.68	9.44	0.06	3.15	3.66
	30 - 60	7.47	3.42	18.23	9.66	5.04	1.28	1.05	21.39	11.77	0.02	2.4	2.96
2	0 -30	7.95	2.74	13.23	9.73	3.33	1.13	1.06	16.45	9.91	0.06	3.08	3.70
	30 - 60	7.44	3.58	19.09	10.10	5.27	1.34	1.10	22.38	12.32	0.03	2.30	4.64
3	0 -30	7.96	2.71	13.08	9.62	3.30	1.12	0.94	14.47	8.71	0.06	3.12	3.68
	30 - 60	7.45	3.52	18.77	9.94	5.18	1.32	1.08	22.01	12.12	0.03	2.30	4.06
4	0 -30	7.92	2.61	12.60	9.26	3.17	1.08	1.01	15.67	9.43	0.06	3.01	3.72
	30 - 60	7.36	3.39	18.09	9.57	4.99	1.27	1.04	21.21	11.67	0.05	2.30	4.50
5	0 -30	7.96	2.69	12.98	9.55	3.27	1.11	1.04	16.15	9.72	0.06	3.05	3.68
	30 - 60	7.46	3.49	18.61	9.85	5.14	1.31	1.07	21.83	12.01	0.03	2.30	4.35
6	0 -30	7.94	2.66	12.84	9.44	3.24	1.10	1.03	15.97	9.62	0.06	3.01	3.73
	30 - 60	7.46	3.46	18.45	9.77	5.10	1.30	1.06	21.64	11.92	0.04	2.20	4.79
7	0 -30	7.94	2.65	12.78	9.40	3.22	1.09	1.03	15.89	9.57	0.06	3.08	3.72
	30 - 60	7.43	3.44	18.34	9.71	5.07	1.29	1.05	21.51	11.85	0.04	2.30	4.87
II- After the second season (after maize crop)													
C- Surface placement of treatments (Mixed with the 0 – 30 cm layer)													
1	0 -30	7.96	2.40	11.59	8.53	2.92	0.99	0.93	14.42	8.68	0.07	3.15	4.38
	30 - 60	7.48	3.37	17.96	9.51	4.96	1.26	1.03	21.06	11.60	0.02	2.5	2.93
2	0 -30	7.92	2.27	10.96	8.06	2.76	0.94	0.88	13.63	8.21	0.09	2.80	8.62
	30 - 60	7.46	3.54	18.88	10.00	5.22	1.33	1.09	22.15	12.09	0.02	2.47	2.96
3	0 -30	7.93	2.32	11.20	8.23	2.82	0.96	0.90	13.93	8.38	0.09	2.87	7.18
	30 - 60	7.46	3.31	17.65	9.35	4.88	1.24	1.01	20.71	11.40	0.02	2.50	2.95
4	0 -30	7.84	2.42	11.68	8.59	2.94	1.00	0.94	14.53	8.74	0.12	2.37	8.26
	30 - 60	7.45	3.34	17.81	9.43	4.92	1.25	1.02	20.89	11.05	0.03	2.44	2.98
5	0 -30	7.94	2.35	11.34	8.34	2.86	0.97	0.91	14.11	8.49	0.1	2.84	7.90
	30 - 60	7.46	3.44	18.35	9.72	5.07	1.29	1.05	21.53	11.85	0.02	2.47	2.96
6	0 -30	7.92	2.37	11.44	8.42	2.88	0.98	0.92	14.23	8.57	0.11	2.66	8.98
	30 - 60	7.46	3.41	18.18	9.63	5.02	1.28	1.04	21.33	11.74	0.03	2.47	2.99
7	0 -30	7.92	2.38	11.49	8.45	2.90	0.98	0.92	14.29	8.61	0.11	2.77	8.83
	30 - 60	7.46	3.36	17.91	9.49	4.95	1.26	1.03	21.01	11.57	0.02	2.47	2.98
D- Subsurface placement of treatments (A single layer at 50 cm depth)													
1	0 -30	7.97	2.60	12.60	9.23	3.16	1.07	1.01	15.64	9.41	0.06	3.00	3.70
	30 - 60	7.47	3.41	18.18	9.63	5.02	1.28	1.04	21.33	11.74	0.03	2.20	2.979
2	0 -30	7.94	2.73	13.18	9.69	3.32	1.13	1.06	16.39	9.87	0.07	2.91	3.73
	30 - 60	7.44	3.57	19.03	10.08	5.26	1.34	1.09	22.33	12.29	0.04	1.98	6.38
3	0 -30	7.95	2.69	12.99	9.55	3.27	1.11	1.04	16.15	9.73	0.04	2.94	3.72
	30 - 60	7.44	3.50	18.99	9.88	5.15	1.31	1.08	22.09	12.16	0.03	2.03	5.22
4	0 -30	7.92	2.59	12.5	9.19	3.15	1.07	1.01	15.55	9.35	0.06	2.84	3.75
	30 - 60	7.35	3.38	18.03	9.55	4.98	1.27	1.04	21.15	11.64	0.04	1.92	6.09
5	0 -30	7.95	2.68	12.93	9.51	3.26	1.10	1.04	16.08	9.68	0.07	2.87	3.72
	30 - 60	7.45	3.47	18.51	9.80	5.11	1.30	1.06	21.71	11.95	0.04	2.05	5.80
6	0 -30	7.93	2.64	12.74	9.37	3.21	1.09	1.02	21.13	4.26	0.07	2.87	3.77
	30 - 60	7.43	3.44	18.35	9.72	5.07	1.29	1.05	21.53	11.85	0.04	1.87	6.67
7	0 -30	7.94	2.61	12.60	9.26	3.17	1.08	1.01	15.67	9.43	0.07	2.91	3.75
	30 - 60	7.43	3.42	18.23	9.66	5.04	1.28	1.05	21.39	11.77	0.04	1.95	6.84

