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Feasibility of Sub-Soiling, Mole Drain and Suger Beet Compost Applications to Improve Soil Properties and Production of Sorghum and Barley at Nubaria Area

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ABSTRACT

The current work was conducted in two successive seasons (summer season-2015and winter season-2015/2016) where sorghum and barley ware planted in summer and winter season at the farm of Nubaria Agriculture Research Station (Calcareous soil), Behera Governorate to study improving some soil properties by leaching process and application of compost under mole drain and sub-soiling. At summer season where starting leaching process and cultivating sorghum plant, the obtained results revealed that the reduction in soil salinity through the leaching period (four irrigation gifts each of them was 400 m3/fed. ,the interval between them was 15 days) at the sub-soiling area were 38.88% and 35.24% for 0-30, 30-60 cm soil depths, respectively. While, at mole drain treatment area, they were 41.84% and 41.76% for the same depths. The reductions in soil salinity through sorghum cultivation periods for the same depths at sub-soiling treatment area were 35.34% and 42.43% for 0-30, 30-60 cm depths, respectively and they were 27.32% and 25.59% for the same depths at the mole drain treatment.The total amounts of salts leached from top 60 cm of sub-soiling and mole drain treatments through leached periods were 3532.1 and 4025.8 kg/fed., respectively. While they were 2340.2 and 1483.1 kg/fed. during sorghum cultivation season for the two treatments, respectively. The results indicated also that, sub-soiling and mole drain treatments under open surface drainage lowered the water table level, but sub-soiling seemed to be more effective on lowering the water table level in soil. Sorghum green yields at area treated by sub-soiling varied from 9.76 to 12.83 ton/fed. with an average of 10.97 ton/fed., while they varied from 8.46 to 10.14 with an average 9.25 ton /fed. at other area, (treated by mole drain).At winter season where the effect of applying sugar beet compost on soil properties and barley (C.V. Giza 123) yield was studied, the obtained results indicated that ECe increased from 4.3 to 4.6 dSm-1 ,this increase was 6.5% for both areas in the surface layer (0-30) cm, while at the (30-60) cm depth the data showed that there were little differences in ECe under treated soils. The mean values of total porosity at the sub-soiling area increased from 4.8 to 5.07% for (0-30) and (30-60) cm depth , respectively, while at mole drain treatment the increase was 5.1 and 3.19% for the same above-mentioned depths, respectively. On the other hand, the mean values of bulk density (Pb) showed little decrease 1.57 and 0.78 % at (0-30) and (30-60) cm soil depth, respectively for both treated areas with application 3.0 Ton/fed. compost at both areas under study.The mean values of saturated hydraulic conductivity (Ks) at the area treated by sub-soiling increased as a result of application compost from 1.39 to1.53 cm/h (9.15% increase) and from 1.33 to 1.5 cm/h (11.33% increase) at (0-30) and (30-60) cm depths, respectively. On the other hand, they increased from 1.38 to 1.44 cm/h (4.17%) and 1.33 to 1.46 cm/h (8.9%) at mole drain treatment. The mean values of the relative increase in barely grain yield which obtained at rate 3 ton/fed. for sub-soiling and mole treatments, the increasing percentages were about 12.66% and15.69 %, respectively. On the other hand, the mean values of the relative increase in straw yield were 10.53 % and 17.85 % for both treatments, respectively.

Keywords: Soil improvement, mole drain, leaching process, soil properties, compost, sorghum, barely.

INTRODUCTION

The northern parts of the Nile Delta are suffering from increasing the salt-affected soils where, climate factors increase salinization. Beside other factors, such as higher ground water (Mohamed *et al*., 2013, Mohamed and Gouda, 2018). The increased salinization of soils and high ground water level in recent decades is considered to be a major problem of agriculture in Egypt and is thought to be a result of the Nile's weak demineralization of the soil due to the absence of flooding. It is also facilitated by the introduction of 12 month irrigation without a corresponding good drainage system, leading to the absorption and accumulation of salts in toxic quantities for plants (Kalkhan *et al*., 2000). Soil salinization is considered to be ecologically dangerous, because it suppresses the growth of many agricultural plants. It also decreases the agricultural productivity in arid and semiarid zones (FAO, 1986).

The major problems of soil under calcareous conditions are poor in physical properties and deficient in organic matter (Azza *et al*., 2017). Elissondo *et al*. (2001) found a decrease in B.d in Typic Argiudolls, and Soracco (2009) found an increase in the infiltration rate due to the practice of loosening soil with a chisel plow in the same soil type, but this effect did not persist after harvest.

Improving crop growth following sub-soiling and mole drains are generally considered to be the result of the physical shattering of the hardpan, which allows increasing water penetration into the subsoil. This may also accelerate the leaching of sodium from the subsoil thereby further reducing the possibility of reformation of the hardpan Lickacz (1993). Aiad *et al*. (2012) revealed that soil compaction influenced soil strength, bulk density, root penetration, aeration and nutrient uptake; all of which could have a direct bearing on crop production. Said (2003) Antar *et al*. (2008) and Wang *et al*. (2019) concluded that the cumulative and basic infiltration rate of the treated soil by sub-soiling markedly was increased relative to the untreated one. They also, found that increasing the thickness of the plough layer reduced the thickness of the hard pan, improved soil properties a sharp decrease in the bulk density, penetration resistance in coincidence with a sharp increase in total porosity, macro pores, increase of soil moisture, increased the root distribution and microbial activity in the deep soil layer relative to the untreated one.

Sub-soiling in the drainage mode seeks to lift and shatter the soil peds to induce improved structure and so improve the water movement to the permanent pipe system (Abdel-Mawgoud *et al*., 2006). Sub-soiling will enhance downward movement of irrigation water carrying off excess salts from surface layers. After wards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper ones. Sub-soiling, on the suitable soil type and done properly can reduce waterlogging problems (Moukhtar *et al*., 2002, Moukhtar *et al*., 2003 and Antar *et al*., 2012).

