Soil physical properties and wheat yield as affected by applying compost and inorganic nitrogen in conventional and no-tillage systems under calcareous soil

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Abstract: A field experiment was conducted along the two successive seasons of winter (2013/2014) and (2014/2015) at El-Nubaria Agricultural Experimental Station of the Agricultural Research Center (ARC), El-Behera Governorate, Egypt. Aim was to evaluate the effect of tillage systems, application of compost and the levels of inorganic nitrogen on soil physical properties and yield of wheat (*Triticum aestivum L.*) grown on loamy calcareous soil. The experiment was factorial (3 factors) with 12 treatments and three replicates:1) two tillage systems conventional tillage (CT) and no tillage (NT), 2) two compost application treatments without application C_0 and 48 m^3ha^{-1}(C_1) and 3) three levels of inorganic nitrogen: 0 (N_0), 50% (N_{50}) and 100% (N_{100}) from recommended N dose. Conventional tillage and application of compost decreased the soil bulk density as well as increased the total porosity, saturated hydraulic conductivity. Also CT along with applied compost increased the percentages of rapidly draining pores (RDP), slowly draining pores (SDP), water holding pores (WHP) and decreased fine capillary pores (FCP). All yield characters significantly increased at N_{100} along with application of compost under CT. Results also indicated that application of 50% recommended dose of mineral N combined with addition of compost under CT had positive effect on yield of wheat plant with non-significant trend with C_0 x N_{100} under CT treatment. Thus, can be reduced the used amount of mineral fertilizer in soil and consequently the hazards of use many chemical fertilizers in soil and expenses of production will be reduced.

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1. Introduction

Wheat is the main winter cereal crop in Egypt for grain and straw production. Wheat grains are the main source for human feed while the straw is a main source of fodder for animal feed to support the rapid developing animal production. Wheat is among the crops whose yield are limited by low nutrients availability in sand soils **(Masoud *et al.,* 2012)**. Thus excessive chemical fertilizers are used to supply wheat plants with the major nutrients which in turn induce environment pollution.

Soil fertility and crop productivity in arid and semi-arid areas are low, owing to inadequate soil organic matter and plant-available nutrients, poor soil structure and low water availability **(Raiesi, 2006; Moreno *et al.*, 2006; Zarea, 2011).** Most of the newly reclaimed soils in Egypt are sandy and /or calcareous. These soils are known to have a low productivity due to their poor physical and chemical properties. High $CaCO_3$ content in calcareous soil causes more difficulties i.e. surface crusting and cracking. Under such severe conditions, desired yield levels are difficult to attain. Proper management of these soils calls for specialized approaches for sustainable productivity **(Balba 1987).**

Sandy soils are deficient in organic matter which is less than 5% and it can be replenished by the application of organic matters and composts to the soil **(Sarwar 2005)**. The application of organic and chemical fertilizers could influence soil physical properties because they could change soil organic carbon (SOC) content **(Aref and Wander 1998; Ellmer*et al.,* 2000)** and the chemical composition of soil solution **(Haynes and Naidu 1998).** SOC is considered as a binding agent and as a nucleus in the formation of soil aggregates **(Bronick and Lal 2005),** and the chemical composition of soil solution can greatly be related with dispersion/flocculation of clay particles and thus soil aggregation. It is commonly accepted that organic manure and compost application can increase SOC content directly and then improve aggregation, hydraulic conductivity, total porosity, and penetration resistance **(Arriaga and Lowery 2003; Celik *et al.,* 2004; Hati *et al.,* 2007; Rasool *et al.,* 2008).** Higher soil organic matter concentrations have been proved to enhance the yield and yield components of cereals.

Management methods that decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts (**Bilalis *et al.* 2009**). Moreover, emerging evidence indicates that integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints **Abbasiand Yousra (2012). Yaduvanshi and Sharma (2008)**, found that application farmyard manure with chemical amendment increased wheat yield and N, P and K uptake in grain yield. **Gong *et al.* (2009) and Enke Liu *et al.* (2010)** indicated that, long-term additions of organic manure have the most beneficial effects on grain yield of wheat and maize.