On the other hand, duration of the cultivation period that are associated with the applied crop-management practices caused active decomposition rate and more accumulation of organic matter complexes resulted from the roots exudates, and also, from the plant residues remained after the previous crop (wheat) and, hence, exceed day after day the organic matter contents of the soil.

Results showed remarkable increases in C.E.C with both surface and subsurface application methods especially at the second crop season. Maximum increases (123.8% and 129.5% higher than the control) were found with treatment No. (6) and (7) of the subsurface application method after the second season, respectively.

Figure 7 show relative percentages values of the increases higher than the control (the control is relatively 100%) of cation exchange capacity with the experiment treatments.

As a result of addition of clay containing amendments, more of the inorganic colliodal particles (clay contents) will be created while addition of organic manure amendments that containing humified materials will increase the organic colloidal particles. As a result of these particles, formations of organic-clay complexes are expected to increase and show active functioning in soil system (Kononova, 1966 and Allison, 1973). These formations are highly effective in new reclaimed soils to buildup new aggregates and create more suitable medium for roots system to establish effective plant growth (El-Shakweer et al;1997). The enormous influence of organic matter on so many of the soil's properties (i.e. biological, chemical and hydrophysical properties) makes it of critical importance to create healty topsoil.

4- Vital role of the experiment treatments on improving the yield of wheat and maize crops grown on the tested soil:

Table (7) shows the improving effects of the tested treatments on the grain and straw yield of wheat and the grain yield of maize. It could be noticed in Table 7 that maximum increase was found with the treatment No. 6, as with the surface application method their increases higher than the control were 70%, 65% and 76.6 with the grain and straw yield of wheat and grain yield of maize, respectively, while the corresponding increases with the subsurface application method were 65.3%, 60.0% and 70 %.