Mole drain depends on the soil permeability and the necessity of drainage also. If the spacing is less than 2 m, there is a danger of damage of the previously constructed drain, where as if the spacing is greater than 5 m, the fissuring effect may not cover the intervening space. Local experience rather than the adopting a particular value determines the spacing of the mole drain. The length of mole channels depends on the grade of the mole drains formed, soil type, shape, size and topography of the field. Flat slopes require shorter drain. A balance has to be found between risk of scouring with high water velocities on deep grades and risk of pond and channel collapse at low grades in order to decide grade of mole channel. In order to protect the outlet of mole drain, a small piece of approximately 1 m length PVC pipe is inserted at the outlet side of the drain. For longer life of mole drains, the timing of the installation is very critical. At the time of moling, the soil at moling depth should be plastic and soil above this depth should be friable so that there is adequate traction and the soil will crack well from the leg slot to the soil surface (Abdel-Mawgoud *et al*., 2003 and Moukhtar *et al*., 2012).The construction of mole drain is more effective in reducing soil bulk density and increasing basic infiltration rate, decreasing soil salinity and sodicity especially, in the top soil (0-60 cm). Mole and compost rates have highly significant effect on yields and yield components of wheat and sunflower (Aiad, 2014 and El-Henawy *et al*., 2016).

Antar *et al*. (2012) revealed that soil salinity and sodcity in the topsoil, were reduced after sub-soiling and moling installation. Sub-soiling and/or moling seemed to be more effective on reducing soil bulk density especially in the surface layer (0-30cm). Sub-soiling and/or moling treatments were superior in enhancing soil porosity. Basic infiltration rate (BIR) was increased with sub-soiling and/or moling.

Compost has a positive effect on soil fertility as well as the productivity of the field crops. Addition of significant quantities of agricultural residues as compost in sandy soils improves their physical, chemical and biological properties. Seddik and Laila (2004) found that addition of rice straw compost to the sandy soil decreased bulk density and hydraulic conductivity and increased total porosity, field capacity and available water. Moreover, the use of compost as an amendment improving the soil chemical and biological properties and /or provided plants with essential nutrients, (Awad, 1994 and Zhao, 2019).

Measurement of hydraulic conductivity coefficient (K) at different soil water tensions and quantification of water-conducting macro-porosity (θM) are important for improving understanding of soil physical behavior. The properties of the soil macro-pore network (i.e., macro-pore volume fraction and diameter and continuity of macro-pores) have a big impact on the infiltration characteristics of agricultural soils (Hillel, 1998). Studies for quantifying macro-pore flow revealed that more than 70 % of water flux can move through macro-pores (Watson and Luxmoore, 1986). In general, water flow through structured soils is mainly conducted by macro-pores, even though they constitute only a very small fraction of total porosity (Cameira *et al*., 2003). Macro porosity represents an important indicator of soil physical properties particularly in relation to the site-specific water transmission properties, and can be used as a sensitive measure to assess soil structural degradation. The importance of soil macro porosity for water transport properties of the soil presents a challenging task for its quantitative assessment (Schwen *et al*., 2011).

The main aim of the present work is to study the effect of improving some soil properties of calcareous soil by leaching process and application of sugar beet compost under sub-soiling and drain mole and sub-soiling through two crop summer crop (sorghum) and winter crop (barely).

MATERIALS AND METHODS

The current work was conducted in two successive seasons (summer season-2015and winter season-2015/2016) where sorghum and barley were planted in summer and winter season at farm of Nubaria Agriculture Research Station (Calcareous soil), Behera Governorate to study the effect of improving some soil properties by leaching and application of sugar beet compost under mole drain and sub-soiling on some soil physical and chemical properties. The total study area was one feddan chosen to carry out this study, half feddan for sub-soiling and another half feddan for mole drain.

Table (1) shows some physical and chemical properties of soil under study. Four irrigation gifts were added with interval 15 days at the beginning of summer season after constructed sub-soiling and mole drain. Each irrigation gift was 400 m3/fed. Ten observation wells 1.5 m depth from soil surface were installed in the studied area (five observation wells in the field provided with sub-soiling and the other five observation wells in the field provided with mole drains) to monitor the fluctuation of water table in both areas. The water table depths were measured daily using a sounder. Also, the salinity of the ground water was measured in the observation wells using portable EC-meter. Soil samples were taken from ten locations, five in each area, for two depths (0-30, 30-60 cm) from soil surface before and after leaching and at the beginning and at the end of sorghum to study the effect of leaching under application of sub-soiling at 60-70 cm depth from soil surface and 60 cm spacing between each sub-soiling and mole drain at depth 70 cm depth from soil surface with about 13 m spacing between each two mole drains on some soil properties. Mole drains were filled by wheat straw and corn residues. Also, at the end of winter season soil samples were taken from the same locations and depths to determine some soil properties. During winter season (Barley cultivation) different application rates of compost amendments (0 and 3 ton/fed.) were used to study its effect on some soil properties .The chemical characteristics of compost amendment are shown in Table (2).

To determine soil salinity and pH through the study the soil samples were chemically analyzed according to methods described by Page (1982). Also, some soil physical parameters such as, hydraulic conductivity, bulk density, total porosity were determined according to (Klute, 1986), the results are presented in Table (1).

Unconfined compressive strength UCS (ton/ft2) at surface and subsurface soil layers for each treated area also estimated, the pocket penetrometer was used to measure soil resistance to deformation forces (unconfined compressive strength UCS(ton/ft2), Black (1965).The values of unconfined compressive strength of soil are calibrated directly on a scale on the piston barrel. It could be expressed in terms of consistency according to Black (1965) as follows: very soft (<0.25), soft (0.25-0.50), medium (0.50-0.100), stiff (1.00-2.00), very stiff (2.00-4.00) and hard (>4.00). Moreover, barley yield was estimated at the end of the season.

Moreover, water stable aggregates determination was carried out for the same soil layers using the wet sieving technique as described by Yoder (1936) and modified by Ibrahim (1964). The wet sieving aggregation stability (WSS) was calculated using the equation:

$$\mathbf{WSS = (m/M) \times 100}$$

Where: m : is water stable aggregates fraction weight in g.
M : is weight of soil sample used in g.