Soil tillage is among on important factors affecting soil properties and crop yield. Among the crop production factors, tillage contributes up to 20%of the crop production factors **(Khurshid *et al.*, 2006)** and affects the sustainable use of soil resources through its influence on soil properties (**Lal and Stewart 2013).** Tillage has been used to prepare seedbeds, incorporate fertilizers, manures and residues into the soil, and to control weeds **(Leij and Ghezzehei 2002).** One way to assess the effects of tillage on soil structure is to evaluate hydraulic properties. Hydraulic properties that are agronomically important include, but are not limited to, soil bulk density, soil water retention, pore size distribution **(Haverkamp *et al.*, 2005; Walczak *et al.*, 2006; Shukla 2013)** and saturated hydraulic conductivity **(Logsdon and Jaynes 1996; Prieksat *et al.*, 1994). Iqbal *et al.*, (2013)** revealed that deep tillage decreased bulk density 2 to 5% compared to other tillage practices. It is presumed that this lower bulk density results from the fact that tillage can temporarily relieve soil compaction. This may be beneficial in soils compacted by heavy equipment, human and animal traffic. The reduction in bulk density also makes tillage important for seedbed preparation for planting. Therefore, in compacted soils right after tillage, seed germination may be improved. **(Lampurlanes and Martinez, 2003; Osunbitan *et al.*, 2005; Dam *et al.*, 2005).** No-till soils generally have greater bulk densities and penetration resistance **Bauder *et al.* (1981)** and **Pierce *et al.* (1992)** which can restrict root growth and affect fertilizer uptake. **Halvorson *et al.* (2006)** found that conventional tillage produced 16% higher yields than no tillage. **Howard *et al.* (2002)** found that disk-till yields were greater than no-tillage. **Azarpour *et al.* (2011)** reported that tillage had significant effect on seed yield, biological yield, harvest index, plant height and 100 seed weight of faba been plant and in general, high seed yield was obtained by conventional tillage along with 25 kg/ha N compared with minimum tillage and the other nitrogen fertilizer levels**.**

This study aim to evaluate the effect of tillage systems, applying of compost with three levels of mineral nitrogen on soil physical properties and yield of wheat (*Triticum aestivum L cv. Sakha 93)* grown on a loamy calcareous soil.

2. Materials and Methods

Site description

A field experiment was conducted along the two successive seasons of winter (2013/2014) and (2014/2015) at El-Nubaria Agricultural Experimental Station of the Agricultural Research Center (ARC), El-Behera Governorate, Egypt, lying between 30 ° 54$^-$ latitude and 29° 30$^-$ longitude and attitude of 22 meter above sea level. Main properties of soil and applied compost are shown in Tables 1 and 2.

Table 1. Main characteristics of the studied soil.

Particle size distribution (%)				Texture class	Bulk density (Mgm^{-3})	Total porosity (%)	Hydraulic conductivity (cmh^{-1})	Organic matter (gkg^{-1})	CaCO$_3$ (gkg^{-1})
Coarse sand	Fine sand	Silt	Clay						
13.15	32.37	39.45	15.03	Loamy	1.48	44.79	0.71	4.51	206
*pH	*EC (dSm^{-1})	Soil anions mmolcL^{-1}				Soil cations mmolcl^{-1}			
		HCO3$^-$	Cl$^-$	SO4^{-2}	CO3^{-2}	Ca^{+2}	Mg^{+2}	Na$^+$	K$^+$
8.10	1.27	1.49	5.79	5.43	0	2.07	2.11	7.44	1.09

* pH of 1: 2.5 soil: water, EC: of past extract

Table 2. Main characteristics of applied compost.

Density (Mgm^{-3})	Organic matter (gkg^{-1})	Total C (gkg^{-1})	Total N (gkg^{-1})	C/N ratio	Total P (gkg^{-1})	Total K (gkg^{-1})	pH 1:5	EC 1:5 (dSm^{-1})
0.67	423.55	245.66	15.5	15.85	6.8	21.1	7.32	1.21

Experimental design and tillage systems

The experimental treatments were arranged in a split –split plot design. There were 12 treatments with three replicates. The experiment included 3 factors as follows: (1) two tillage methods: no-tillage (NT) and conventional tillage (CT) as main plot; (2) two treatments of compost: without application C$_0$ and 48 m^{3}ha^{-1}(C$_1$) as sub-plot and (3) three levels of mineral nitrogen: 0 (N$_0$), 50 (N$_{50}$) and 100% (N$_{100}$) from recommended dose (240 kg N ha^{-1}) as sub-sub plot. In (NT) crops were directly drilled in the previous year stubble and (CT) consisting of chisel and disking plowing.