Thus, it could be concluded from this study that optimum and quick improvement to the new reclaimed sandy soils could be realised as a combination of mixture of organic amendment (organic manure) and inorganic amendment (clay deposits) are added to the surface soil layer. This mixture supply the soil with humus and clay particles. Humus substances have many negative charges which are able to hold onto positively charged nutrients keeping them from leaching deep into the subsoil when irrigation water moves through the topsoil. Clay particles also have negative charges on their surfaces but organic matter may be the major source of negative charges for coarse and medium textured soils. The intimate contact of humus with the rest of the soil allow many reactions such as the release of available nutrients into the soil water, which gain a good topsoil and huge diversity of life.

It could be recommended that the following four main issues must be considered when applying amendments to new reclaimed sandy-textured soils:

1-The optimum source(s) of amendment to be applied. This include mixture of more than one amendment of inorganic and organic origin.

2-The optimum amount needed per unit area from the selected amendment and/or from the mixture.

3-The optimum method of application the amendment. This include surface and/or subsurface application methods. Other alternative methods may be applied.

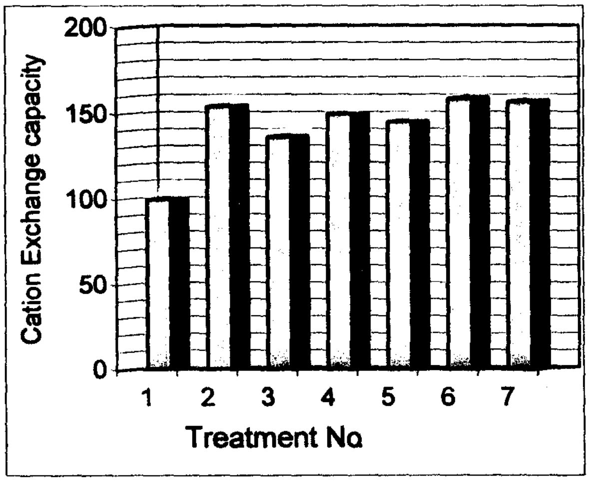
4-The optimum timing of applying the amendment reference to the planned crop.

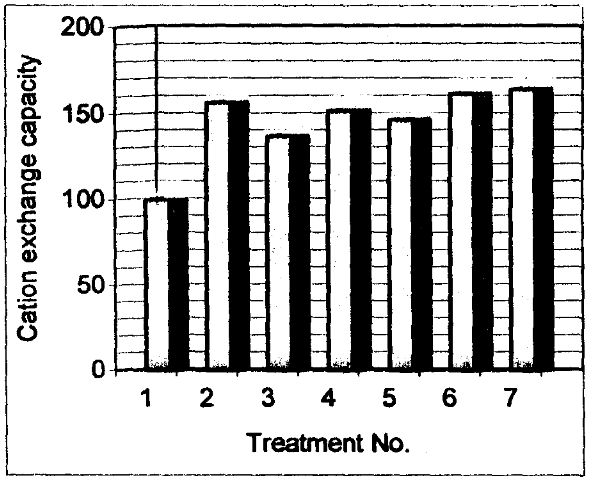
Figure 8 show relative percentages values of the increases higher than the control (the control is relatively 100%) of yield components of wheat (the first crop season) and maize (the second crop season) with the experiment treatments.

Cation exchange capacity (C.E.C.)

1-After the first crop (wheat)

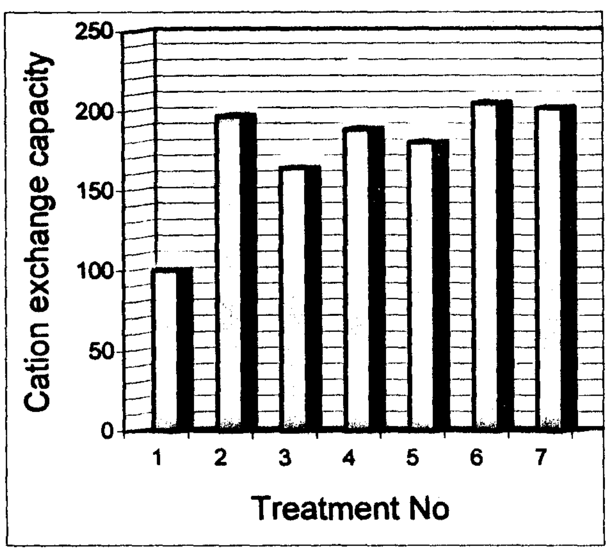
A-Surface Application method B-Subsurface Application method