Structure coefficient values (SC) were calculated as suggested by El-Shafei and Ragab (1975):

$$SC = \frac{\text{Aggregates} > 0.25\text{mm diameter \%}}{\text{Aggregates} < 0.25\text{mm diameter \%}}$$

To carry out this work three main stages (periods) were included to fulfill this study :

Soil leaching stage :

As the soil is suffering from high salinity, a programme of soil leaching including four successive irrigations was performed during the fallow season before planting sorghum. To carry out soil leaching about 400 m3/fed. was applied in each irrigation. The interval between the four leaching irrigations were 15 days. In this stage, initial soil samples were taken before leaching process then, final soil samples were collected from the same locations and depths after leaching for analysis and estimating the amount of leached salts from the soil.

The Leached Salts were calculated as suggested by van Hoorn and van Alphen (2006):

$$\textbf{Leached Salts} = Sp * B.d * \Delta ECe * depth * 0.2668$$

Where: Sp= saturation percentage
B.d = bulk density
ΔECe = ECe(dS/m) Initial - ECe(dS/m) Final

Sorghum planting stage:

Initial soil samples were collected before planting of sorghum , then final soil samples were taken from the same depths and location at the end of the summer season during sorghum harvesting . The amounts of salts leached from soil during summer season were calculated under different treatments (sub-soiling and mole drain). Moreover, sorghum yield was estimated at the end of the season.

Barley planting stage :

Initial soil samples were collected before planting of barley (C.V. Giza 123), then final soil samples were taken from the same depths and location at the end of the winter season during barley harvesting under different sugar beet compost and mole drains treatments. Then soil salinity (ECe) , Soil bulk density (B.d) , total porosity (TP) and saturated hydraulic conductivity (ks),water stable aggregate (WSA) were determined.

Table 1. Some physical and chemical properties of the experimental soil.

Soil characteristics	0-30	30-60
Particle size distribution		
sand %	56.22	54.74
Silt %	22.81	23.11
Clay %	20.97	22.15
Soil texture	sandy loam	sandy loam
Bulk density (B.d) (g/cm^3)	1.31	1.38
Hydraulic conductivity (cm/ h)	1.84	2.43
$CaCO_3$ %	23.11	25.62
Organic matter %	0.26	0.19
pH (1:2.5) soil-water suspension	8.37	8.41
EC_e (dS/m)	9.88	11.27
Soluble cations (me/l)		
Ca^{++}	31.98	28.87
Mg^{++}	10.29	11.3
Na^{+}	44.71	52.42
K^{+}	11.82	20.11
Soluble anions (me/l)		
$CO_3^{=}$		
HCO_3^{-}	13.15	20.15
Cl^{-}	51.83	54.22
$SO_4^{=}$	33.82	38.33

Table 2. Chemical properties of the sugar beet compost used at the studied areas during winter season.

E.C (dSm^{-1}) (1:10)	PH (1:25)	Ash%	OM %	C/N %	Moisture Content %	B.d (g/cm^3)	N	P	K	Fe	Mn	Zn	Cu	Ca %	Mg %	Na %
							Total(%)		Available (ppm)							
4.24	7.72	47.7	26.1	10.3	15.93	0.48	2.1	0.8	137	984	67	74.3	3.82	0.77	0.2	0.4

RESULTS AND DISCUSSION

1. The effect leaching process on soil salinity:

Moling or sub-soiling enhances downward movement of irrigation water carrying off excess salts from surface layers. Afterwards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it is close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper ones (Moukhtar *et al*., 2002 and Said, 2003).

The ECe values of soil samples were determined at the beginning of the study (initial)from the area provided by sub-soiling which ranged from 8.92 to 9.81 dS/m with an average 9.26and ranged between8.73 and 9.96 dSm-1 with an average 9.28 dSm-1for 0-30, 30-60 cm depths, respectively (Table 3). The ECe values for the same area at the end of leaching period were ranged between 5.45 and 5.94 dS/m with an average 5.66 dSm-1 and ranged from 5.26 and 6.43 dS/m with an average 6.01 dS/m , for the same depths, respectively. From the previous values, it can notice that the reductions in soil salinity through the leaching period were 38.88% and 35.24% for 0-30, 30-60 cm depths, respectively.

On the other hand, soil ECe values of the same area (sub-soiling) for sorghum cultivation season ranged between 3.4 and 3.8 dSm-1 with an average 3.66 dS/m between 3.31 and 3.55 dS/m with an average 3.46 dS/m for 0-30, 30-60 cm depths, respectively (Table 4).The reductions in soil salinity for the same area were35.34% and 42.43% for 0-30, 30-60 cm depths, respectively.

Table 3. Total amounts of salts leached from the soils through the leached period at the studied areas.

Treatments	Soil depth (cm)	SP %	B.d g/cm^3	EC$_e$(dS/m) Initial	EC$_e$(dS/m) Final	ΔEC$_e$ (dS/m)	Leached Salts (kg/fed)
Sub-soiling	0-30	50	1.27	9.26	5.66	3.60	1841.4
	30-60	50	1.28	9.28	6.01	3.27	1690.7
	Total						3532.1
Mole drain	0-30	50	1.25	9.44	5.49	3.95	1987.8
	30-60	50	1.27	9.53	5.55	3.98	2038.0
	Total						4025.8

Table 4. Total amounts of salts leached from the soils through the sorghum cultivation period at the studied areas.

Treatments	soil depth (cm)	SP %	B.d g/cm^3	EC$_e$ (dS/m) initial	EC$_e$ (dS/m) final	ΔEC$_e$ (dS/m)	Leached Salts (kg/fed)
Sub-soiling	0-30	50	1.27	5.66	3.66	2.00	1024.1
	30-60	50	1.28	6.01	3.46	2.55	1316.0
	Total						2340.2
Mole drain	0-30	50	1.25	5.49	3.99	1.50	756.0
	30-60	50	1.27	5.55	4.13	1.42	727.1
	Total						1483.1

Regarding to soil salinity at 0-30 cm depth of the other area which provided with mole drain, ranged between 9.18 and 10.08, between 5.28 and 5.82and between 3.89 and 4.18 dS/m with an average 9.44, 5.49 and 3.99 dS/m at the beginning and at the end of leaching and the end of season, respectively. While for 30-60 cm depth they ranged from 9.1 to 10.17, 5.16 to 6.31 and 3.92 to 4.52dS/m for previous period, respectively with an average 9.53, 5.55 and 4.13dS/m, respectively.

