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Effect of compost rates at different depths on some chemical properties and productivity of soils

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ABSTRACT

Two field experiments were conducted on clay loam soil during the two successive seasons, summer season 2013 using maize plants and winter season 2013/2014 using wheat plants at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate to evaluate the effect and residual effects of compost rates placed in 20 and 40 cm depths, arranged in parallel orientation with respect to one another and spaced at 3 m apart or placed on the surface soil layer as well as the control on improving some soil chemical properties and availability of some nutrients either macro or micro, and the productivity of yield and yield components of maize and wheat plants. Furthermore, economical analysis was done by calculating the net income and investment ratios to determine the economical treatment. The experiments were conducted in a split plot in a randomized complete block design (RCBD) with three replicates. Results can be summarized as follows:(1)- All treatments slightly decreased the soil reaction (pH). Furthermore, all treatments caused progressive increases in soil salinity (EC) and total soluble salts (TSS) for the two soil depths (0-20 and 20-40cm) in the two growing seasons. Also, soluble cations and anions slightly increased with all treatments. While, SAR values were decreased compared with the control for the two soil depths in the two growing seasons. (2)- Generally the application depth and the addition rates of compost clearly enhanced the nutrient statues of the investigated soil.(3)- Organic carbon (O.C, %) and C/N ratio were slightly increased in surface and subsurface soil layers as a result of the application depth and the addition rates of compost. (4)- All treatments led to markedly increases in the available macronutrients (N, P and K) and available micronutrients (Fe, Zn, Mn and Cu) of the soil at the two soil depths in the two growing seasons either with mole depth or compost rates.(5)- The yield and yield components of maize and wheat positively responded to all treatments compared with the control. The highest values of yield and its components for maize and wheat plants were obtained by the addition of 10 ton compost fed $^{-1}$in 40 cm mole depth. The highest grain yield of maize plants increased to 68.46 %, also, the highest grain and straw yields of wheat plants increased to 70.27 and 91.67 %, over the control, respectively. (6)- According to the economical analysis, the application of 10 ton compost fed^{-1}in 40 cm mole depth was the best treatment compared with the other treatments, since it gave the highest net income (12346.38 L.E fed^{-1}.). While, the lowest values were always incorporated with control (10 cm surface depth without any applications of compost). (7)- Therefore, it is more useful to use those treatments (compost rates at different depths) to get a markedly improve in both chemical properties and nutrients which reflect on higher yield incorporated with high net income, as well as to substitute a part of chemical fertilizers by using compost to minimize the pollution resulted from the intensive use of it.

Keywords: Moles, compost and soil chemical properties.

INTRODUCTION

When compost is applied to the soil, it can support plant growth and enhance plant yield as well as improve the physical, chemical and biological properties of soils (Convertini *et al*., 2004). Compost also increases the organic matter content of the soil and it is considered a source of nutrients for agricultural production (Bevacqua and Mellano, 1993 and Smith, 1995). Pinamonti (1998) indicate that both compost mulches increased organic matter content, available phosphorous and exchangeable potassium of the soil.

Epstein *et al*., (1975) found that sludge and compost increased the salinity and chloride levels of the soil to a level which may affect salt-sensitive plants. Nitrate-nitrogen levels were the highest at the 15–20 cm soil depth but decreased sharply below this level. Available phosphorus was high during the 2-year study and appeared to be in excess of that needed for good crop growth. McAndrew and Malhi (1990) reported that compared to adjacent unplowed (check) treatments, deep plowing resulted in significant improvements in soil chemical properties at most of the sites. The sodium adsorption ratio (SAR) of the AB horizon (12- or 15- to 30 cm depth) was lower after deep plowing at all four sites. Extractable and soluble Ca increased in the Ap horizon (0-12 cm) of deep plowing soils, whereas extractable Na decreased in the Ap or AB horizons at three sites. The pH of the Ap horizon increased from acidic to neutral at three sites, while EC of the Ap horizon decreased at two sites. El-Maddah and El-Sodany (2003) reported that the crossed moles of deep plowing at 30 and 60 cm depth were better during the two seasons since they decreased EC, SAR and total soluble salts. Alamouti and Navabzadeh (2007) reported that by increasing the plowing depth, the soil organic carbon and crop yields improved but there were no significant differences between the semi-deep and deep tillage system.

Eghball *et al.*, (2004) found that the residual effects of manure and compost applications significantly increased soil electrical conductivity and pH levels and plant-available P and NO_3–N concentrations. El-Shouny (2006) reported that the application of different rates of soil amendments, i.e., FYM and sulphur to clay soil at Kafer El-Shiekh Governorate decreased pH and ESP but increased the soluble cations and anions. El-Hady and Abo-Sedera (2006) reported that the soil conditioning positively affect chemical and biological properties of the soil where it slightly decreased soil pH and increased OM, organic carbon, total nitrogen % in the soil, Because the increase in total nitrogen is higher than that in organic carbon, narrower C/N ratio of treated soils were obtained indicating the mineralization of organic nitrogen compounds and hence the possibility to save and provide available forms of N to grow plants and increase N, P and K in treated soil. El-Sodany and El-Maddah (2009) reported that the use of organic matter led to a slightly decreases in soil reaction (pH) and progressive increases in soil salinity (EC), soluble ions (Ca, Mg, Na, HCO_3, Cl and SO_4), total soluble salts (TSS) and sodium adsorption ratio (SAR). El-Maddah *et al*., (2012) found that all soil conditioners slightly decreased the soil reaction (pH) and increase soil salinity, Organic carbon (O.C, %) , C/N ratio, available NPK and Soil extractable metals (Fe, Zn, Mn and Cu).

On the other hand, addition of compost could be a way to create a better environment for plants growth. Maiorana, *et al*. (2005) concluded that the compost application allowed good yields and quality, even without an additional mineral fertilization.

McAndrew and Malhi (1990) reported that compared to adjacent unplowed (check) treatments, crop yield increased due to deep plowing (DP) at the three sites where yields were measured. Abou El-Seoud *et al*. (1997) found that increasing compost addition in the newly reclaimed soils significantly increased both the dry matter production and yield of fruits.

Sowicki (2003) stated that compost addition significantly increased sunflower dry weight, seed yield, oil content and major elements (NPK). Osman *et al*. (2014) found that increasing the addition of compost up to 4 ton fed^{-1} increased significantly values of plant height, plant dry matter at 90 days from planting as well as the head diameter, seed yield $plant^{-1}$, 1000 seed weight and seed yield (ton fed^{-1}) of sunflower plant at harvest time 120 days from planting.

Hence,the purpose of this work is to find out the effect and residual effects of compost rates placed in moles at 20 and 40 cm depth, arranged in parallel orientation with respect to one another's at 3 m spacing or placed on the surface layer on improving some soil chemical properties, status of nutrients and productivity of crops. Moreover, substituting a part of chemical fertilization with compost to minimize the pollution resulted from its intensive application . Furthermore, the whole improvements of such soils are economically determined by calculating the net income for all treatments.

MATERIALS AND METHODS

Field experiments were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate during the two consecutive growing seasons (summer season of 2013 and winter season of 2013/2014) to study the direct and residual effects of compost rates placed in moles 20 and 40 cm deep arranged in parallel orientation with respect to one another and spaced at 3m aparts or placed on the surface layer as well as the control on improving some soil chemical properties, some nutrients contents and the productivity of crops for clay loam soil. Some soil properties of the experimental soil are presented in Table (1-a) and analysis results of the used compost are shown in Table (1-b).

The factors involved in this study were three plowing depths (D1 = Surface tillage ≈ 10 cm depth, D2 = 20 cm mole depth and D3 = 40 cm mole depth) as the main plots, while the compost rates (C1 = 0.0 ton/fed (without), C2 = 5.0 ton/fed and C3 = 10.0 ton/fed were considered as sub plots. The plot area of the experiment was 48 m^2 (6 m in width and 8 m in length) with three replicates where the area of the experiment was divided into 9 plots using a split plot in randomized complete block design.

The moles were constructed at 20 and 40 cm depths by special ditcher, then the compost was placed on the soil surface or filled moles manual. The addition of compost were done before maize sowing in the first season only and the residual effects of compost were studied on wheat crop in the second one, where the same experimental plots were left without application of compost.

Maize grains (*Zea mays*, three way cross 321) were planted in the first season (summer 2013) at the rate of 14 kg/fed. during the first week of June 2013. While wheat grains (Sakha 93 variety) were planted in the second season (winter 2013/2014) at the rate of 60 Kg/fed. during the third week of November 2013.

During the two seasons, half of the basal doses of N, P and K were applied according to the recommendations for each crop, to minimize the pollution resulting from mineral fertilizres. 60 Kg N/fed in the form of ammonium nitrate (33.5 % N), 15.5 Kg P_2O_5/fed in the form of supper phosphate (15.5 % P_2O_5) and 24 Kg K_2O /fed in the form of potassium sulphate (48% K_2O) for maize and 35 Kg N/fed as ammonium nitrate, 7.5 Kg P_2O_5/fed as supper phosphate and 12 Kg K_2O /fed as potassium sulphate) for wheat.

Table1-a. Initial soil properties of the experimental site before sowing.

Soil depth, cm	0-20	20-40	Soil depth, cm	0-20	20-40
Physical properties					
Particle size distribution			Texture class	Clay loam	Clay loam
Coarse sand, %	4.07	3.55	Bulk density (Db, g cm^{-3})	0.17	0.16
Fine sand, %	18.87	18.91	Total porosity (E, %)	0.07	0.06
Silt, %	38.06	37.58	Hydraulic conductivity (Kh, cm hr^{-1})	0.00	0.00
Clay, %	39.00	39.96	$CaCO_3$, %	3.76	3.64
Chemical properties					
Organic matter (O.M, %)	2.80	2.40	Organic carbon (O.C, %)	1.622	1.390
Total nitrogen (T.N, %)	0.148	0.138	C/N ratio	10.96	10.07
EC, dSm^{-1}	2.61	2.95	pH, 1:2.5 (susp.)	8.11	8.27
Soluble cations, meq l^{-1}			Soluble anions, meq l^{-1}		
Ca^{2+}	7.38	8.21	CO_3^{2-}	0.00	0.00
Mg^{2+}	6.63	7.97	HCO^{3-}	4.65	4.84
Na^+	11.81	13.08	Cl^-	11.73	14.45
K^+	0.28	0.24	SO_4^{2-}	9.72	10.21

Table 1-b.Initial chemical characteristics of the used compost.