Soil analyses

After harvesting disturbed and undisturbed soil samples were collected to determine soil properties. Bulk density with its corresponding soil moisture content was determined by core samples. Total porosity was computed from according the following equation: TP= $(1 - B_d/P_d) \times 100$ where: TP is total porosity, B_d is bulk density and P_d is particle density (2.65 g/cm^3). Saturated hydraulic conductivity was determined by constant head methods. Soil moisture content was monitored by measuring gravimetrically (drying methods). Soil Moisture-Tension Characteristic Curves determined by using pressure-membrane technique. Pore size diameters were determined for the ranges of soil matric. Soil organic matter determined by using the **Walkley - Black** method as described by **Jackson (1973).**

Crop management

Wheat seeds were sown on the last of November for the two seasons. The grains were broadcasted on the soil at the rate of 144 kg ha^{-1}. Nitrogen fertilizer added as ammonium sulphate (0.21 kg N kg^{-1}) at rate of 240 kg N ha^{-1} in 2 equal doses, before the first and second irrigation. Compost and phosphorus fertilizer (32.5 kg P ha^{-1} in as ordinary calcium super phosphate 67.74 g P kg^{-1}) incorporated into the soil during land preparation. K was applied at rate of 47.81 kg K ha^{-1} as potassium sulfate (0.398 kg K kg^{-1}), which was given before the first irrigation.

At the maturity stage, ten plants from each plot were randomly taken, separated into grains and straw then dried and kept for analyses. Analyses of soil and plant samples were done using methods cited by **Chapman and Pratt (1961)**; **Jackson (1973); Page *et al.*, (1982)** and **Klute (1986)**.

3. Results and Discussion

Effect of tillage methods, application of compost and nitrogen levels on soil properties

Soil bulk density

Soil bulk density (BD) is one of the useful values that are used as an indication for soil structure. This soil property is mainly affected by the distribution of pore space. Data in Table 3 show that CT decreased soil bulk density (BD) as compared with NT. Tillage reduced compactness of soil and increased the number of pore spaces, which decreased soil bulk density. The reduction percentages of the CT were 6.85 % as compared with NT. These findings are in accordance with those obtained by **Iqbal *et al.* (2013)** and **Samuel *et al.* (2017).**

Also data in Table 3 indicate that the application of compost was of a more pronounced effect on diminishing values of the bulk density than the untreated plots. Percent reduction from the control were 4.99 %. Previous studies showed that organic components have a dilution effect that results in reduced bulk density and increased total porosity **(Martin and Stephens 2001; Bronick and Lal 2005; Xin *et al.* 2016).**

Concerning the main effect of inorganic N fertilizer treatments on soil bulk density, data reveal that N levels had no significant effect in bulk density**.** These results are in accordance with that of **Yang *et al.* (2016)** who stated that there were no significant differences on BD at chemical fertilizer application treatments.

Also data reveal that the lowest BD value (1.276 Mg m^{-3}) was found at treatment of N_{100}along with application of compost under CT. The application of compost along with different levels of nitrogen under CT significantly reduced the bulk density which might be due to increased root growth due to nitrogen addition which, in turn, resulted in the addition of increased amount of organic matter to soil. This result was in agreement with the findings of **Shamsul Hoque (2009).**

Total porosity

Porosity or the part of soil volume occupied by pore space is inversely proportional to soil bulk density. It is in general; viewed as a good indicator of other soil physical properties such as compaction, air water relationship. Data presented in Table (3) showed that total porosity values increased significantly by CT treatment. The increasing percentages for CT were 7.88 % as compared with NT. The preceding results may be arising from the continuous exposure soil to tillage operations relative to NT which it is normally more dense and compacted. This proves that conventional tillage is the most effective tillage system in creating a loose and highly porous tillage layer thereby favors rapid and complete germination and seedling establishment. The obtained results are in agreement with those of **El-Sherbiny (2007); Harvey (2012) and El-Kotb *et al.* (2016).**

Data in Table 3 show that the addition of compost at calcareous soil was more effective on increasing soil total porosity as relative to control. Average increase were 5.57 %. These results may be attributed to the microbial decomposition products of organic components such as poly- saccharides and bacterial gums are known to act as soil particle binding agents **(Caravaca *et al.*, 2002; Wilson *et al.*, 2009; Xin *et al.* 2016)** into macro-aggregates and micro-aggregates **(Singh *et al.* 2009)**.