The reductions in soil salinity during the leaching period were 41.84% and41.76% for 0-30, 30-60 cm depths, respectively. They were 27.32% and 25.59% during sorghum cultivation for the two soil depths, respectively.

From the abovementioned results, we can calculate the total amounts of salts removed from soil depths from the two areas during the leaching process and during sorghum cultivation season

(Fig.1).The total amounts of salts leached from sub-soiling and mole drain areas during leached periods were 3532.1 and 4025.8 kg/fed. for 0-60 cm depth, respectively. While they were 2340.2 and 1483.1 kg/fed. during sorghum cultivation season for the two areas, respectively. The high amounts of salts removed can be due to the soil texture (sandy loam) and the type of soluble salts (NaCl as a dominant salt).

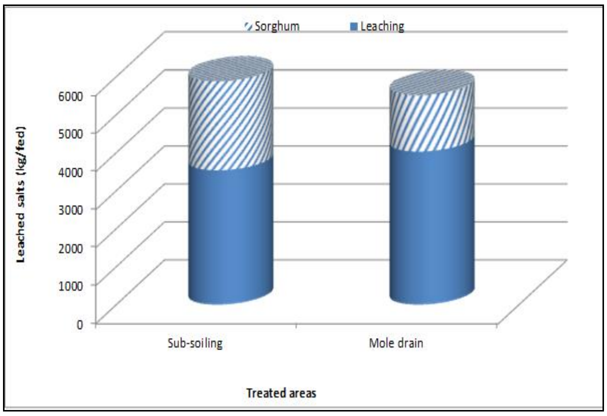

Fig. 1. Total leaching salts (kg/fed) from treated soil at depths (0-60 cm.) during leaching period and sorghum cultivation.

Sub-soiling reduced the soil salts by 60.58% (total amount of salts leached from soil depth 0-60 cm were 5872.3 kg/fed. but the mole drain reduced the soil salts by 57.73% (the total salts leached from soil depth 0-60 cm were 5508.9 kg/fed). Finally, it can be concluded that, the sub-soiling treatment was more effective in leaching of salts from surface layer than mole drain treatment, this may be interpreted on base that mole drains spacing was wider (13 m) than sub-soiling (0.6 m) in this case the fissuring effect may not cover the intervening space while the sub-soiling spacing (0.6m) will more cover the intervening.

2.Water table depths:

Data illustrated in Fig (2) show the mean values of water table depths below soil surface before and after construction of sub-soiling and mole drain. They varied from 43.00 to 51.18 cm (with an average 48.63 cm) and 66.42 to 75.32(with an average 71.70 cm) below soil surface before and after construction of sub-soiling, respectively. While they were varied from 43.8 to 53.68 (with an average 48.47 cm) and 70.44 to 71.52 cm (with an average 70.82 cm) below soil surface before and after construction of mole drain, respectively. Results indicate that, sub-soiling and mole drain treatments with open surface drainage lowered the water table level. Otherwise, sub-soiling seemed to be more effective in reducing the water table in the soil.

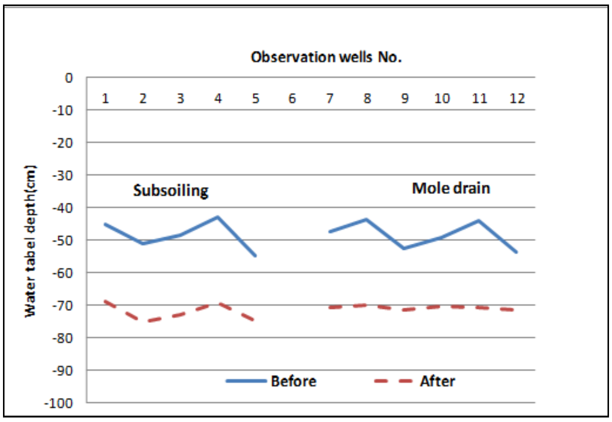

Fig. 2. Average water table depth in observation wells at the areas under study before and after leaching.

On the other hand, the values of the ground water salinity at sub-soiling area varied between 7.12 and 7.84 with an average 7.31 dS/m and from 4.16 to 4.32 with an average 4.27dS/m before and after sub-soiling, respectively as illustrated in (Figure 3). While the ground water salinity at the other area before and after constructed mole drains varied from 6.96 to 7.24 with an average 7.16 dS/m and from 4.49 to 4.68 with an average 4.58 dS/m, respectively. These results could be interpreted according to Moukhtar *et al*, (2003) who reported that, moiling or sub-soiling enhance downward movement of irrigation water carrying off excess salts from surface layers. Afterwards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it is close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper ones.

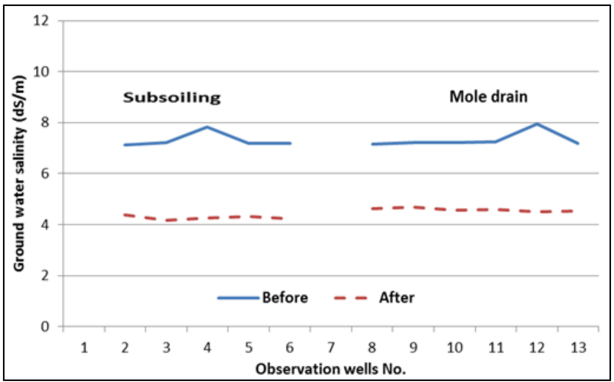

Fig. 3. Average ground water salinity (dS/m) in observation wells at the areas under study before and after leaching.

3. Sorghum green yield:

Improved crop growth following sub-soiling and mole drains are generally considered to be the result of the physical shattering of the hardpan, which allows increasing water penetration into the subsoil. This may also accelerate the leaching of sodium from the subsoil thereby further reducing the possibility of reformation of the hardpan (Lickacz, 1993).