Properties	Compost	Properties	Compost
Density, g/cm3	0.57	Organic matter, %	26.89
Moisture content, %	16.70	Organic carbon, %	15.60
Ash, %	73.11	C/N ratio	11.14
pH (1:10 manure: water)	7.60	Total N, %	1.400
EC, dS m^{-1}(1:10 manure : water)	4.02	Total P, %	1.10
Ca, %	0.84	Total K, %	1.30
Mg, %	0.29	Fe, ppm	1215.00
Na, %	0.27	Zn, ppm	31.00
Cl, %	0.14	Mn, ppm	56.00
Nematode,insect/200 gm	…	Cu, ppm	93.00

The normal agricultural practices except those under study were carried out as usual for each crop according to the recommendations of El-Gemmeiza Research Station.

At harvesting of each growing season, soil samples (0-20 and 20-40 cm depths) were collected from each plot. The collected soil samples were air-dried, ground and passed through 2 mm sieve and stored for chemical analysis.

Soil pH in soil water suspension (1: 2.5) and soil electrical conductivity (EC, dSm^{-1}) in soil paste extract were measured. Soluble cations and anions were determined in soil paste extract using the methods described by Page *et al*. (1982**).**

Sodium Adsorption Ratio (SAR) was calculated as:

$$SAR = \frac{Na^{+}\ meq/l}{\sqrt{\frac{Ca^{++} + Mg^{++}\ meq/l}{2}}}$$

Total soluble salts, % were calculated according to the following equation:

$$T.S.S\ \% = \frac{EC\ dSm^{-1} \times 0.064 \times SP}{100}$$

where: SP = Saturation percentage

Organic matter was determined by Walkely and Black method according to Black (1965). Total NPK of the soil were determined according to Hesse (1971). Total nitrogen by macro-Kjeldahel method, total phosphorus colorimterically using ascorbic acid and total potassium by flame photometer method.

Available NPK of soil were determined according to Hesse (1971). Available N was extracted by 2M KCl and determined using the micro-kjeldahel method. Available P was extracted by 0.5N $NaHCO_3$ solution at pH 8.3 and determined using ascorbic acid method and available K was extracted by ammonium acetate solution at pH 7.0 and determined using the flame photometer.

The concentrations of micronutrients (Fe, Zn, Mn and Cu) of soil samples were determined by DTPA-method as described by Lindsay and Norevell (1978) and measured by an Atomic Absorption Spectrophotometer (AAS).

Total yield of both maize and wheat for each plot was separately harvested, weighed and related to tons fed^{-1}, also wheat straw (Ton fed^{-1}.). 100 corn seed and 1000 wheat seed weight were determined for each treatment. Ten random plants per plot were sampled at harvest of each crop to determine the following characters.

Maize growth characters:

1- Plant height, (cm) 2- Ear length, (cm)
3- Ear diameter, (cm) 4- Number of rows per ear.
5- Number of kernels per row
6- Dry matter after 80 days of sowing (g $plant^{-1}$)

Wheat growth characters.

1- Plant height, cm 2- Spike length, cm
3- Dry matter after 90 days of sowing, g 10 $plants^{-1}$

Economic evaluation was done to compare between different treatments to state which one is the best. The test was executed according to the price of the yield (1500 LE Ton^{-1}) maize in the first season and (2800 LE Ton^{-1}) grain of wheat and (1000 LE Ton^{-1}) straw of wheat in the second season, as well as the cost of different treatments were calculated considering conventional method of both fixed and variable costs. Total cost per fed was calculated by multiplying the hourly cost by the actual time required by the machine to cover one feddan. The collected data were statistically analyzed according to procedure out lined by Sendecor and Cochran (1981). The mean values were compared at 0.05 level using L.S.D.

RESULTS AND DISCUSSION

I- Effect of different treatments on some soil chemical properties.

1-Soil reaction (pH).

Results in Tables (2 and 3) indicate that all different treatments led to a decrease in soil reaction (pH) for the two seasons at (0-20 and 20-40 cm depths) compared with the control. The decreases in soil pH values were ranged from 1.13 to 4.64 %, 1.96 to 5.64 % in the first season .The corresponding decreases for the second season were from 0.13 to 0.92%, 0.26 to 0.78 % in the second one under the control for the two soil depths, respectively. Where, the lowest value was obtained by the addition of 10 ton compost fed^{-1} in 40 cm mole depth.

Data in Tables (2 and 3) also, reveal that the application depth was significantly decrease soil pH, where the use of 40 cm mole depth (D3) decreased it more than 10 cm surface depth or shallow tillage (D1). The decreases percent reached to 3.76, 4.83 % in the first season and 0.61, 0.56 % in the second one compared with the control at the two soil depths, respectively.

The results show that increasing the compost rates gave significant decreases in soil pH. The lowest pH value was recorded by the addition of 10 ton compost/fed, which decreased to 4.22, 5.24 % in the first season and 0.57, 0.70 % in the second one compared with the control for the two soil depths, respectively. Similar conclusion was obtained by El-Shouny (2006), who reported that application different rates of soil amendments, i.e., FYM and sulphur to clay soil at kafer El-Shiekh Governorate decreased pH. These results are also in line with El-Sodany and El-Maddah (2009) and El-Maddah *et al*. (2012). These results reveal that there is no wide variation between the different treatments on soil pH values because the magnitude of pH change depends on many soil properties, including buffering capacity and length of time after the application of the compost.

2-Soil salinity (EC) and soluble ions.

Data in Tables (2 and 3) and Fig. (1) show that all different treatments caused a significant affects on soil EC values. The highest values were obtained by the addition of 10 ton compost fed^{-1} in 40 cm mole depth, where it increased to 41.00, 32.88 and 38.29, 32.89 % over the control in the first and second seasons for the two soil depths, respectively. Similar results were obtained by El-Fayoumy *et al*. (2000), who reported that the addition of sludge-sulphur as soil amendments caused a significant increase in EC values at both El-Nubaria and El-Gemmeiza sites.

The results show that the application depth led to significant increase on EC values. The use of 40 cm mole depth was more effective on increasing EC values than 10 cm surface depth or shallow tillage. The increases percent of EC values were reached to 34.36, 28.59 % and 31.72, 29.08 % over the control in the first and second seasons for the two soil depths, respectively

Table 2: Effect of different treatments on some soil chemical properties in the first season (summer 2013).

Applicatior depth cm	Compost rates (ton fed^{-1})	pH, 1:2.5 (susp.)		EC, dSm^{-1}		Cations, meq/l Ca^{++}		Mg^{++}		Na^{+}		K^{+}		Anions, meq/l HCO$_3^{-}$		Cl^{-}		SO$_4^{--}$		SAR		TSS, %	
		0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
D1 (surface)	C1 (0)(control)	7.97	8.15	2.61	2.95	7.38	8.21	6.63	7.97	11.81	13.08	0.28	0.24	4.35	4.54	12.03	14.75	9.72	10.21	4.46	4.60	0.13	0.14
	C2 (5)	7.76	7.85	3.14	3.53	9.34	10.97	9.19	9.86	12.54	14.16	0.33	0.31	4.78	5.38	14.74	17.72	11.88	12.20	4.12	4.39	0.16	0.18
	C3 (10)	7.67	7.77	3.55	3.87	11.20	12.70	10.57	11.39	13.35	14.25	0.38	0.36	5.24	5.87	16.79	19.49	13.47	13.34	4.05	4.11	0.18	0.20
D2 (20 cm)	C1 (0)	7.88	7.99	2.82	3.15	8.14	9.20	7.40	8.72	12.34	13.29	0.32	0.29	4.71	5.00	13.24	16.02	10.25	10.48	4.43	4.44	0.14	0.16
	C2 (5)	7.70	7.80	3.42	3.65	10.93	11.35	10.28	10.73	12.66	14.12	0.33	0.30	4.75	5.20	16.18	18.42	13.27	12.88	3.89	4.25	0.18	0.18
	C3 (10)	7.63	7.71	3.61	3.91	11.40	12.82	11.47	11.76	12.87	14.18	0.36	0.34	5.16	5.71	16.77	19.31	14.17	14.08	3.81	4.04	0.19	0.20
D3 (40 cm)	C1 (0)	7.74	7.83	3.22	3.63	9.70	11.48	9.50	10.38	12.65	14.12	0.35	0.32	5.21	5.74	14.80	17.87	12.19	12.69	4.08	4.27	0.17	0.18
	C2 (5)	7.67	7.75	3.62	3.83	11.93	12.65	11.25	11.54	12.63	13.75	0.39	0.36	5.58	5.84	16.86	19.18	13.76	13.28	3.71	3.95	0.19	0.19
	C3 (10)	7.60	7.69	3.68	3.92	12.15	13.03	11.55	11.96	12.70	13.83	0.40	0.38	5.62	5.88	17.01	19.70	14.17	13.62	3.69	3.91	0.19	0.20
A Applicatic depth cm	D1 (surface)	7.80	7.92	3.10	3.45	9.31	10.63	8.80	9.74	12.57	13.83	0.33	0.30	4.79	5.26	14.52	17.32	11.69	11.92	4.21	4.36	0.16	0.17
	D2 (20 cm)	7.74	7.83	3.28	3.57	10.16	11.12	9.72	10.40	12.62	13.86	0.34	0.31	4.87	5.30	15.40	17.92	12.56	12.48	4.04	4.24	0.17	0.18
	D3 (40 cm)	7.67	7.76	3.51	3.79	11.26	12.39	10.77	11.29	12.66	13.90	0.38	0.35	5.47	5.82	16.22	18.92	13.37	13.20	3.83	4.05	0.18	0.19
	F - test	7.49*	0.02*	342.88	024.62															46.39	44.50	96.99*	5.00*
	L.S.D 0.05	0.09	0.09	0.03	0.03															0.05	0.05	0.00	0.01
B Compost rates (ton	C1 (0)	7.86	7.99	2.88	3.24	8.41	9.63	7.84	9.02	12.27	13.50	0.32	0.28	4.76	5.09	13.36	16.21	10.72	11.13	4.32	4.44	0.15	0.16
	C2 (5)	7.71	7.80	3.39	3.67	10.73	11.66	10.24	10.71	12.61	14.01	0.35	0.32	5.04	5.47	15.93	18.44	12.97	12.79	3.91	4.20	0.17	0.18
	C3 (10)	7.63	7.72	3.61	3.90	11.58	12.85	11.20	11.70	12.97	14.09	0.38	0.36	5.34	5.82	16.86	19.50	13.94	13.68	3.85	4.02	0.19	0.20
	F - test	54.11*	11.49	179.93	017.55															155.29	108.49*	49.49*	71.00*
	L.S.D 0.05	0.06	0.06	0.02	0.03															0.03	0.03	0.01	0.01
* B	F - test	7.22*	6.11*	13.40*	03.55*															33.97*	04.59	26.00*	52.00*
	L.S.D 0.05	0.10	0.10	0.04	0.05															0.06	0.06	0.01	0.01

Table3.Effect of different treatments on some soil chemical properties in the second season (winter 2013/2014).