2-After the second crop (maize)

C-Surface Application method D-Subsurface Application method



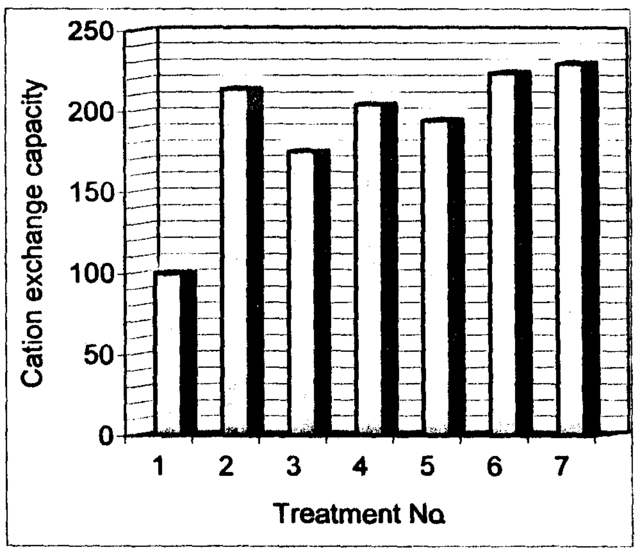


Figure 7: Relative percentages values of cation exchange capacity (C.E.C.) with the tested experiment treatments.

*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

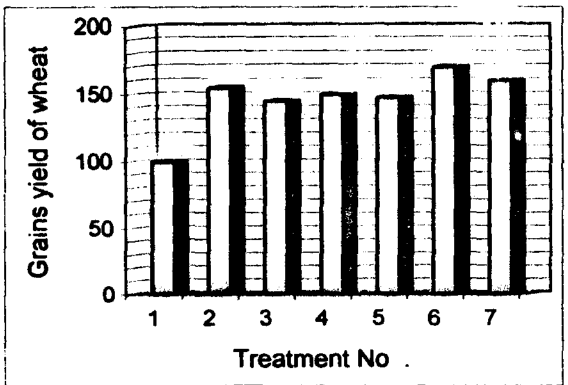
Table (7): Effect of the tested experiment treatments on the yield of wheat and maize crops.

Treatment No.	Wheat yield, Kg/exp. unit		Grain yield of maize Kg/exp. unit
	Grain	Straw	
1-Surface placement of the amendment (mixed with 0 – 30 cm soil layer)			
1	3.224	4.073	3.035
2	4.997	6.109	4.900
3	4.675	5.702	4.594
4	4.836	5.905	4.747
5	4.771	5.824	4.686
6	5.481	6.720	5.360
7	5.158	6.313	5.052
2-Subsurface placement of the amendment(a single layer at the 50 cm depth)			
1	3.000	3.986	2.920
2	4.500	5.978	4.526
3	4.200	5.380	4.234
4	4.350	5.580	4.380
5	4.435	5.700	4.322
6	4.959	6.377	4.964
7	4.653	5.978	4.672
L.S.D. 5 % :			
Placement Method (1)	0.2301	0.0208	0.0085
Treatment Type (2)	0.1790	0.0144	0.0176
Interaction of (1) x (2)	0.2531	0.0203	0.0249