The sorghum green yields at the strips near from sub-soiling line were more than the yields at strips faraway by 28.3 to 45.6%,while they were from 26.93 to 34.62 % at the area treated by mole drain. Sorghum green yields at the strips on the area treated by sub-soiling varied from 9.76 to 12.83 ton/fed. with an average 10.97 ton/fed., while they varied from 8.46 to 10.14 with an average 9.25 ton /fed. at other areas (treated by mole drain).The results indicated that yields are increased when the ECe decreases as affected by sub-soiling and/or moling. According to Tavakkoli *et al*. (2011) and Ambede *et al*., (2012), the main ionic constituents of soluble salts in the soil are sodium, calcium, magnesium, sulphate and chloride, as well as carbonates and bicarbonates. The action of these salts is directly linked to injuries in the function of photosystem (Adel and Mohsen, 2008).

The green yield at the area treated by sub-soiling was more than the area treated by mole drain by 15.68%. This may be related to improving soil in the area treated by sub-soiling which was more than improving the soil at the other area.

4. Effect of applied soil amendment (sugar beet compost) on soil chemical and physical properties during barely cultivation:

1. Soil salinity

The ECe values of soil samples which were taken at the end of winter season from the studied areas under different application rates of compost are presented in Table (5). Data indicate that ECe increased from 4.3 to 4.6 dS/m (6.5%) for both areas in the surface layer (0-30) cm, while at the (30-60) cm depth the data showed that there were little differences in ECe under treated soils.

2. Soil physical properties

Sugar beet compost increased the water holding capacity. Soil bulk density and total porosity are mostly affected by soil structure. Data presented in Table (5) reveal that the mean values of soil bulk density (g/cm3) and total porosity (%) for the studied areas which using two doses from compost (0 and 3 Ton/fed.). Application of 3 ton/fed. compost recorded more increase of mean values of total porosity for both areas (area treated by sub-soiling and area treated by mole drain).The mean values of total porosity at the sub-soiling area increased by 4.8 and 5.07% for (0-30) and (30-60) cm depths , respectively while at mole drain area the increase was 5.1and 3.19% for the same depths, respectively. On the other hand, the mean values of bulk density decreased with application 3Ton/fed. compost at both areas. It could be attributed to the low specific gravity of the compost and the role of these organic products in enhancing soil aggregation. These results agree with those reported by Abdel-Aziz *et al*., (1996) and Mohamedin *et al*., (2004).Total porosity provides valuable information about soil structure and is inversely correlated with bulk density. Compost improves the soil physical and chemical properties.

The mean values of hydraulic conductivity (Ks) are presented in Table (5). The mean values of hydraulic conductivity (Ks) at the area treated by sub-soiling increased as a result of compost application from 1.39 to1.53 cm/h (9.15%) and from 1.33 to 1.5 cm/h (11.33%) at (0-30) and (30-60) cm depths, respectively. On the other hand, they increased from 1.38 to 1.44 cm/h (4.17%) and 1.33 to 1.46 cm/h (8.9%) at the other areas under the study. It can conclude that adding compost at rate (3 Ton/fed.) increased hydraulic conductivity in both areas but the increasing at the sub-soiling area was more pronounced than the other one. The increase in hydraulic conductivity as affected by adding compost may be attributed to the increasing of total soil porosity and the reduction in soil bulk density which consequently reduce the rate of water flow through the soil layers.

Referring to the unconfined compressive strength UCS (ton/ft2) ,the data in Table (5) revealed that the addition of compost at rate 3 Ton/fed. in the sub-soiling area lead to reducing the USC values by about 8.87 and 9.37 % for (0-30) and (30-60) cm depths, respectively, while at the other areas (mole drain) the reductions were 8.15 and 4.18 % for the same depths, respectively.

Concerning the water stable aggregate (WSA), the results in Table (5) revealed that increasing the compost rate from 0 to 3 ton/fed. increased the coarse aggregates (›0.25 mm) at surface layer from 14.66 to 33.29 (55.96%) and from 13.87 to 32.67 (57.55%) at both areas sub-soiling and mole drain areas, respectively. While at subsurface depth (30-60 cm) they increased from 13.74 to 19.72 (30.32%) and from 13.39 to 18.97 (29.41%) at the previous areas, respectively. It is clear that, the effect of adding compost (3 ton/fed.) on the water stable aggregates (WSA) in the surface area(0-30cm depth) is more affected than at the subsurface area (30-60cm depth). It is clear that the effect of adding 3 ton/fed compost on the water stable aggregates (WSA) on surface layer (0-30cm depth) was more than its effect on the subsurface depth (30-60cm depth). Similar trend was observed for the structure coefficient (SC). The increase of aggregates formation as a result of soil conditioning may be attributed to the effect of organic products which cause a great stability of formed water stable aggregates (Awad *et al*.,1986).

Generally, it can be concluded that the application of amendment during barely cultivation improved the physical properties of the soil (Ks, B.d, and TP) and chemical properties, (EC and pH).

Table 5. Effect of compost on soil physical and chemical properties of the studied soils under barely cultivation.

Treatments	Amend.	Soil depth	EC_e	PH	B.d	Total porosity TP	Hydr. Cond. Ks	UCS	WSA		
	(Ton/fed)	(cm)	(dS/m)		(g/cm$^{3)}$	%	(cm/h)	(Ton/ft^2)	>0.25	<0.25	SC
Sub -soiling	Zero	0-30	4.3	8.2	1.27	51.10	1.39	4.17	14.66	85.34	0.170
		30-60	4.6	8.3	1.28	49.20	1.33	4.27	13.74	86.26	0.159
	3	0-30	4.6	8.2	1.25	53.70	1.53	3.80	33.29	66.71	0.499
		30-60	4.5	8.3	1.27	51.83	1.50	3.87	19.72	80.28	0.246
Mole	Zero	0-30	4.3	8.3	1.27	50.80	1.38	4.17	13.87	86.13	0.161
		30-60	4.6	8.4	1.28	48.63	1.33	4.07	13.39	86.61	0.155
	3	0-30	4.6	8.2	1.25	53.53	1.44	3.83	32.67	67.33	0.485
		30-60	4.5	8.3	1.27	50.23	1.46	3.90	18.97	81.03	0.234

5. Barely grain and straw yields:

Figures (4 and 5) illustrated the grain and straw yields for sub-soiling and mole areas with adding zero and 3 ton/fed. compost.