The highest porosity was observed in treatment of N_{100} along with application of compost under CT. These results are in agreement with **Yang *et al.* (2011)** and **Yang *et al.*, (2016)** who reported that organic manure combined with chemical fertilizer application can reduce soil BD, increase total porosity, improve soil water retention, and decrease unsaturated hydraulic compared with only chemical fertilizer application.

Table 3. Physical properties as affected by tillage methods, application of compost and nitrogen levels.

Tillage	Compost	Nitrogen levels											
		N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean
		Bulk density (Mgm^{-3})				Total porosity (%)				Hydraulic conductivity (cmh^{-1})			
0-10 cm													
NT	C_0	1.470	1.461	1.451	1.461	44.528	44.868	45.245	44.881	1.137	1.146	1.158	1.147
	C_1	1.381	1.373	1.368	1.374	47.887	48.189	48.377	48.151	2.552	2.565	2.573	2.563
Mean		1.426	1.417	1.410	1.417	46.208	46.528	46.811	46.516	1.845	1.856	1.866	1.855
CT	C_0	1.348	1.354	1.337	1.346	49.132	48.906	49.547	49.195	3.564	3.645	3.742	3.650
	C_1	1.307	1.299	1.276	1.294	50.679	50.981	51.849	51.170	5.396	5.475	5.542	5.471
Mean		1.328	1.327	1.307	1.320	49.906	49.943	50.698	50.182	4.480	4.560	4.642	4.561
Grand mean		1.377	1.372	1.358	1.369	48.057	48.236	48.755	48.349	3.162	3.208	3.254	3.208
Means of compost													
	C_0	1.409	1.408	1.394	1.404	46.830	46.887	47.396	47.038	2.351	2.396	2.450	2.399
	C_1	1.344	1.336	1.322	1.334	49.283	49.585	50.113	49.660	3.974	4.020	4.058	4.017
L.S.D $_{0.05}$		T=0.045, C=0.024, N=n.s T*C=0.028, T*N= n.s, N*C= n.s, T*C*N=n.s				T= 0.804, C= 0.505, N= n.s T*C=0.522, T*N= n.s, N*C=n.s, T*C*N= n.s				T=0.085, C=0.024, N=n.s, T*C=0.025, T*N=n.s, N*C=0.031, T*C*N=0.044			

NT: no tillage, CT: conventional tillage, C_0 and C_1: non and 240 $Mgha^{-1}$, N_0, N_{50} and N_{100}: 0, 50 and 100 % from Nitrogen recommended dose. n.s: non-significant at the 5% levels of probability at L.S.D test.

Saturated hydraulic conductivity

Hydraulic conductivity is the ability of soil to transmit water. The rate of movement of water through soil is of considerable importance influencing the entry of water into soil and the movement of water to plant roots. As soil bulk density decreases; the total pore space increases and consequently influence soil hydraulic properties, e.g. saturated hydraulic conductivity, infiltration rate and the related transport processes. The effects of tillage treatments and addition of compost and nitrogen levels on soil saturated hydraulic conductivity (Ksat) of the studied calcareous soil are illustrated in Table 3. The data show that Ksat was markedly increased by CT. The increasing percentages were 145.88 % as relative to NT. Such increase is rendered to the beneficial effects of plowing on soil loosening and the consequent increase in soil porosity and drainable pores (**Alaoui and Goetz 2008**). As soil mechanical disturbance changes soil structure and increases soil porosity, it also results in increase of the thickness of the aerobic layer in the tilled depth. This leads to rapid changes in soil hydraulic conductivity. **Bhattacharyya *et al.* (2006)** and **Horel *et al.* (2015)** found that soil Ksatvalues were significantly greater in conventional tillage systems compared to no–tillage practices.