Applicatic depth cm	Compost rates (to fed^{-1})	pH, 1:2.5 (susp.		EC, dSm^{-1}		Cations, meq/l Ca^{++}		Mg^{++}		Na^{+}		K^{+}		Anions, meq/l HCO$_3^{-}$		Cl^{-}		SO$_4^{--}$		SAR		TSS, %	
		0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40	0-20	20-40
D1 (surface)	C1 (0)(control)	7.59	7.67	2.69	2.98	8.68	9.31	7.84	9.34	10.14	10.90	0.24	0.25	3.89	4.23	12.11	13.26	10.91	12.31	3.53	3.57	0.13	0.15
	C2 (5)	7.58	7.65	3.24	3.55	11.17	12.23	10.3	11.48	10.60	11.50	0.30	0.29	4.38	4.83	15.15	16.27	12.88	14.40	3.23	3.34	0.17	0.18
	C3 (10)	7.57	7.64	3.62	3.89	12.74	13.80	11.9	13.08	11.14	11.69	0.35	0.33	5.20	5.35	17.04	17.79	13.97	15.77	3.17	3.19	0.19	0.20
D2 (20 cm)	C1 (0)	7.58	7.65	2.89	3.21	9.62	10.73	8.50	10.11	10.52	11.00	0.29	0.28	4.33	4.65	12.84	14.10	11.73	13.36	3.50	3.41	0.15	0.16
	C2 (5)	7.56	7.63	3.48	3.68	12.51	12.84	11.3	12.16	10.65	11.53	0.30	0.29	4.47	4.82	15.73	16.40	14.60	15.58	3.08	3.26	0.18	0.19
	C3 (10)	7.55	7.60	3.67	3.94	13.34	14.03	12.2	13.41	10.81	11.66	0.34	0.32	4.85	5.26	16.94	17.79	14.92	16.36	3.02	3.15	0.19	0.20
D3 (40 cm)	C1 (0)	7.57	7.64	3.24	3.72	11.09	12.86	10.5	12.15	10.44	11.78	0.32	0.31	4.88	5.28	14.85	16.58	12.67	15.24	3.17	3.33	0.17	0.19
	C2 (5)	7.54	7.63	3.67	3.86	13.28	13.88	12.1	13.10	10.88	11.28	0.35	0.34	5.71	5.35	16.13	17.44	14.76	15.81	3.05	3.07	0.19	0.20
	C3 (10)	7.52	7.61	3.72	3.96	13.50	14.38	12.4	13.53	10.90	11.33	0.36	0.36	5.78	5.38	16.42	17.69	15.11	16.53	3.03	3.03	0.19	0.20
A Applicati n depth c	D1 (surface)	7.58	7.65	3.18	3.47	10.86	11.78	10.0	11.30	10.63	11.36	0.30	0.29	4.49	4.80	14.76	15.77	12.58	14.16	3.31	3.37	0.16	0.18
	D2 (20 cm)	7.56	7.63	3.35	3.61	11.82	12.53	10.7	11.89	10.66	11.40	0.31	0.30	4.55	4.91	15.17	16.10	13.75	15.10	3.20	3.27	0.17	0.18
	D3 (40 cm)	7.54	7.63	3.54	3.85	12.62	13.71	11.7	12.93	10.74	11.46	0.34	0.34	5.46	5.34	15.80	17.24	14.18	15.86	3.08	3.15	0.18	0.20
	F - test	367.91	01.02	199.23	907.96															4771.66	4143.93	82.00*	26.39
	L.S.D 0.05	0.01	0.01	0.02	0.02															0.01	0.01	0.01	0.01
B Compost rates (tor	C1 (0)	7.58	7.65	2.94	3.30	9.80	10.97	8.96	10.53	10.37	11.23	0.28	0.28	4.37	4.72	13.26	14.65	11.77	13.64	3.40	3.44	0.15	0.17
	C2 (5)	7.56	7.64	3.46	3.70	12.32	12.98	11.3	12.25	10.71	11.44	0.32	0.31	4.85	5.00	15.67	16.70	14.08	15.26	3.12	3.22	0.18	0.19
	C3 (10)	7.55	7.62	3.67	3.93	13.19	14.07	12.2	13.34	10.95	11.56	0.35	0.34	5.27	5.33	16.80	17.76	14.66	16.22	3.07	3.12	0.19	0.20
	F - test	579.00	71.00	13962.23	10792.68															4111.67	16450.19	309.42*	09.42
	L.S.D 0.05	0.01	0.01	0.02	0.02															0.01	0.01	0.01	0.01
A * B	F - test	53.50*	47.50*	482.01*	093.16															207.58*	393.89*	10.71*	22.14*
	L.S.D 0.05	0.01	0.01	0.03	0.03															0.02	0.02	0.01	0.01

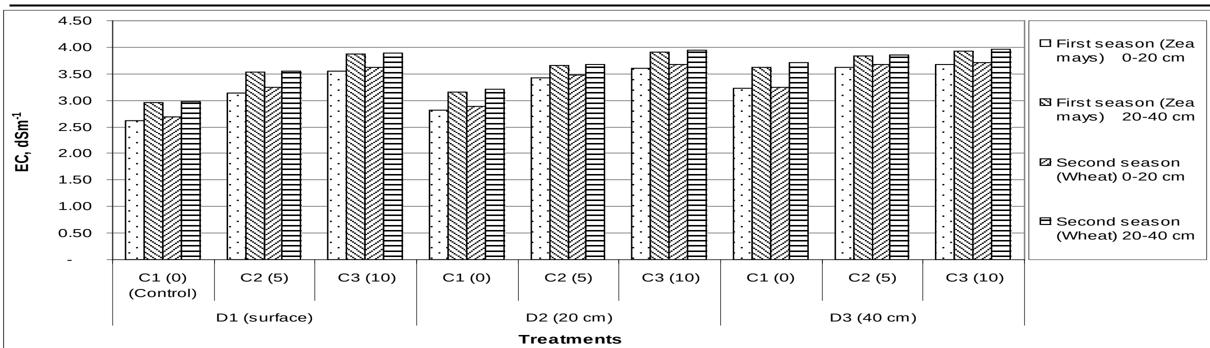

Fig. (1): Effect of different treatments on soil electrical conductivity (EC, dSm^{-1}).

Concerning the effect of compost rates, the results reveal that soil EC values were significant increase by increasing compost rates addition. The highest EC values were recorded by the addition of 10 ton compost fed^{-1}, where the increases were 38.44, 32.20 and 36.43, 31.88 % over the control for the two seasons at the two soil depths, respectively.

Concerning the soluble ions, the results in Tables (2 and 3) show that the soluble calcium, magnesium, sodium, potassium, bicarbonate, chloride and sulphate increased with all different treatments, which take the same trend as soil EC values. The increases percent of soluble Ca, Mg, Na, K, HCO_3, Cl and SO_4 were reached to 64.63, 74.21, 7.54, 42.86, 29.20, 41.40 and 45.78 % at 0-20 cm depth, 58.71, 50.06, 5.73, 58.33, 29.52, 33.56 and 33.40 % at 20-40 cm depth in the first season, and 55.53, 58.67, 7.50, 50.00, 48.59, 35.61 and 38.51 % at 0-20 cm depth, 54.46, 44.86, 3.94, 44.00, 27.19, 33.39 and 34.30 % at 20-40 cm depth in the second one over the control, respectively.

The application depth led to significant increases in soluble ions. The highest values of soluble Ca, Mg, Na, K, HCO_3, Cl and SO_4 were reached to 11.26, 10.77, 12.66, 0.38, 5.47, 16.22 and 13.37 meq/l at 0-20 cm depth, they also were 12.39, 11.29, 13.90, 0.35, 5.82, 18.92 and 13.20 meq/l at 20-40 cm depth in the first season, while they were 12.62, 11.73, 10.74, 0.34, 5.46, 15.80 and 14.18 meq/l at 0-20 cm depth, and were 13.71, 12.93, 11.46, 0.34, 5.34, 17.24 and 15.86 meq/l at 20-40 cm depth in the second season, respectively. Also, the addition of compost rates increased soluble Ca, Mg, Na, K, HCO_3, Cl and SO_4 as compared with the control. Similar conclusion was obtained by El-Shouny (2006), who reported that application of different rates of FYM and sulphur to clay soil increased soluble cations and anions. The higher mean values of the treated soil with compost at the end of the second season compared with the first one may be due to high residual effect of this compost in the second season. These results are in agreement with that obtained by El-Maddah *et al*. (2012).

3- Sodium adsorption ratio (SAR) and total soluble salts (TSS).