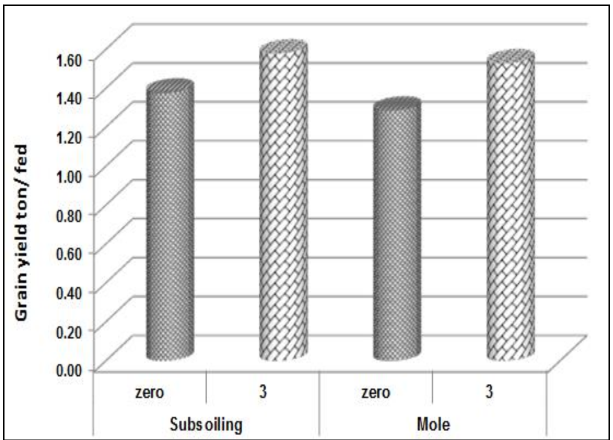

Fig. 4. The effect of soil treatments and sugar beet compost on grain yield of barely crop at the studied areas.

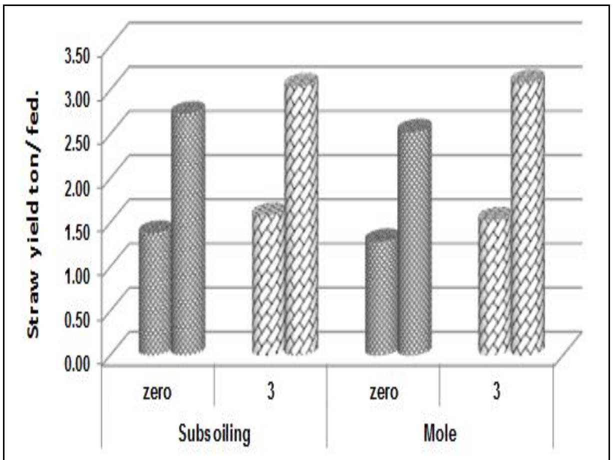

Fig. 5. The effect of soil treatments and sugar beet compost on straw yield of barely crop at the studied areas

The mean values of barley grain yield increased from 1.38 to 1.58 and from 1.29 to1.53 ton/fed. for sub-soiling and mole drain areas, respectively. While the mean values of the straw yield increased from 2.72 to 3.04 and from 2.53 to 3.08 ton/fed. for both areas, respectively. The mean values of the relative increase in grain yield which obtained at rate of 3 ton/fed. sugar beet compost for sub-soiling and mole areas increased by about12.66% and 15.69 %, respectively. On the other hand ,the mean values of the relative increasing in the grain yields were 15.69 % and 12.66 % while, in straw yield were 10.53 % and 17.85 % for both areas, respectively.

CONCLUSION

From the above mentioned results, there are many effective ways for improving salt-affected soils, such as soil leaching, sub-soiling, mole drain and applying compost . At summer season where starting leaching process and cultivated sorghum plant, the obtained results revealed that the total amounts of salts leached from top 60 cm soil depth of sub-soiling and mole drain treatments through leached periods were 3532.1 and 4025.8 kg/fed., respectively. While, they were 2340.2 and 1483.1 kg/fed. during sorghum cultivation season for the same two areas, respectively. The results indicated also that, sub-soiling and mole drain treatments with open surface drainage lowered the water table level, but sub-soiling seemed to be more effective on lowering the water table from the soil. Sorghum green yields at area treated by sub-soiling and mole drain were 10.97 and 9.25 ton /fed., respectively.

Generally, it could be concluded that the application of surge beet compost during winter season (barely crop) improved the physical properties of the soil (Ks, B.d, TP, UCS and WSA) and chemical properties, (EC and pH). On the other hand, the mean values of barely grain yields were relatively increased by 15.69 % and 12.66 % for sub-soiling and mole areas, respectively. While, the barely straw yields were 10.53 % and 17.85 % for previous areas, respectively.

REFERENCES

Abdel-Aziz , S.M.; M.E. EL. Fayoumy; M.H. Gomaa and H.M. Ramadan (1996). Soil and crop responses to applied soil conditioners. Alex. Sci. Ech.,17(3):261, J. Agric. Sci., 66: 241-252.

Abdel-Mawgoud A.S.A.; M.A.B. El Shweikh; A.I.N. Abdel-Aal and M.I.I. Abdel-Khalik (2003).Open Drainage and Moling for Desalinization of Salty Clay Soils in Northeastern Egypt. 2.3. 9th International Drainage Workshop, September 10-13, 2003 in Utrecht, The Netherlands.

Abdel-Mawgoud, H.S.A.; A.A.S. Gendy and S.A. Ramadan (2006). Improving root zone environment and production of a salty clay soil using subsoiling and gypsum application. AssiutJ.ofAgric.Sci., 37(2):147-164.

Adel, R. A. U. and A. G. Mohsen (2008).Effect of sugar industry wastes on K status and nutrient availability of a newly reclaimed loamy sandy soil. Archives of Agronomy and soil Sci., 54:665-679.

Aiad, M.A. (2014). Effect of mole drains and compost application on some soil properties, water relations and its productivity at north delta. J. Soil Sci., and Agric. Eng., Mansoura Univ., 5 (2): 219 -236.

Aiad M. A. F., M. A. AbdEl-Aziz. B.A. Zamil and A. S. Anter (2012).Combating Soil deterioration at North Delta, Egypt.J.Agric.Res. Kafr El-Sheikh Univ., 38(2).322-341.

Ambede, J. G.; G. W. Netondo; G. N. Mwai; D. M. Musyimi (2012). Salinity affects germination, growth, physiology, and biochemistry of bambara groundnut. Brazilian Journal of Plant Physiology, v.24, p.151-160.

Antar, S. A.; A. S. El-Henawy and A. A. E. Atwa (2008).Improving some properties of heavy clay salt-affected soil as a result of different subsurface tillage. J. Agric. Sci. Mansoura Univ., 33 (10): 7675- 7687.

Antar, S. A. ; A.A.M. Mohamedin and, A.M. El-Meligy (2012). Improving root zone and production of clay salt affected soil as a result of different subsurface tillage. 11th ICID International Drainage Workshop on Agricultural Drainage Needs and Future Priorities. Cairo, Egypt September 23 – 27, 2012.

Awad, A. M. A. (1994). Crop residues effects on soil organic matter, wheat yield and nutrients dynamic. Ph. D. thesis, Fac. Agric., Alex. Univ., Egypt.