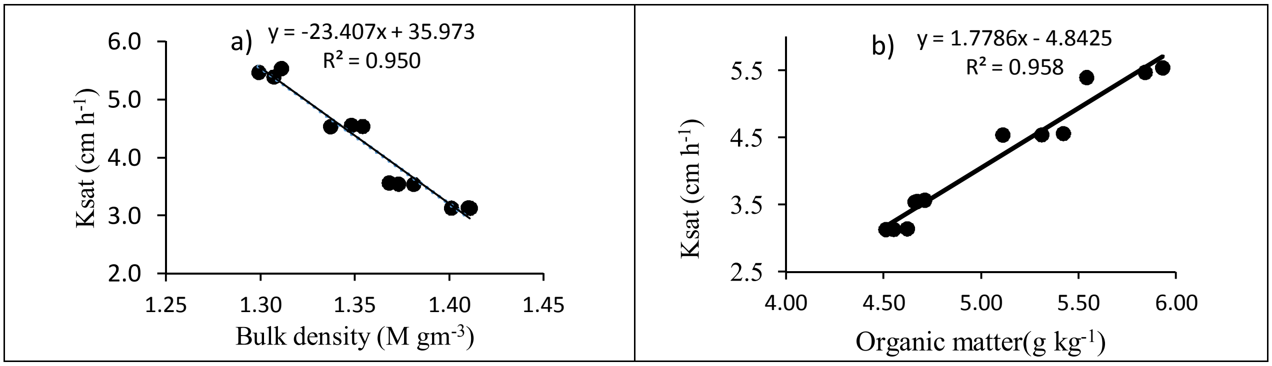

Fig. 1. a) Correlation between Ksat and BD b) between Ksat and organic matter.

Concerning the effect of compost on Ksat data at Table 3 reveal that addition of compost increased significantly the values of Ksat. Increment percentages were 67.44 % as compared with untreated soil. The previous results are in agreement with the findings of other workers **(Kushwaha *et al.*, 2001; El-Maghraby**

2002; ElHady and Abo-Sedera 2006; El-Maghraby and. Shaaban 2011).

Data from Table 3 revealed that inorganic nitrogen fertilizer had no significant effect on Ksat. **Blanco-Canqui and Schlegel (2013)** reported that inorganic fertilization did not affect saturated hydraulic conductivity. However, the highest Ksat value of 5.542 cm h^{-1} was recorded under treatment of N_{100} along with application of compost under CT.

This result indicated that the root system may be a more important factor influencing saturated hydraulic conductivity. Because high yields were obtained from the N_{100} x C_1 x CT treatment resulting better root growth may have increased the number and length of continuous pores within the soil. By harvest time, dead crop roots could have formed a large network of macropores connected to the soil surface, allowing for high hydraulic conductivity. Similar results were obtained by **Murphy *et al.* (1993) and Xin *et al.* (2016).**

Fig. 1 illustrated that Ksat is strong negative correlated with BD and positive correlated with soil organic matter content. This mainly attributed to improvement in soil structure was associated with improvement in water movement

in soil under saturated flow. These findings agree with results reported by **Jabro et al. (2009)** and **Jabro et al. (2010)** who found that greater Ksat values correspond with lower soil bulk density values.

Generally, it can deduced, from the previous discussion that the N100 along with applied of compost under CT was the mostly effective in increases the values of total porosity and saturated hydraulic conductivity as well as decreases the values of bulk density in a significant trend compare with NT and untreated plots and with other treatments.

Void ratio and air filled porosity

Data presented in Table 4 clear that, CT increased both of void ratio and air filled porosity. Air filled porosity means a space occupied by air in the soil. From the data it is clear that a more loosen soil is present under CT treatment and can allow more air into the soil. On the other hand, NT treatment produced the harder layer of soil and did not allow to occur the greater space by air and ultimately decreased the air filled porosity. Increasing percentage in void ratio for CT relative to NT were 15.73 % whereas, air filled capacity recorded 35.83 %.

Results of Table 4 indicate that the application of compost was of a more pronounced effect on increasing values of void ratio and air filled porosity than the untreated plots. Increment percentages of void ratio were 10.89 % whereas, for air filled porosity were 15.84 %.