Results in Tables (2 and 3) indicate that sodium adsorption ratio (SAR) and total soluble salts (TSS) markedly affected by either the application depth or the compost rates addition. The lowest values of SAR and the highest values of TSS were recorded by the addition of 10 ton compost/fed in 40 cm mole depth, where the SAR decreased by 17.32, 14.92 and 14.22, 15.03 % under the control, while, the TSS increased by 46.01, 37.47 and 43.64, 37.59 % over the control, in the first and second seasons for the two soil depths, respectively. These mean that the values of SAR were generally decreased with all different treatments in the first and second seasons

Concerning the application depth, the results show that, the SAR values were significantly decreased, while, the TSS values were significantly increased by increasing the application depth. The lowest SAR and the highest TSS values were recorded by using 40 cm mole depth, where SAR values were decreased by 14.23, 12.02 and 12.61, 11.89 % under the control and TSS values increased by 38.56, 32.39 and 36.35, 33.16 % over the control in the first and second seasons at the two soil depths, respectively.

Data in Tables (2 and 3)also indicate that the addition of compost rates caused significant decreases in SAR values and significant increases in TSS. The lowest values of SAR and the highest values of TSS were obtained by the addition of 10 ton compost fed^{-1}. The decreases percent of SAR values were reached to 13.78, 12.56 % and 12.90, 12.50 % under the control in the two seasons at the two soil depths, respectively, while the increases percent of TSS was reached to 42.92, 36.22 % and 40.90, 35.80 % over the control in the first and second seasons at the two soil depths, respectively.

Effect of different treatments on soil macronutrients and C/N ratio.

1-Soil macronutrients.

Results in Tables (4 and 5) and Fig. (3) indicate that total macronutrients of soil (N, P and K) were increased with all treatments for the two soil depths (0-20 and 20-40 cm) at the end of the two growing seasons compared with the control. The highest values of total soil N, P and K were obtained by using 10 ton compost fed^{-1} in 40 cm mole depth, where the increases were 21.62, 19.57 %, 63.04, 68.29 % and 32.23, 33.09 % in the first season and 23.49, 21.58 %, 63.04, 68.29 %, 32.23, 33.09 % in the second one over the control at the two soil depths, respectively.

The results reveal that total soil N, P and K were significantly increased by increasing application depth, where 40 cm mole depth was more effective on increasing total soil N, P and K than 10 cm surface depth. The increases percent of total soil N, P and K reached to 15.09, 42.75 and 21.72 % at 0-20 cm depth, 12.56, 45.53 and 22.39 % at 20-40 cm depth, over the control in the first season, while in the second one reached to 17.00, 42.75 and 21.72 % at 0-20 cm depth, 14.63, 45.53 and 22.39 % at 20-40 cm depth, respectively.

The results show that the application of compost rates led to significant increases in total soil N, P and K. The highest values were obtained by the application of 10 ton compost fed^{-1}, where they increase by 16.22, 55.07 and 30.49 % at 0-20 cm depth, 14.01, 60.16 and 31.36 % at 20-40 cm depth over the control in the first season, and 17.00, 55.07 and 30.49 % at 0-20 cm depth, 14.87, 60.16 and 31.36 % at 20-40 cm depth in the second one, respectively.

These results suggest that it may be practical to apply these compost rates to soils to increase NPK concentrations in the soil and thereby enhance its availability to crops. These results are in agreement with those reported by El-Hady and Abo-Sedera (2006) and El-Maddah *et al*. (2012).

2- Organic carbon (O.C) and C/N ratio.

Data in Tables (4 and 5) and Fig. (3) show that all treatments led to markedly affected in organic carbon (O.C) and C/N ratio of the soil at the end of the two seasons compared with the control. The highest values of (O.C) and C/N ratio were recorded by using 10 ton compost/fed in 40 cm mole depth, which increased by 23.66, 25.54 % and 1.67, 5.00 % over the control in the first season, and 25.54, 27.02 % and 1.66, 4.47 % in the second one at the two soil depths, respectively. Similar conclusions were obtained by El-Hady and Abo-Sedera (2006) and El-Maddah *et al*. (2012).

Table 4. Effect of different treatments on soil macronutrients(%) and C/N ratio after maize harvesting in the first season (summer 2013).

Application depth cm	Compost rates (ton fed^{-1})	Total macronutrients, % N 0-20cm	N 20-40cm	P 0-20cm	P 20-40cm	K 0-20cm	K 20-40cm	Organic carbon, % 0-20cm	Organic carbon, % 20-40cm	C / N ratio 0-20cm	C / N ratio 20-40cm
D1 (surface)	C1 (0)(control)	0.148	0.138	0.046	0.041	0.422	0.405	1.622	1.390	10.96	10.07
	C2 (5)	0.155	0.143	0.055	0.050	0.477	0.465	1.702	1.446	10.98	10.11
	C3 (10)	0.161	0.147	0.068	0.062	0.544	0.526	1.772	1.494	11.01	10.16
D2 (20 cm)	C1 (0)	0.150	0.139	0.049	0.043	0.428	0.410	1.647	1.404	10.98	10.10
	C2 (5)	0.168	0.150	0.061	0.055	0.522	0.515	1.855	1.523	11.04	10.15
	C3 (10)	0.175	0.160	0.071	0.066	0.550	0.531	1.939	1.660	11.08	10.38
D3 (40 cm)	C1 (0)	0.153	0.142	0.053	0.047	0.431	0.415	1.684	1.447	11.01	10.19
	C2 (5)	0.178	0.159	0.069	0.063	0.552	0.533	1.970	1.632	11.07	10.26
	C3 (10)	0.180	0.165	0.075	0.069	0.558	0.539	2.006	1.745	11.14	10.58
A Application depth cm	D1 (surface)	0.155	0.143	0.056	0.051	0.481	0.465	1.699	1.443	10.98	10.12
	D2 (20 cm)	0.164	0.150	0.060	0.055	0.500	0.485	1.814	1.529	11.03	10.21
	D3 (40 cm)	0.170	0.155	0.066	0.060	0.514	0.496	1.887	1.608	11.07	10.34
	F – test	843.49*	543.50*	286.79*	247.94*	338.65*	254.40*	902.53*	1019.16*	1240.71*	36.18*
	L.S.D 0.05	0.002	0.002	0.002	0.002	0.005	0.006	0.019	0.016	0.01	0.12
B Compost rates (ton)	C1 (0)	0.150	0.140	0.049	0.044	0.427	0.410	1.651	1.414	10.98	10.12
	C2 (5)	0.167	0.151	0.062	0.056	0.517	0.504	1.842	1.534	11.03	10.18
	C3 (10)	0.172	0.157	0.071	0.066	0.551	0.532	1.906	1.633	11.08	10.37
	F – test	2978.57*	1842.01*	29857.05*	29857.04*	13063.68*	14970.59*	4224.49*	3806.43*	1806.30*	119.95*
	L.S.D 0.05	0.001	0.001	0.001	0.001	0.004	0.003	0.012	0.011	0.01	0.07
A * B	F – test	188.57*	132.00*	319.00*	301.00*	370.63*	369.26*	265.25*	294.25*	149.83*	15.58*
	L.S.D 0.05	0.002	0.002	0.001	0.001	0.006	0.005	0.021	0.019	0.01	0.13

Table 5. Effect of different treatments on soil macronutrients (%) and C/N ratio after wheat harvesting in the second season (winter 2013/2014).

Application depth cm	Compost rates (ton fed^{-1})	Total macronutrients, % N 0-20cm	N 20-40cm	P 0-20cm	P 20-40cm	K 0-20cm	K 20-40cm	Organic carbon, % 0-20cm	Organic carbon, % 20-40cm	C / N ratio 0-20cm	C / N ratio 20-40cm
D1 (surface)	C1 (0)(control)	0.149	0.139	0.046	0.041	0.422	0.405	1.620	1.388	10.87	9.99
	C2 (5)	0.156	0.144	0.055	0.050	0.477	0.465	1.700	1.444	10.90	10.03
	C3 (10)	0.162	0.148	0.068	0.062	0.544	0.526	1.770	1.492	10.93	10.08
D2 (20 cm)	C1 (0)	0.152	0.141	0.049	0.043	0.428	0.410	1.655	1.412	10.89	10.01
	C2 (5)	0.170	0.152	0.061	0.055	0.522	0.515	1.863	1.531	10.96	10.07
	C3 (10)	0.177	0.162	0.071	0.066	0.550	0.531	1.947	1.668	11.00	10.30
D3 (40 cm)	C1 (0)	0.157	0.146	0.053	0.047	0.431	0.415	1.712	1.465	10.90	10.03
	C2 (5)	0.182	0.163	0.069	0.063	0.552	0.533	1.998	1.650	10.98	10.12
	C3 (10)	0.184	0.169	0.075	0.069	0.558	0.539	2.034	1.763	11.05	10.43
A Application depth cm	D1 (surface)	0.156	0.144	0.056	0.051	0.481	0.465	1.697	1.441	10.90	10.03
	D2 (20 cm)	0.166	0.152	0.060	0.055	0.500	0.485	1.822	1.537	10.95	10.13
	D3 (40 cm)	0.174	0.159	0.066	0.060	0.514	0.496	1.915	1.626	10.98	10.20
	F – test	1183.99*	828.50*	286.79*	247.94*	338.65*	254.40*	902.53*	1030.12*	2489.08*	1035.95*
	L.S.D 0.05	0.002	0.002	0.002	0.002	0.005	0.006	0.019	0.016	0.01	0.01
B Compost rates (ton)	C1 (0)	0.153	0.142	0.049	0.044	0.427	0.410	1.662	1.422	10.89	10.01
	C2 (5)	0.169	0.153	0.062	0.056	0.517	0.504	1.854	1.542	10.94	10.07
	C3 (10)	0.174	0.160	0.071	0.066	0.551	0.532	1.917	1.641	10.99	10.27
	F – test	2978.55*	1841.99*	29857.05*	29857.04*	13063.68*	14970.59*	4224.51*	3970.26*	2331.61*	10670.30*
	L.S.D 0.05	0.001	0.001	0.001	0.001	0.004	0.003	0.012	0.010	0.01	0.01
A * B	F – test	188.57*	131.99*	319.00*	301.00*	370.63*	369.26*	265.25*	305.50*	217.13*	1340.89*
	L.S.D 0.05	0.002	0.002	0.001	0.001	0.006	0.005	0.021	0.018	0.01	0.01