Awad, F.; M. Abd El-Rahman and F.F. Awad (1986).The combined effect of some soil conditioners and saline irrigation water. Agrochemical, 30 (6):427.

Azza R. Ahmed ; Mona K. M. Abdel-Razek ; M. S. Awaad and M. A. bayoumi (2017). Efficiency of Different Nitrogen Fertilizer Sources on Soil Productivity, Fertility and Economically of Wheat Followed by Maize Crops Grown underCalcareous Soil Conditions.J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (12): 813 – 820.

Black,C.A.(1965).Methods of Soil Analysis, Amer. Soc. Agro. Inc., Madison, Wisconsin, U.S.A.

Cameira, M.R.; R.M. Fernando and L.S., Pereira (2003). Soil macropore dynamics affected by tillage and irrigation for a silty loam alluvial soil in southern Portugal. Soil & Tillage Research 70, 131-140.

El-Henawy A.S.; A.M. Hamad and A.S. Antar (2016). Impact of mole drains and N-fertilizer rates on some soil properties and sugar beet production in clay soil. International Journalof Advanced Research, 4 (6): 220-229.

Elissondo, E.; J.L. Costa; E. Suero; K.P. Fabrizzi and F.Garcia, (2001).Evaluación de algunas propieda desfisicas de suelo sluego de la introduccion de labranzasverticales en unsueloba josiembra directa.CienciadelSuelo. 19, 11–19.

El-Shafei, Y.Z. and R.A. Ragab (1975). Soil surface sealing caused by rain drop impact. Egypt. J. Soil Sci., 16:47-68.

FAO (1986). The Land Resource Base. Room: FAO (ARC/86/3), Roma.

Hillel, D. (1998).Environmental Soil Physics. Academic Press, London, 771 P.

Ibrahim,S.A.(1964). Studies on the size distribution of water stable aggregates in the soil of Nile Delta.M.Sc.Thesis, Ain Shams Univ., cairo, Egypt.

Kalkhan, M.A.; T.J. Stohlgren and G.W. Chong (2000). A Predictive Spatial Model of Plant Diversity: Integration of Remotely Sensed Data, GIS and Spatial Statistics, Proc. 8th Biennial Remote Sensing Application (Conf.RS, 2000), Albuquerque, 2000, pp. 1–8.9. Northrop, L.J., Landsat Detection of Irrigation).

Klute, A. (Ed.) (1986).Methods of Soil Analysis.No. 9 Part 1, Amer. Soc.Agron., Inc. Madison, Wisconsin, USA.

Lickacz, J. (1993). Management of solonetzicsoils.Agdex 518-8.Revised, Edmonton, Alberta,Canada.

Mohamed, E. S. and M. S. Gouda (2018). Assessment of Agricultural Sustainability in Some Areas West of Nile Delta Egypt. J. Soil Sci. Vol. 58, No. 3, pp. 309 – 323.

Mohamed, E. S. , A. Belal and A. Saleh (2013). Assessment of land degradation east of the Nile Delta, Egypt using remote sensing and GIS techniques, Arab J Geosci 6:2843–2853.

Mohamedin, A.A.M; A.M. El-Meligy and M.A.M.Abdalla (2004). Feasibility of tile drainage, gypsum applications and deep ploughing to improve soil properties and production at north of El-fayoum depression Egypt.J. Soil.Sci, 44(4), 547-558.

Moukhtar, M. M.; A.S.A Abdel-Mawgoud; A.I.N.Abdel-Aal; M.A.B. El-Sheikh and M.I.I. Abdel-halik (2003). Hindrance from Degradation in Rootzone of Soils under Saline Groundwater Table in Egypt.Mansoura University J. Ageic. Sci. 199-208.

Moukhtar, M. M.; E. M. El-Hadidy; M.Y.S. El-Arquan and M.A.B. El-Shewikh (2002). Soil Amelioration Technique of Cover Drainage Combined Subsoiling for Saline-Sodic Clay in `Engineering (CIGR) on July 28-31 - 2002, Chicago, USA.

Moukhtar, M.M.; Madiha H. El-Hakim; A.I.N. Abdel-Aal; A.S.A. Abdel-Mawgoud ; M.A.B. El-Sheikh and M. Ismail (2012).Mole Drainage in Egyptian Salty Clay Soil.11th ICID International Drainage Workshop on Agricultural Drainage Needs and Future Priorities. Cairo, Egypt, September 23 –27.

Page, RH. (1982). Chemical and Microbiological Analysis. Part II: Methods of Soil Analysis. Agron.No. 9, Madison, U.S.A.

Said, H.M. (2003).Effect of tillage implements on the state of compacted different soils. Egypt. J. Soil Sci. 43: 91-107.

Schwen, A., G. Bodner, P. Scholl, G. D. Buchan, and W. Loiskandl (2011). Temporal dynamics of soil hydraulic properties and the water-conducting porosity under different tillage, Soil & Tillage Research, 113(2), 89- 98.

SeddikWafaa M. A. and K. M. Laila (2004).Effect of some natural soil amendments on some soil physical properties, peanut and carrot yield in sandy soil. Egypt J. Agric. Res., 82 (2), 2004.

Soracco, C.G. (2009). Efecto de la compactaciónsobre el sistemaporoso del suelo en diferentessituaciones de labranza: Modelización y realidad [tese]. La Plata: Universidad Nacional de La Plata.

Tavakkoli, E.; F. Fatehi ; S. Coventry ; P. Rengasamy; G. K. McDonald (2011).Additive effects of Na+ and Cl- ions on barley growth under salinity stress. Journal of Experimental Botany, v.62, p.2189-2203, 2011.

Van Hoorn, J.W. and J.G. van Alphen (2006). Salinity control. In: H.P. Ritzema (Ed.), Drainage Principles and Applications, p. 533-600, Publication 16, International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. ISBN 90-70754-33-9.

Wang Y.; S. CHEN; D. Zhang; L. YANG;T. CUI ;H. JING and Y. LI (2019). Effects of subsoiling depth, period interval, and combined tillage practice on soil properties and yield in the Huang-Huai-HaiPlain,China Journal of Integrative Agriculture, 18(0): 2–14.