Regard to the interaction effect results indicate that the highest values of void ratio were obtained at application of compost along with N_{100} under CT treatment. These results are in agreement with **Baki *et al.* (2015).**

Table 4. Void ratio, air filled porosity and organic matter as affected by tillage methods, application of compost and nitrogen levels.

Tillage treatments	Compost rates	Nitrogen levels											
		N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean
		Void ratio				Air filled porosity				Organic matter (g kg^{-1})			
NT	C_0	0.803	0.814	0.826	0.814	16.290	18.640	20.110	18.347	4.510	4.620	4.670	4.600
	C_1	0.919	0.930	0.937	0.929	20.130	20.730	23.160	21.340	5.110	5.420	5.540	5.357
Mean		0.861	0.872	0.882	0.871	18.210	19.685	21.635	19.843	4.810	5.020	5.105	4.978
CT	C_0	0.966	0.957	0.982	0.968	24.380	24.550	26.110	25.013	4.550	4.660	4.710	4.640
	C_1	1.028	1.040	1.077	1.048	26.370	28.180	32.120	28.890	5.310	5.840	5.930	5.693
Mean		0.997	0.999	1.029	1.008	25.375	26.365	29.115	26.952	4.930	5.250	5.320	5.167
Grand mean		0.929	0.935	0.956	0.940	21.793	23.025	25.375	23.398	4.870	5.135	5.213	5.073
Means of compost													
	C_0	0.884	0.885	0.904	0.891	20.335	21.595	23.110	21.680	4.530	4.640	4.690	4.620
	C_1	0.973	0.985	1.007	0.988	23.250	24.455	27.640	25.115	5.210	5.630	5.735	5.525
L.S.D $_{0.05}$		T= 0.108, C=0.075, N= n.s, T*C= 0.045, T*N= n.s N*C=0.015, T*C*N= ns				T= 3.13, C=0.78, N= n.s T*C= 22.42, T*N= n.s, N*C=n.s, T*C*N= 1.113				T= 0.103, C=0.725, N= n.sT*C= 0.357, T*N= n.s, N*C=0.618, T*C*N= 0.433			

NT: no tillage, CT: conventional tillage, C_0 and C_1: non and 240 $Mgha^{-1}$, N_0, N_{50} and N_{100}: 0, 50 and 100 % from Nitrogen recommended dose.n.s: non-significant at the 5% levels of probability at L.S.D test.

Pore size distribution

Table 5 show the pore size distribution i.e. rapidly draining pores (RDP), slowly draining pores (SDP), water holding pores (WHP) and fine capillary pores (FCP) as derived from the soil moisture retention data of the studied calcareous soil. Data reveal that CT treatment was able to increasing the percentages of RDP, SDP, and WHP as well as, decreasing FCP against the NT. The increasing percentages at CT were 31.12, 26.42 and 35.11 % for RDP, SDP, and WHP, respectively as compare with NT respectively. CT decrease FCP as relative to NT.

The reduction percentages were 19.20 %. The results suggest that the redistribution of pores by tillage is more evident. This may be because chisel plow is very destructive and it may induce large pores which can transmit more water as evidenced Ksatvalues. These result is supported by the study conducted by **Samuel *et al.* (2017)** who noted that tillage improved coarse mesopores by 32% compared with no-till.

Concerning the effect of addition of compost on the distribution of pore size, data in Table 5 indicate that there are markedly increase in RDP, SDP, and WHP as compare with untreated plots. Increasing percentages were 18.84, 23.11 and 36.03 % for RDP, SDP, and WHP, respectively. So, it could be concluded that application rates of compost affecting WHP more than RDP and SDP. **Xin *et al.* (2016)** observed that higher volume of macropores (>40 µm) was observed in the compost-treated soil than in the control soil. **Schjønning *et al.* (2005)** suggested that fertilization increased the volume of macropores whether the fertilizer used was compost or mineral fertilizer because the addition of compost and mineral fertilization to soil increases yield, and root biomass which can modify the pore geometry of the soil. Referring to the FCP, the data reveal the tendency of decrease for the composted treatments comparing with the control, whereas the decreasing percent reached to 19.02 %. The promoting effect of compost on the RDP, SDO, and WHP with consequent declining to the FCP can be considered a desirable condition especially in compacted calcareous soils. This indicates the positive response of calcareous soil pore space to the organic compost additions. These results are matched with those reported by **El-Shirbeny (2002) and Harvey (2012).**

Table 5. Pore size distribution percent (on volume basis) as affected by tillage methods, application of compost and nitrogen levels.