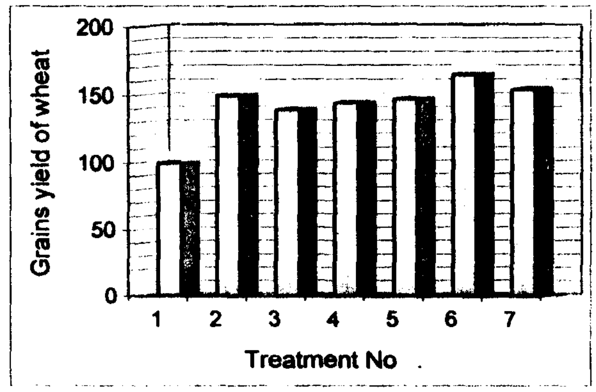
Yield of wheat and maize crops.

1-Grains yield of wheat (The first crop)

A-Surface Application method

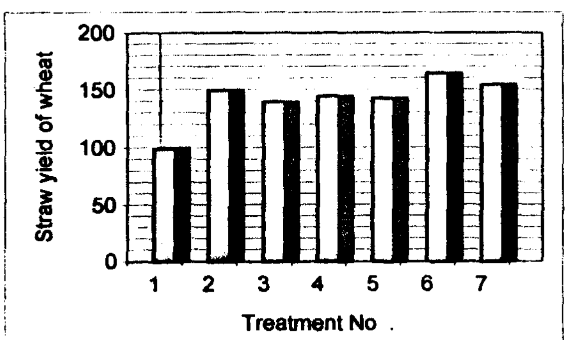


B-Subsurface Application method

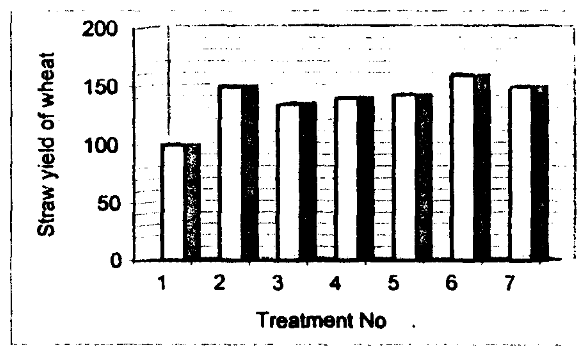


2- Straw yield of wheat (The first crop)

C-Surface Application method

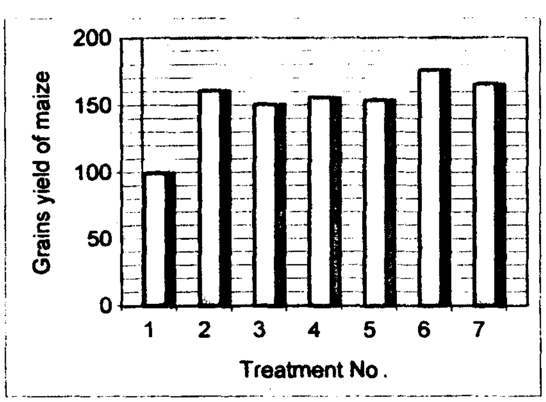


D-Subsurface Application method



3- Grains yield of maize (The second crop)

E-Surface Application method



F-Subsurface Application method

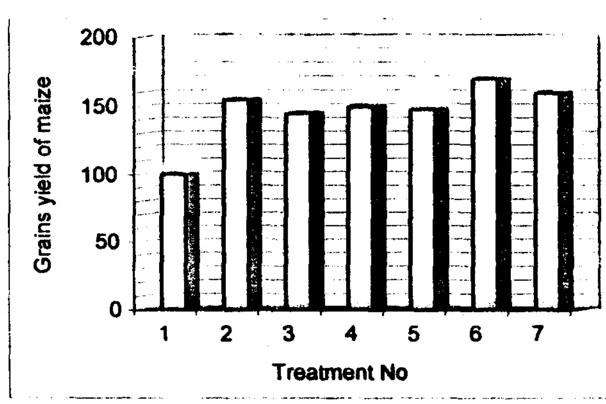


Figure 8: Relative percentages values of the vital role of the tested treatments on yield of wheat and maize crops.