Watson, K. and R. Luxmoore (1986). Estimating macro-porosity in a forest watershed by use of a tension infiltro-meter. Soil Sci. Soc. Am. J., 50:578-582, 1986.

Zhao, X.; G. Yuan, H. Wang ; D. Lu; X. Chen and J. Zhou (2019). Effects of full straw incorporation on soil fertility and crop yield in rice-wheat rotation for silty clay loamy cropland. Agronomy, 9(3), 133.Rotation for Silty Clay Loamy Cropland. Agronomy, 9, 133.

Yoder, R.E. (1936). A direct method of aggregate analysis of soils and a study of the physical nature of erosion losses. J. Am. Soc. Agron., 28:337-351.

إجراء الحرث تحت التربه والصرف بالمول و اضافة الكمبوست (مخلفات بنجر السكر) لتحسين بعض خواص التربة وانتاجية السورجم والشعير فى منطقة النوبارية

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أجريت هذه الدراسة في موسمين متتاليين (موسم صيف 2015 وموسم شتاء 2016/2015) حيث تم زرعة السورجم في الصيف و الشعير في فصل الشتاء في مزرعة محطة البحوث الزراعية بالنوبارية بمحافظة البحيرة لدراسة تحسين بعض خصائص التربة (التربة الجيرية) من خلال عملية الغسيل واضافة ا الكمبوست (مخلفات بنجر السكر) تحت نظامى الحرث تحت التربه والصرف بالمول في فصل الصيف ، حيث بدأت عملية الغسيل وزراعة نبات السورجم ، و أظهرت النتائج التي تم الحصول عليها أن انخفاض ملوحة التربة خلال فترة الغسيل (لمدة شهرين وبمعدل 400 متر مكعب / للفدان، كانت الفترة بين الريات 15 يومًا) فى معاملة الحرث تحت التربه بنسبة 38.88 ٪ و 35.24 ٪ لأعماق التربة 0-30 ، 30-60 سم ، على التوالي. بينما ، في معاملة الصرف بالمول كانت 41.84 ٪ و 41.76 ٪ لنفس الأعماق المذكوره على التوالى. وكانت نسبة الانخفاض في ملوحة التربة خلال فترات زراعة السورجم لنفس الأعماق في منطقة معاملة الحرث تحت التربه 35.34 ٪ و 42.43 ٪ للعمق 0-30 ، 30-60 سم ، على التوالي وكانت 27.32 ٪ و 25.59 ٪ لنفس الأعماق في منطقة معاملة الصرف بالمول وكانت الكميات الإجمالية للأملاح التي تم ازالتها من الطبقة السطحية للتربة (0-60 سم) فى كلا من معاملتى لحرث تحت التربه والصرف بالمول خلال فترت الغسيل 3532.1 و 4025.8 كجم / للفدان على التوالي، بينما كانت كميات الاملاح المزالة 2340.2 و 1483.1 كجم / للفدان خلال موسم زراعة السورجم للمعاملتين المذكورتين تحت الدراسة على التوالى. كما أشارت النتائج أيضًا إلى أن الحرث تحت التربه والصرف بالمول تحت نظام الصرف المكشوف خفضت مستوى منسوب الماء الارضى ، لكن يبدو أن الحرث تحت التربه كان أكثر فاعلية في خفض منسوب الماء الارضى فى التربة. وتراوحت انتاجية السورجم في المناطق التي تم عمل حرث تحت التربه بها من 9.76 إلى 12.83 طن / فدان بمتوسط 10.97 طن / فدان ، في حين تراوحت بين 8.46 و 10.14 بمتوسط 9.25 طن / فدان في مناطقة الصرف بالمول. في فصل الشتاء ، حيث تمت دراسة تأثير استخدام الكمبوست (مخلفات بنجر السكر) على بعض خصائص التربة ومحصول الشعير (جيزة 123) ، أشارت النتائج التي تم الحصول عليها إلى زيادة ملوحة التربة ECe من 4.3 و 4.6 dSm-1 وكانت نسبة هذه الزيادة 6.5 ٪ مقارنة بملوحة التربة فى بداية الموسم لكل من المعاملتين في الطبقة السطحية (0-30) سم ، بينما على عمق (30-60) سم ، أظهرت النتائج أن هناك اختلافات طفيفة في ECe فى كلتا المعاملتين . كما زادت القيم المتوسطة للمسامية الكلية نتيجة اضافة 3 طن/فدان كومبوست في منطقة معاملة الحرث تحت التربه بحوالي 4.8 و 5.07٪ للعمق (0-30) و (30-60) سم ، على التوالي ، بينما في منطقة والصرف بالمول كانت الزيادة 5.1 و 3.19٪ لنفس الأعماق المذكورة ، على التوالي. من ناحية أخرى ، أظهرت القيم المتوسطة للكثافة الظاهرية انخفاضًا طفيفًا بنسبة 1.57 و 0.78٪ عند عمق التربة (0-30) و (30-60) سم ، على التوالي لكلا المنطقتين المعالجتين باضافة 3.0 طن / فدان كومبوست في كلا المنطقتين قيد الدراسة.ونتيجة لاضافة الكمبوست بمعدل 3 طن/فدان في منطقة معاملة الحرث تحت التربه زادت القيم المتوسطة للتوصيل الهيدروليكي المشبع (Ks) من 1.39 إلى 1.53 سم / ساعة (بزيادة 9.15 ٪) ومن 1.33 إلى 1.5 سم / ساعة (بزيادة 11.33 ٪) لعمق (0-30) و (30-60) سم على التوالي. من ناحية أخرى ، زادت من 1.38 إلى 1.44 سم / ساعة (4.17 ٪) ومن 1.33 إلى 1.46 سم / ساعة (8.9 ٪) في منطقة معاملة الصرف بالمول لنفس الاعماق على التوالى . وادى اضافة الكمبوست بمعدل 3 طن / للفدان لكلا منطقتى الحرث تحت التربه والصرف بالمول الى زيادة النسبة المئوية لمحصول حبوب الشعير بحوالي 12.66٪ و 15.69٪ على التوالي. و كانت القيم المتوسطة للزيادة النسبية في القش 10.53 ٪ و 17.85 ٪ ، على التوالي.