Tillage	Compost	Nitrogen levels							
		N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean
		Rapidly drainable pores				Slowly drainable pores			
NT	C_0	7.24	7.31	7.44	7.33	3.55	3.68	3.85	3.69
	C_1	8.24	8.35	8.47	8.35	4.14	4.48	4.61	4.41
Mean		7.74	7.83	7.96	7.84	3.85	4.08	4.23	4.05
CT	C_0	8.84	8.92	9.95	9.24	4.32	4.52	4.73	4.52
	C_1	11.21	11.32	11.46	11.33	5.52	5.76	5.86	5.71
Mean		10.03	10.12	10.71	10.28	4.92	5.14	5.30	5.12
Grand mean		8.88	8.98	9.33	9.06	4.38	4.61	4.76	4.59
Means of compost									
	C_0	8.04	8.12	8.70	8.28	3.94	4.10	4.29	4.11
	C_1	9.73	9.84	9.97	9.84	4.83	5.12	5.24	5.06
L.S.D $_{0.05}$		T=2.03, C= 2.16, N=.06, T*C= 0.49, T*N= 0.09, N*C= 1.13, T*C*N=0.11				T= 1.12, C= 1.09, N=0.08, T*C=1.13, T*N=1.20, N*C=0.03, T*C*N= 1.14			
		Water holding pores				Fine capillary pores			
NT	C_0	5.78	5.87	5.91	5.85	22.87	22.71	22.69	22.76
	C_1	7.14	7.34	7.42	7.30	17.32	17.21	17.18	17.24
Mean		6.46	6.61	6.67	6.58	20.10	19.96	19.94	20.00
CT	C_0	7.14	7.24	7.36	7.25	17.31	17.18	17.11	17.20
	C_1	9.78	10.81	10.98	10.52	15.25	15.11	15.00	15.12
Mean		8.46	9.03	9.17	8.89	16.28	16.15	16.06	16.16
Grand mean		7.46	7.82	7.92	7.73	18.19	18.05	18.00	18.08
Means of compost									
	C_0	6.46	6.56	6.64	6.55	20.09	19.95	19.90	19.98
	C_1	8.46	9.08	9.20	8.91	16.29	16.16	16.09	16.18
L.S.D $_{0.05}$		T= 1.31, C= 0.915, N= 0.06, T*C=0.42, T*N= 1.22, N*C= 1.04, T*C*N= 1.25				T= 0.19, C= 0.13, N= 0.25, T*C= 0.07, T*N= 0.26 N*C= 0.16 T*C*N= 0.06			

NT: no tillage, CT: conventional tillage, C_0 and C_1: non and 240 Mgha^{-1}, N_0, N_{50} and N_{100}: 0, 50 and 100 % from Nitrogen recommended dose.n.s: non-significant at the 5% levels of probability at L.S.D test.

Effect of tillage methods, application of compost and nitrogen level on yield of wheat plant

Data from Table 7 reveal that CT increased values of grain yield, straw yield, grain + straw yield and harvest index compare with NT. The rate of increase reached 18.48, 9.67, 12.86 and 5.36 % for grain yield, straw yield, grain+ straw yield and harvest index, respectively. The higher yield in the CT might be due to CT broke the soil hard pan which may resulted to deeper root penetration for more nutrients uptake and ultimately higher grain yield was obtained and soil compaction occurred at NT directly affected the system of macrospores and soil physical growth factors; i.e. soil moisture, soil aeration, soil temperature and soil penetration resistance. **Karunatilake*et al.*, (2000)**; **Memon*et al.* (2011)** and **Javeed*et al.*, (2013)** resulted that higher grain yield was recorded in the deep tillage treatment in maize crop.