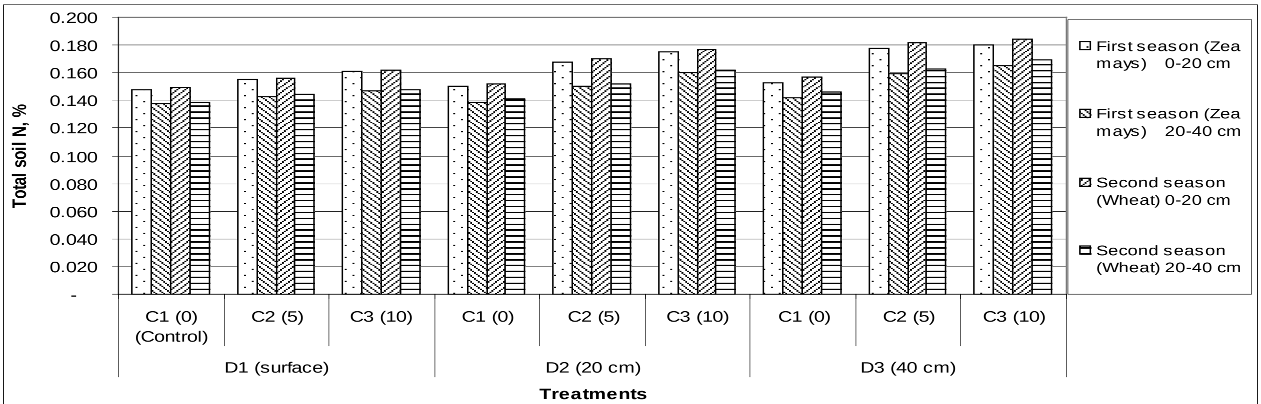

Fig.(2): Effect of different treatments on total soil N, %.

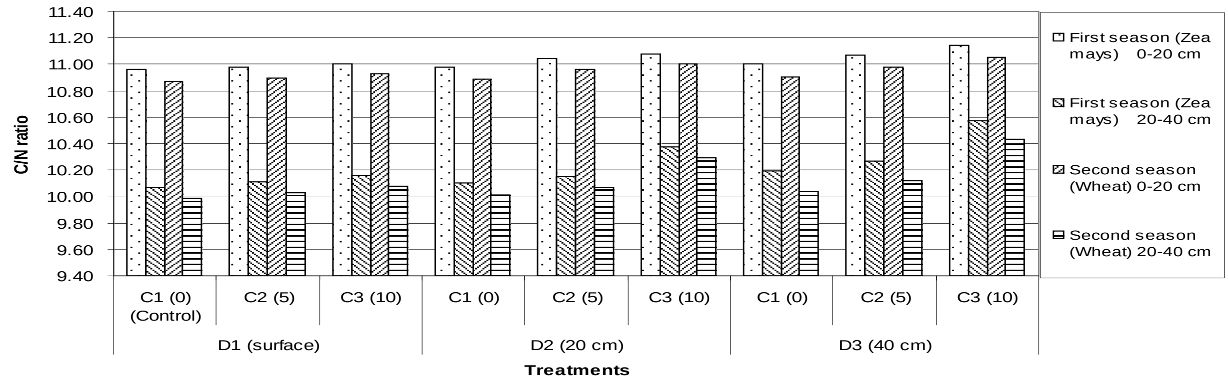

Fig. (3): Effect of different treatments on C/N ratio of the soil.

Concerning the application depth, the results clearly show that, the values of (O.C) and C/N ratio of the soil were significantly increased by increasing the application depth. It can be noticed that the use of 40 cm mole depth was more effective than other treatments on increasing (O.C) and C/N ratio of the soil. The increases percent were reached to 16.31, 15.68 % and 1.03, 2.68 in the first season, and 18.18, 17.15 % and 0.97, 2.11 in the second one at the two soil depths, respectively. Similar results were obtained by El-Maddah *et al.* (2007), they reported that the application of organic amendments to soil increase carbon content and C/N ratio especially in subsurface layer when the amendments placed in 30 and 60 cm mole depths.

Also, the application of compost rates led to significantly increased of (O.C) and C/N ratio at the end of the two seasons compared with the control. The highest values of (O.C) and C/N ratio were recorded by the application of 10 ton compost fed^{-1}, where its increased by 17.48, 17.48 % and 1.07, 2.97 % over the control in the first season, and 18.33, 18.23 % and 1.11, 2.85 in the second one for the two soil depths, respectively. Similar results were recorded by Antoline *et al.* (2005) and Mendoza *et al.* (2006), they reported that organic matter increased by the addition of sludge to the soil.

II- Effect of different treatments on the status of soil nutrients.

1-Soil available macronutrients.

Data in Tables (6 and 7) and Fig. (4) indicated that all treatments caused markedly increases in available soil nitrogen, phosphorus and potassium. The highest values of available soil N, P and K were obtained by the application of 10 ton compost/fed in 40 cm mole depth, where they increased by 30.78, 16.34 %, 26.43, 22.67 % and 27.32, 28.35 % over the control in the first season, and were 30.88, 15.05 %, 26.05, 17.46 % and 29.63, 26.30 % in the second one at the two soil depths, respectively. Similar results were recorded by El-Fayoumy *et al.* (2000), they reported that the addition of sludge-sulphur as soil amendments resulted in increasing of NPK percentage availability for wheat and corn during the two seasons.

The results revealed that the available soil N, P and K values significantly increased by increasing application depth. It can be noticed that the use of 40 cm mole depth was more effective than the other treatments on increasing available soil N, P and K, where they were increased by 21.98, 11.47 %, 20.78, 17.57 % and 18.48, 18.92 % over the control in the first season, and by 22.39, 10.13 %, 20.99, 13.69 % and 22.56, 18.25 % in the second one compared with the other two soil depths, respectively.

Table (6): Effect of different treatments on soil available macro and micronutrients contents after maize harvesting in the first season (summer 2013).

Application depth cm	Compost rates (ton fed^{-1})	Available macronutrients (ppm)						Available micronutrients, ppm							
		N		P		K		Fe		Zn		Mn		Cu	
		0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
D1 (surface)	C1 (0)(control)	33.01	31.76	10.86	8.16	333.23	305.70	4.01	2.53	3.96	2.73	3.48	2.60	1.70	1.32
	C2 (5)	37.04	33.27	11.90	8.74	367.22	331.32	4.63	2.93	4.32	2.96	4.03	3.01	1.89	1.48
	C3 (10)	41.52	35.97	13.24	9.71	405.86	379.55	5.20	3.83	4.75	3.52	4.77	4.07	2.14	1.77
D2 (20 cm)	C1 (0)	33.45	31.92	10.94	8.22	335.63	309.51	4.14	2.57	4.00	2.74	3.52	2.64	1.72	1.34
	C2 (5)	39.25	35.15	12.68	9.23	393.34	362.21	4.92	3.27	4.62	3.26	4.57	3.69	2.02	1.69
	C3 (10)	42.67	36.27	13.55	9.94	415.68	385.02	5.31	3.91	4.83	3.60	4.84	4.16	2.19	1.80
D3 (40 cm)	C1 (0)	35.06	32.84	12.08	8.96	343.63	314.23	4.22	2.75	4.40	3.02	3.71	2.97	1.83	1.41
	C2 (5)	42.54	36.42	13.54	9.81	416.50	384.02	5.31	3.91	4.87	3.60	5.00	4.13	2.20	1.81
	C3 (10)	43.20	36.95	13.73	10.01	424.26	392.36	5.42	4.00	4.94	3.67	5.09	4.21	2.23	1.85
A Application depth cm	D1 (surface)	37.19	33.67	12.00	8.87	368.77	338.86	4.61	3.10	4.34	3.07	4.09	3.23	1.91	1.52
	D2 (20 cm)	38.46	34.45	12.39	9.13	381.55	352.25	4.79	3.25	4.48	3.20	4.31	3.50	1.98	1.61
	D3 (40 cm)	40.27	35.40	13.12	9.59	394.80	363.54	4.98	3.55	4.74	3.43	4.60	3.77	2.09	1.69
	F - test	489.20*	185.73*	620.64*	474.94*	343.97*	371.51*	430.09*	2208.05*	585.38*	1300.62*	1050.00*	2043.08*	460.79*	489.39*
	L.S.D 0.05	0.43	0.39	0.14	0.10	4.27	3.90	0.05	0.03	0.05	0.03	0.05	0.04	0.02	0.02
B Compost rates (ton)	C1 (0)	33.84	32.17	11.29	8.45	337.50	309.81	4.12	2.62	4.12	2.83	3.57	2.74	1.75	1.36
	C2 (5)	39.61	34.95	12.71	9.26	392.35	359.18	4.95	3.37	4.60	3.27	4.53	3.61	2.04	1.66
	C3 (10)	42.46	36.40	13.51	9.89	415.27	385.64	5.31	3.91	4.84	3.60	4.90	4.15	2.19	1.81
	F - test	11026.42*	2949.18*	6502.15*	5425.85*	9212.14*	10232.18*	12256.29*	30817.49*	3895.84*	13094.56*	22964.52*	33783.16*	6798.26*	14220.99*
	L.S.D 0.05	0.25	0.24	0.08	0.06	2.53	2.32	0.03	0.02	0.04	0.02	0.03	0.02	0.02	0.01
A * B	F - test	227.72*	89.12*	203.82*	185.04*	205.92*	348.75*	204.00*	1294.83*	120.00*	518.98*	705.13*	1593.78*	171.14*	491.49*
	L.S.D 0.05	0.44	0.42	0.15	0.10	4.39	4.01	0.06	0.04	0.06	0.04	0.05	0.04	0.03	0.02

Table (7): Effect of different treatments on soil available macro and micronutrients contents after wheat harvesting in the second season (winter 2013/2014).