*** The control is considered = 100% and numbers of treatments are explained in the "materials and methods".**

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الملخص العربي

تحسين الخواص الهيدروفيزيائية لأرض جديدة مستصلحة بإستخدام محسنات محلية صديقه للبيئة فى محافظة الفيوم

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تتطلع الخطط القومية فى مصر إلى زيادة إمكانيات إصلاح الأراضى أفقيا ورأسيا ، وفى نفس الوقت فإن الأعمال الجارية تهدف لتحسين خواص الأراضى الجديدة المستصلحة. لذا يهدف هذا البحث إلى تحسين الخواص الهيدروفيزيائية لأرض جديدة مستصلحة تقع فى محافظة الفيوم بجمهورية مصر العربية بإستخدام ثلاثة محسنات تربة محلية وصديقة للبيئة.

وأجريت تجربة حقلية مكونة من ٥٦ وحدة تجريبية حقلية كل منها ٣ x ٥ ر٣ متر مربع موزعة فى تخطيط عشوائى كامل فى أرض جديدة مستصلحة بقرية كوم أوشيم بمحافظة الفيوم بجمهورية مصر العربية وذلك لدراسة إمكانيات تحسين التربة بواسطة ثلاثة محسنات تربة محلية وطبيعية صديقة للبيئة. وقد شملت المعاملات ٤٥ طن/فدان طفلة ، ٤٥ طن /فدان ترسيبات نهر النيل ، ٣٠ طن سماد عضوى ، كما شملت المعاملات ٣ معاملات أخرى لنصف الكميات السابقة مخلوطة فى تباديل كل واحدة مع الأخرى . ونفذت المعاملات فى ٤ مكررات فى مجموعتين كل منها تمثل طريقة لإضافة المعاملات (الأولى إضافة المعاملات فى الطبقة السطحية صفر–٣٠ سم ، والثانية إضافة المعاملات تحت السطح على عمق ٥٠ سم)، وزرعت كل معاملات المجموعتين بمحصول القمح يليه الذره . وعند حصاد كل من المحصولين تم تسجيل وزن المحصول والخواص الهيدروفيزيائية والتوزيع الحجمى للمسام والخواص الكيميائية فى عينات التربة المأخوذة بعد الحصاد مباشرة على عمقين صفر–٣٠سم ، ٣٠–٦٠ سم.

وتبين النتائج حدوث تحسن فى الخواص الهيدروفيزيائية والتوزيع الحجمى للمسام والخواص الكيميائية للتربة وكذلك محصول كل من القمح والذره. كما تبين أن إضافة ٤٥ طن /فدان من الطفلة زادت نسبة الطين فى الطبقة السطحية ومع زراعة المحصول تزداد نسبة التحسن فى الخواص التى تمت دراستها فى التربة.

وتبين النتائج أنه بإضافة مخلوط من ٥ر٢٢ طن /فدان طفله +١٥ متر مكعب /فدان من السماد العضوى ثم زراعة القمح يليه الذره فقد أدى ذلك إلى تحسن فى الماء الميسر بمقدار ٧ر٥٠% ، ٠ر٧٠% ، وفى المسامية الكلية بمقدار ٣ر٢٧% ، ٨ر ٢٥% ، وفى المسامية الشعرية الدقيقة بمقدار ٧ر٩٦% ، ٨ر٩١% وفى السعة التبادلية الكاتيونية بمقدار ٠ر١٠٥% ، ٨ر١٢٣% ، وفى محصول حبوب القمح ٠ر٧٠% ، ٠ر٦٥% وفى محصول الذره ٦ر٧٦% ، ٠ر٧٠% أعلى من الكنترول مع كل من طريقة الإضافة السطحية وطريقة الإضافة تحت السطحية على التوالى . وقد نوقشت النتائج وقدمت فى رسومات بيانية توضيحية .