Application depth cm	Compost rates (ton fed^{-1})	Available macronutrients (ppm)						Available micronutrients, ppm							
		N		P		K		Fe		Zn		Mn		Cu	
		0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
D1 (surface)	C1 (0)(control)	33.39	32.70	11.67	10.08	335.56	319.83	4.10	2.68	3.98	2.82	3.53	2.62	1.73	1.37
	C2 (5)	37.56	34.25	12.86	10.68	370.18	345.96	4.75	3.11	4.35	3.05	4.10	3.06	1.91	1.54
	C3 (10)	42.14	36.90	14.28	11.57	410.86	394.55	5.33	4.10	4.76	3.62	4.85	4.13	2.14	1.85
D2 (20 cm)	C1 (0)	33.88	32.83	11.77	10.14	338.12	322.11	4.20	2.75	4.03	2.85	3.57	2.65	1.76	1.40
	C2 (5)	40.47	36.07	13.78	11.24	408.00	369.96	5.11	3.77	4.67	3.42	4.72	3.79	2.15	1.78
	C3 (10)	42.95	37.29	14.49	11.80	419.93	398.55	4.48	4.25	4.88	3.73	4.95	4.23	2.24	1.89
D3 (40 cm)	C1 (0)	35.78	33.21	13.05	10.84	374.74	331.25	4.32	2.82	4.43	3.13	3.82	3.05	1.87	1.52
	C2 (5)	43.12	37.21	14.60	11.70	424.03	399.46	5.50	4.24	4.86	3.75	5.04	4.25	2.25	1.90
	C3 (10)	43.70	37.62	14.71	11.84	435.00	403.93	5.61	4.34	4.94	3.84	5.13	4.32	2.29	1.93
A Application depth cm	D1 (surface)	37.70	34.62	12.94	10.78	372.20	353.45	4.73	3.30	4.36	3.16	4.16	3.27	1.93	1.59
	D2 (20 cm)	39.10	35.40	13.35	11.06	388.68	363.54	4.60	3.59	4.53	3.33	4.41	3.56	2.05	1.69
	D3 (40 cm)	40.87	36.01	14.12	11.46	411.26	378.21	5.14	3.80	4.74	3.57	4.66	3.87	2.14	1.78
	F - test	486.21*	111.24*	528.83*	101.65*	800.67*	345.08*	954.07*	902.81*	35.14*	687.22*	906.69*	708.79*	544.91*	81.65*
	L.S.D 0.05	0.44	0.40	0.15	0.12	4.22	4.08	0.06	0.04	0.05	0.03	0.05	0.04	0.02	0.02
B Compost rates (ton)	C1 (0)	34.35	32.91	12.16	10.35	349.47	324.40	4.21	2.75	4.15	2.93	3.64	2.77	1.79	1.43
	C2 (5)	40.38	35.84	13.75	11.21	400.74	371.79	5.12	3.71	4.63	3.41	4.62	3.70	2.10	1.74
	C3 (10)	42.93	37.27	14.49	11.74	421.93	399.01	5.14	4.23	4.86	3.73	4.98	4.23	2.22	1.89
	F - test	1029.99	9044.39	018.01	944.50	7710.98	025.16	7840.94*	5607.43	826.71	493.94	1203.16	4225.76	028.14*	4858.99*
	L.S.D 0.05	0.26	0.25	0.09	0.08	2.58	2.42	0.04	0.02	0.04	0.02	0.03	0.02	0.02	0.01
A * B	F - test	224.49*	98.44*	222.01*	07.88*	222.53*	328.57*	175.29*	572.02*	28.51*	365.63*	614.58*	610.09*	198.40*	61.00*
	L.S.D 0.05	0.44	0.42	0.16	0.14	4.47	4.19	0.06	0.04	0.06	0.04	0.05	0.04	0.03	0.02

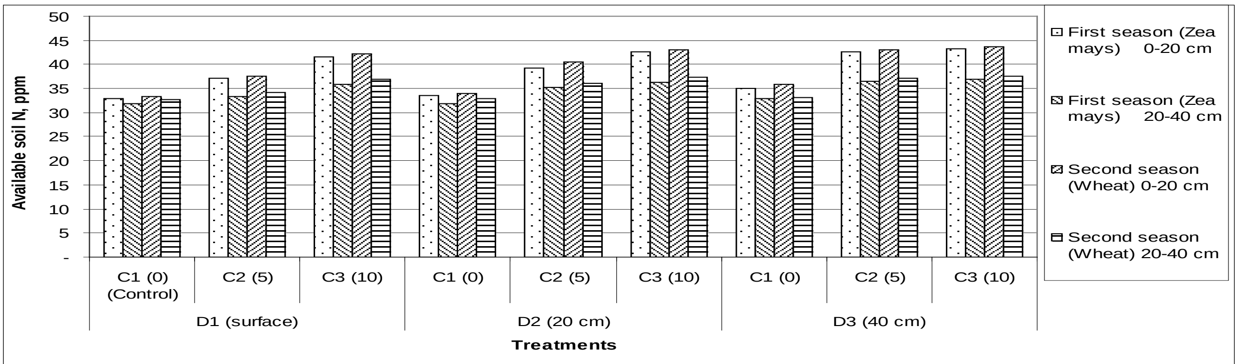

Fig. (4): Effect of different treatments on avaible soil N, ppm.

The results reveal that the application of compost rates caused significantly increased in the available soil N, P and K, where the highest values were recorded by the application of 10 ton compost/fed, where they were increased by 28.64, 14.60 %, 24.37, 21.16 % and 24.62, 26.15 % over the control in the first season, and by 28.57, 13.98 %, 24.19, 16.44 % and 25.74, 24.76 % in the second one in comparison with the other two soil depths, respectively. These results are in agreement with that obtained by El-Maddah *et al.* (2012).

2- Soil micronutrients.

Data in Tables (6 and 7) and Fig. (5) show that the concentrations of soil micronutrients (Fe, Zn, Mn and Cu) were markedly increased with all treatments at the two soil depths in both seasons. Increases of soil micronutrients concentrations were 35.16, 58.10 % and 36.83, 61.94 % for Fe, 24.75, 34.43 % and 24.12, 36.17 % for Zn, 46.26, 61.92 % and 45.33, 64.89 % for Mn and 31.18, 40.15 % and 32.37, 40.88 % for Cu over the control at 0-20, 20-40 cm depths in the first and second seasons, respectively. These results are in harmony with those obtained by El-Maddah *et al.* (2012).

The results reveal that the values of Fe, Zn, Mn and Cu concentrations of the two soil depths were significantly increased by increasing the application depth. The highest values were recorded by using 40 cm mole depth, where they increased by 24.27 and 40.45 %, 19.61 and 25.64 %, 32.18 and 45.00 %, and 22.75 and 28.03 % over the control in the first season, and increased by 25.45 and 41.79 %, 19.18 and 26.71 %, 32.11 and 47.84 %, and 23.51 and 30.17 % in the second one at 0-20 and 20-40 cm soil depths, respectively. These results reveal that the use of 40 cm mole depth was more effective than other treatments on increasing the values of Fe, Zn, Mn and Cu concentrations of the two soil depths.

The results show that the concentrations of Fe, Zn, Mn and Cu of the two soil depths were significantly increased with increasing the addition of compost rates, where the highest values were obtained with the application of 10 ton compost/fed, where they increased by 32.42, 54.68 % and 25.37, 57.84 % for Fe, 22.22, 31.75 % and 22.11, 32.27 % for Zn, 40.80, 59.49 % and 40.98, 61.32 % for Mn and 28.63, 36.87 % and 28.52, 37.96 % for Cu over the control at the two soil depths in the first and second seasons, respectively. These increases may be mainly due to the effect of these treatments on lowering soil pH which reflects on increasing the availability of these micronutrients. These results agree with those of El-Fayoumy *et al.* (2001), They reported that application of organic amendments had a favorable decrease in soil pH and clearly enhanced the nutrients status of soil and its uptake by plants.

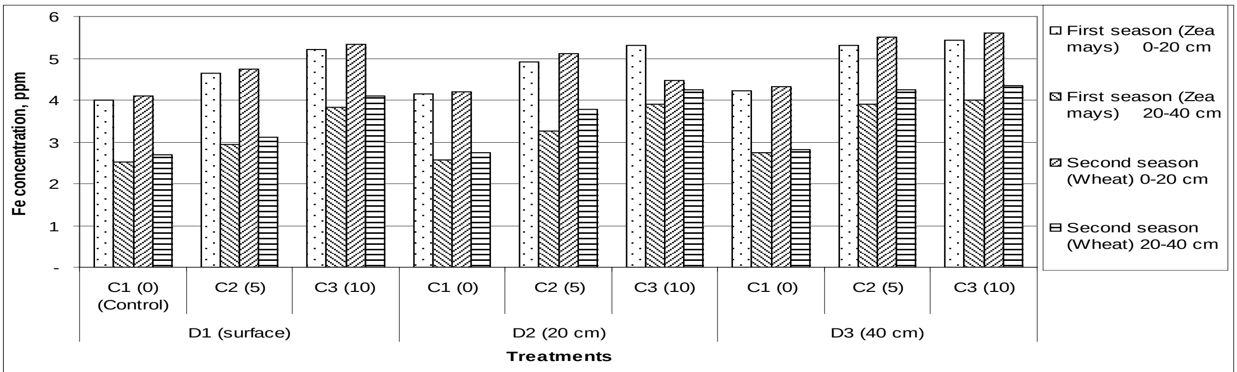

Fig. (5): Effect of different treatments on Fe concentration of the soil, ppm

IV- Effect of different treatments on yield and yield components:

Most of the recorded growth characters of maize and wheat plants were significantly affected by either the application depth or the addition of compost rates. Results in Tables (8 and 9) and Fig. (6) show these effects on yield and yield components of maize and wheat plants where their responses to these treatments were always the same trend, which could be noticed from the tables.

Table (8): Effect of different treatments on maize yield and growth characters in the first season (summer 2013).

Application depth cm	Compost rates (ton fed^{-1})	Plant heigh (cm)	Ear lengt (cm)	Ear diamete (cm)	No. of row per ear	No. of kernels pe row	100 seed weight, g)	Grain yield (Ton fed^{-1}).	R.I.G.Y.	Dry matter, plant^{-1} after 8 days
D1 (surface)	C1 (0)(control)	183.19	14.79	3.39	10.13	27.41	32.03	1.7520	0.00	136.82
	C2 (5)	198.79	17.71	3.98	11.60	35.07	40.04	2.1976	25.43	181.43
	C3 (10)	200.41	18.15	4.06	12.12	36.02	40.60	2.3168	32.24	184.80
D2 (20 cm)	C1 (0)	186.04	15.59	3.54	10.54	29.25	33.81	1.8774	7.16	143.35
	C2 (5)	204.05	18.51	4.16	12.34	37.76	41.88	2.4498	39.83	192.31
	C3 (10)	205.80	18.67	4.19	12.38	38.08	42.56	2.5552	45.84	197.95
D3 (40 cm)	C1 (0)	187.55	15.91	3.63	10.98	30.69	35.18	2.0136	14.93	151.69
	C2 (5)	208.60	19.21	4.26	12.57	39.34	43.08	2.5763	47.05	209.24
	C3 (10)	214.29	19.45	4.31	12.61	39.95	43.63	2.9515	68.46	216.06
A Applicatio depth cm	D1 (surface)	194.13	16.88	3.81	11.28	32.83	37.56	2.0888	19.22	167.68
	D2 (20 cm)	198.63	17.59	3.96	11.75	35.03	39.42	2.2941	30.94	177.87
	D3 (40 cm)	203.48	18.19	4.07	12.05	36.66	40.63	2.5138	43.48	192.33
	F - test	3274.40*	3290.59*	2729.55*	3462.01*	3161.55*	3183.70*	3220.3874*		3180.42*
	L.S.D 0.05	0.50	0.07	0.02	0.04	0.21	0.17	0.0225		1.34
B Compost rat (ton)	C1 (0)	185.59	15.43	3.52	10.55	29.12	33.67	1.8810	7.36	143.95
	C2 (5)	203.81	18.48	4.13	12.17	37.39	41.67	2.4079	37.44	194.33
	C3 (10)	206.83	18.76	4.19	12.37	38.02	42.26	2.6078	48.85	199.60
	F - test	9367.84*	9365.23*	8776.47*	9512.65*	9476.61*	9617.51*	9163.7716*		9499.88*
	L.S.D 0.05	0.72	0.12	0.02	0.06	0.31	0.30	0.0237		1.92
A * B	F - test	146.39*	19.10*	4.22*	72.82*	10.64*	0.81NS	233.5172*		64.02*
	L.S.D 0.05	0.81	0.13	0.03	0.07	0.35	0.33	0.0267		2.14

Generally, all treatments exhibited significant differences on yield and yield components at the end of the two seasons comparing to the control (untreated soil). It can be noticed that increasing the application depth and compost rates addition led to relative increases in the yield. it could be observed that the highest yield of maize in the first season 2.9515 ton/fed and wheat in the second season 3.2139 ton/fed, were obtained by the addition of 10 ton compost/fed in 40 cm mole depth, where they increased by 68.46 and 70.27 % respectively over the control. While, the control treatment gave the lowest yield (1.7520 and 1.8875 ton/fed.) respectively for maize and wheat grains. Also, the same treatment led to significant increases in plant height, ear length, ear diameter, number of rows per ear, number of kernels per row, 100 seed weight and dry matter g plant^{-1} for maize in the first season and in biological yield, straw yield, plant height, spike length, harvest index, 1000 seed weight, number of spikes per m^2 and dry matter g 10 plants^{-1} for wheat in the second one.

With respect to the effect of application depth, the mean values of yield and yield components revealed that all the studied characters were significantly increased during the two seasons with raising the soil depth. The grain yield values obtained by using 40 cm mole depth was greater than 10 cm surface depth or shallow tillage, where ranging from 2.5138 to 2.0888 and 2.7933 to 2.3495 ton/fed for maize and wheat grain yield, respectively. The highest grain yield values increased by 43.48 and 47.99 % of maize and wheat grain/fed, over the control in the first and second seasons, respectively. These results are in line with those reported by Kaoud (1994) who found that deep tillage treatment increased yields of cotton and clover as compared to conventional tillage. Also, corresponding with the results reported by El-Maddah *et al.* (2003), They reported that deep tillage obviously increased the relative yield by 18.40 and 36.40 % for maize in the first season and by 27.88 and 67.27 % for barley in the second one for 30 and 60 cm plow depth respectively over the recorded with the control. This may be due to that the deep tillage breaks up the impediment in the subsoil, and encourage root growth and water extraction more from deeper soil layers.

Table (9): Effect of different treatments on wheat yield and growth characters in the second season (winter 2013/2014).

Application depth cm	Compost rates (ton fed^{-1})	Biological yield (Tonfed-1)	Grain yield Tonfed^{-1}.	Straw yield Ton fed^{-1}.	R.I.G.Y	R.I.S.Y	Plant height, cm	Spike length, cm	Harvest Index,%	1000 Seed weight, g	No. of spikes per m2	Dry matter ,g 10 plants^{-1} after 90 days
D1 (surface)	C1 (0)(control)	3.8302	1.8875	1.9427	0.00	0.00	82.45	9.90	41.03	41.61	261.45	21.63
	C2 (5)	4.8273	2.4096	2.4177	27.66	24.45	87.84	10.76	41.32	43.66	327.61	23.21
	C3 (10)	5.9456	2.7514	3.1942	45.77	64.42	88.38	10.84	41.44	43.90	333.29	23.42
D2 (20 cm)	C1 (0)	5.1119	2.2192	2.8927	17.57	48.90	84.33	10.29	41.05	41.94	271.31	22.02
	C2 (5)	5.9192	2.4513	3.4679	29.87	78.51	89.06	10.96	41.47	44.30	347.29	23.87
	C3 (10)	6.6200	2.9631	3.6569	56.99	88.24	89.45	11.03	42.24	44.55	357.16	24.10
D3 (40 cm)	C1 (0)	5.4300	2.2835	3.1465	20.98	61.97	85.42	10.41	41.19	42.28	287.08	22.24
	C2 (5)	6.4870	2.8825	3.6045	52.72	85.54	90.33	11.20	42.29	45.09	373.48	24.50
	C3 (10)	6.9374	3.2139	3.7235	70.27	91.67	90.80	11.35	42.94	45.31	383.52	25.48
A Application depth cm	D1 (surface)	4.8677	2.3495	2.5182	24.48	29.62	86.22	10.50	41.26	43.06	307.45	22.75
	D2 (20 cm)	5.8837	2.5445	3.3392	34.81	71.88	87.61	10.76	41.59	43.60	325.25	23.33
	D3 (40 cm)	6.2848	2.7933	3.4915	47.99	79.72	88.85	10.99	42.14	44.23	348.03	24.07
	F - test	6816.86*	6829.72*	6796.17*			7610.42*	4803.52*	8378.53*	6572.97*	6811.51*	6520.60*
	L.S.D 0.05	0.0536	0.0164	0.0389			0.09	0.02	0.03	0.04	1.50	0.05
B Compost rates (ton)	C1 (0)	4.7907	2.1301	2.6606	12.85	36.96	84.07	10.20	41.09	41.94	273.28	21.96
	C2 (5)	5.7445	2.5811	3.1634	36.75	62.83	89.08	10.97	41.69	44.35	349.46	23.86
	C3 (10)	6.5010	2.9761	3.5249	57.68	81.44	89.54	11.07	42.21	44.59	357.99	24.33
	F - test	19684.53*	19751.45*	17758.58*			20516.95*	16099.36*	14088.30*	19359.89*	20173.03*	19643.83*
	L.S.D 0.05	0.0371	0.0183	0.0201			0.13	0.02	0.03	0.06	2.00	0.05
A * B	F - test	378.01*	346.80*	1338.76*			36.26*	91.78*	1910.91*	141.70*	134.34*	626.01*
	L.S.D 0.05	0.0645	0.0316	0.0341			0.22	0.04	0.05	0.11	3.46	0.09

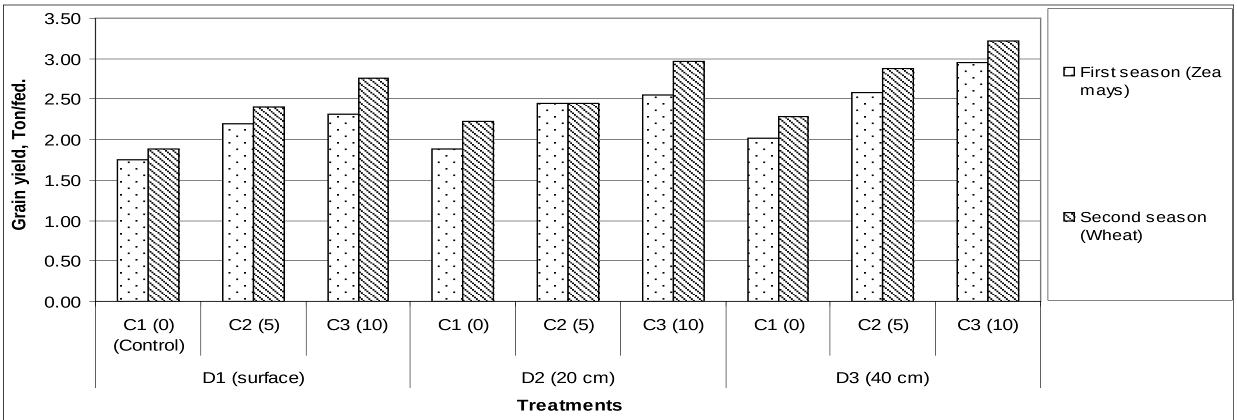

Fig. (6): Effect of different treatments on grain yield, Ton/fed.

It can be noticed from Tables (8 and 9) that the compost rates addition led to relative increases in the yield in both seasons over the control especially the addition of 10 ton compost fed^{-1}, since it recorded the highest values of maize and wheat grain yield, where increased to 48.85 and 57.68 %, respectively over the control. Also, the same treatment led to significant increases in all growth characters for maize and wheat in the first and second seasons. These results are agreement with those of Sowicki (2003), Maiorana *et al.* (2005) and Osman *et al.* (2014).

Thus, it can be confirmed that adapting mole depth in combination with adding compost is an important practice for improving soil chemical properties, moreover enhancing the nutrient status of soil and accordingly increasing crop production comparable to untreated soil.

V-Economical analysis.

Data presented in Tables (10 and 11) and Fig. (7) show that the total inputs costs, outputs, net income and the investment ratio for the tested treatments and the control. The obtained resultes indicate that the highest net income value (12346.38 L.E fed^{-1}.) was incorporated with the application of 10 ton compost fed^{-1} in 40 cm mole depth , while the control treatment (using of 10 cm surface depth without any applications of compost) gave always the lowest value (6912.41 L.E fed^{-1}.). So, the abovementioned treatment should be recommended due to a relative high net income comparing with the other treatments. This may be due to that this treatment was recorded the highest values of yield in the first and second seasons consequently high net income.

It can be noticed that, the net income values obtained by using 40 cm mole depth were in general higher than those of the other application depths, which can be arranged according to their high net income as follows: 40 cm mole depth (D3) > 20 cm mole depth

(D2) > 10 cm surface depth (D1). This may be clear that it is better economically to use 40 cm mole depth to increase the net income.

On the other hand, the results indicate that the net income for the application of 10 ton compost fed^{-1} gave the highest values for both outputs and net income than other applications to the soil. These results are in agreement with those obtained by El-Maddah *et al*. (2007) and El-Maddah *et al*. (2012).

Finally, from the previous data, it could be concluded that under clay loam soil conditions, the use of compost rates filled moles at different depths has pronounced effect to improve some soil chemical properties, substantially increase in the soil contents of either macro or micro nutrients which incorporated with the highest net income and substitute a part of mineral fertilizers by soil conditioners to minimize the pollution resulted from its intensive use .

Table (10): Input production items and output of the experiments through the two growing seasons under study (summer season of 2013 and winter season of 2013/2014).

Items	Treatment	Unit	Unit price (LE)
Input			
Mineral fertilizer			
Nitrogen fertilizer	50% from recommended dose	Kg N	5.07
Phosphorus fertilizer		Kg P_2O_5	6.45
Potassium fertilizer		Kg K_2O	11.38
Compost		Ton	180.00
Land preparation			
Surface tillage 10 cm		per fed	100.00
20 cm mole depth		per fed	130.00
40 cm mole depth		per fed	160.00
Seeds of maize	14 kg fed-1	Kg	13.00
Seeds of wheat	60 kg fed-1	Kg	4.50
labor		per fed	550.00
pesticides		per fed	500.00
Other costs		per fed	200.00
Output			
Maize grain		Ton	1500.00
Wheat grain		Ton	2800.00
Wheat straw		Ton	1000.00

Table (11): Economical assessment for the tested variables (natural soil conditioners) for the two growing seasons under study (summer season 2013 and winter season 2013/2014).

Application depth, cm	Compost rates (ton fed^{-1})	Total yield Ton fed^{-1}.			Total yield price, LE fed^{-1}			Inputs (LE fed^{-1})	Outputs (LE fed^{-1})	Net income LEfed^{-1}	Investment ratio
		Maize grain	Wheat grain	Wheat straw	Maize grain	Wheat grain	Wheat straw				
D1 (surface)	C1 (0)(control)	1.7520	1.8875	1.9427	2628.00	5285.00	1942.70	2943.29	9855.70	6912.41	3.35
	C2 (5)	2.1976	2.4096	2.4177	3296.40	6746.88	2417.70	3843.29	12460.98	8617.69	3.24
	C3 (10)	2.3168	2.7514	3.1942	3475.20	7703.92	3194.20	4743.29	14373.32	9630.03	3.03
D2 (20 cm)	C1 (0)	1.8774	2.2192	2.8927	2816.10	6213.76	2892.70	2973.29	11922.56	8949.27	4.01
	C2 (5)	2.4498	2.4513	3.4679	3674.70	6863.64	3467.90	3873.29	14006.24	10132.95	3.62
	C3 (10)	2.5552	2.9631	3.6569	3832.80	8296.68	3656.90	4773.29	15786.38	11013.09	3.31
D3 (40 cm)	C1 (0)	2.0136	2.2835	3.1465	3020.40	6393.80	3146.50	3003.29	12560.70	9557.41	4.18
	C2 (5)	2.5763	2.8825	3.6045	3864.45	8071.00	3604.50	3903.29	15539.95	11636.66	3.98
	C3 (10)	2.9515	3.2139	3.7235	4427.25	8998.92	3723.50	4803.29	17149.67	12346.38	3.57

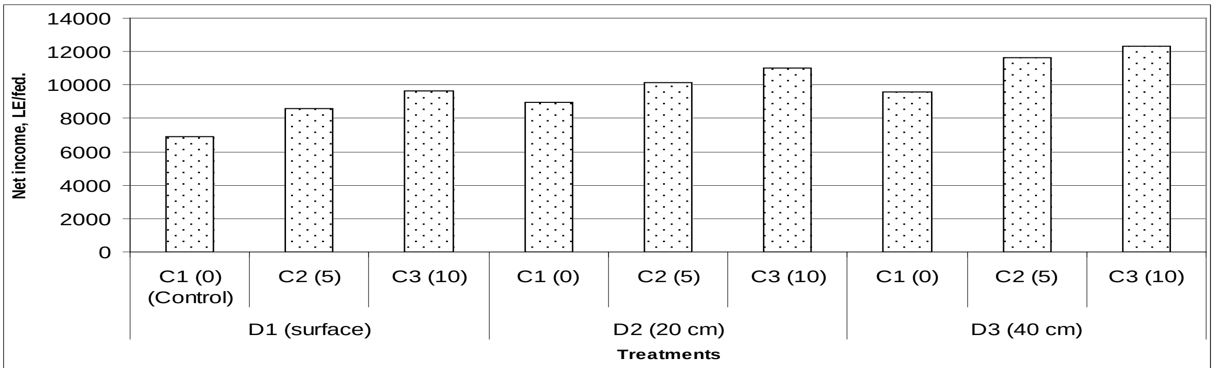

Fig. (7): Effect of different treatments on net income (LE/fed) for the two growing seasons

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تأثير إضافة معدلات من الكمبوست في أعماق مختلفة علي بعض الخصائص الكيميائية للتربة وانتاجيتها

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اجريت تجارب حقليه علي ارض طينية لومية خلال موسمين زراعيين ، موسم صيفي ٢٠١٣ باستخدام نبات الذره الشاميه وموسم شتوي ٢٠١٤/٢٠١٣ باستخدام نبات القمح ، في محطة البحوث الزراعيه بالجميزه ، محافظة الغربيه وذلك لتقييم التأثيرات المباشرة والمتبقية لإضافة معدلات من الكمبوست علي سطح التربة ، وفي أنفاق متوازية علي عمق ٢٠ ، ٤٠ سم والمسافة بين هذه الأنفاق ٣ متر بالاضافة إلي معاملة المقارنة (ارض غير معاملة) علي تحسين بعض الخصائص الكيميائيه للتربة وتيسير بعض المغذيات الكبري والصغري فيها وانتاجية محصولى الذرة والقمح بالاضافه الي إجراء التقييم الاقتصادي المحسوب علي اساس صافي الدخل ونسبة الاستثمار المحدده للمعامله الاقتصاديه. وكان تصميم التجربة قطاعات كاملة العشوائية منشقة مرة واحدة في ثلاث مكررات. ويمكن تلخيص النتائج المتحصل عليها كالتالي☹ (١) أدت كل المعاملات الي انخفاض في رقم حموضة التربه وقيم نسبة الصوديوم المتبادل وزيادة قيم ملوحة التربة والأملاح الكلية الذائبة. مقارنة بمعاملة الكنترول فى العمقين موضوع الدراسة وخلال موسمى النمو . ايضا أدت كل المعاملات الي زيادة معنويه في قيم الكاتيونات والانيونات الذائبة . بينما قيم نسبة الصديوم المدمص فقد إنخفضت مقارنة بمعاملة الكنترول في العمقين وخلال موسمي النمو (٢) أدي عمق الاضافة ومعدلات اضافة الكمبوست عموما الي تحسن واضح في حالة المغذيات في التربه (٣) زادت قيم الكربون العضوي ونسبة الكربون الي النتروجين في الطبقه السطحيه وتحت السطحيه قليلا نتيجه زيادة عمق الاضافة وزيادة معدلات اضافة الكمبوست (٤) أدت كل المعاملات الي زياده واضحه في تيسير العناصر الكبري (النتروجين ، الفوسفور والبوتاسيوم) وكذلك تيسير العناصر الصغري (حديد ، زنك ، منجنيز و نحاس) في التربة في العمقين وخلال موسمي النمو وذلك مع زيادة عمق الاضافة ومعدلات اضافة الكمبوست (٥) حدثت استجابة معنوية في المحصول ومكوناتة لكل من الذرة والقمح مع كل المعاملات مقارنة بمعاملة الكنترول وقد نتجت اعلي قيمة في المحصول ومكوناتة في الذرة والقمح باضافة ١٠ طن كمبوست للفدان في مول بعمق ٤٠ سم حيث سجل محصول حبوب الذرة زيادة قدرها ٦٨.٤٦ % ومحصول حبوب وقش القمح زيادة قدرها ٧٠.٢٧ و ٩١.٦٧ % علي التوالي مقارنة بمعاملة الكنترول (٦) أوضح التحليل الاقتصادي ان اضافة ١٠ طن كمبوست للفدان في مول بعمق ٤٠ سم كان افضل معاملة بالمقارنة مع المعاملات الاخري حيث أعطي اعلي صافي دخل هو ١٢٣٤٦.٣٨ جنيه للفدان (٧) ولذلك فمن المفيد إستخدام هذه المعاملات (معدلات من الكمبوست موضوعة في مولات علي اعماق مختلفة) مع إضافة نصف الكميات الموصي بها من الاسمده المعدنيه لكي تعطي تحسن واضح للخصائص الكيميائيه للتربه ومغذيات التربه والتي تنعكس علي ارتفاع المحصول والدخل الصافي ولتقليل التلوث الناتج من الافراط في إستخدام الاسمده المعدنيه.ومن ثم فإن نتائج هذه الدراسة قد أوضحت جليا أن إضافة معدلات من الكمبوست فى مولات على أعماق مختلفة مع إضافة نصف الكميات الموصى بها من الأسمدة المعدنية يعطى تحسنا واضحا فى الخصائص الكيميائية للتربة وتيسرا للمغذيات النباتية والذى ينعكس بدوره على زيادة المحصول والدخل الصافى فضلا عما يحدثه من تقليل لتلوث التربة والذى ينجم من الإفرط فى إستخدام الأسمدة المعدنية.