Regarding the effect of addition of compost on the yield of wheat plant data in Table 7 indicated that the addition of compost increased grain yield, straw yield, grain + straw yield and harvest index. The increasing percentages were 17.28, 9.39, 12.25 and 4.17 % for grain yield, straw yield, grain + straw yield and harvest index, respectively as compare with non-addition. This response may be due to the decomposition of organic matter and release of their available nutrients. Furthermore, it has beneficial effect on soil chemical, physical and their nutrients uptake. Similar results were obtained by **Ali *et al.*, (2005)** and **Antoun *et al.* (2010).**

Data reveal that grain yield, straw yield, grain + straw yield and harvest index increased with increasing N level. The increasing percentages for N100 as compared with unfertilized plants were 86.73, 50.93, 63.38 and 14.29 % for grain yield, straw yield, grain + straw yield and harvest index, respectively. These increments may be due to that the nitrogen has an important role in encouraging cell elongation, cell division and consequently increasing vegetative growth and activation of photosynthesis process which enhance the amount of metabolites necessary for building plant organs which reflect the increases in grain and straw yields. These results are in agreement with those obtained by **Abbas *et al.* (2007); Zaki*et al.* (2007)** and **Antoun *et al.* (2010).**

Concerning the effect of the interaction between tillage treatments, addition of compost and inorganic N-levels results clarified that in general, plants received N_{100} in the presence of compost under CT gave the highest wheat yield (grain and straw). On the other hand, treatment of C_1 x N_{50} was not significantly different from C_0 x N_{100} under CT. These results are in consonance with findings of **Ali *et al.* (2011)** who found that in most characters of canola plant, treatment of 100 % recommended dose of mineral N did not statistically differ than of 50 % plus compost application at rate of 24 Mg ha $^{-1}$.

Table 7. Yield of wheat plants as affected by tillage methods, application ofcompost and nitrogen levels.

Tillage	Compost	Nitrogen levels							
		N_0	N_{50}	N_{100}	Mean	N_0	N_{50}	N_{100}	Mean
		Grain yield Mg ha^{-1})				Straw yield (Mg ha^{-1})			
NT	C_0	1.750	2.110	3.117	2.326	3.406	4.213	5.309	4.309
	C_1	1.940	2.490	3.785	2.738	3.815	4.919	5.193	4.642
Mean		1.845	2.300	3.451	2.532	3.611	4.566	5.251	4.476
CT	C_0	1.960	2.610	3.730	2.767	3.601	4.628	5.733	4.654
	C_1	2.250	3.331	4.120	3.234	3.991	5.383	6.119	5.164
Mean		2.105	2.971	3.925	3.000	3.796	5.006	5.926	4.909
Grand mean		1.975	2.635	3.688	2.766	3.703	4.786	5.589	4.693
		Means of compost							
	C_0	1.855	2.360	3.424	2.546	3.504	4.421	5.521	4.482
	C_1	2.095	2.911	3.953	2.986	3.903	5.151	5.656	4.903
L.S.D $_{0.05}$		T=0.391 C=0.333 N=0.645 T*C=1.092, T*N= 0.834 N*C=0.561, T*C*N=0.431				T= 0.341 C= 0.496, N=0.693, T*C=0.712, T*N=0.823, N*C=0.664, T*C*N=0.673			
		Grain + Straw yield (Mg ha^{-1})				Harvest index (%)			
NT	C_0	5.156	6.323	8.426	6.635	33.941	33.370	36.993	34.768
	C_1	5.755	7.409	8.978	7.381	33.710	33.608	42.159	36.492
Mean		5.456	6.866	8.702	7.008	33.825	33.489	39.576	35.630
CT	C_0	5.561	7.238	9.463	7.421	35.245	36.060	39.417	36.907
	C_1	6.241	8.714	10.239	8.398	36.052	38.226	40.238	38.172
Mean		5.901	7.976	9.851	7.909	35.649	37.143	39.827	37.540
Grand mean		5.678	7.421	9.277	7.459	34.737	35.316	39.702	36.585
		Means of compost							
	C_0	5.359	6.781	8.945	7.028	34.593	34.715	38.205	35.838
	C_1	5.998	8.062	9.609	7.889	34.881	35.917	41.198	37.332
L.S.D $_{0.05}$		T=0.732 C=0.731, N=1.513, T*C= 1.624, T*N=2.292, N*C= 1.17 1, T*C*N= 1.141				T=1.362, C= 1.011, N= 5.153, T*C=0.042, T*N=1.161, N*C= 0.122, T*C*N= 2.234			

NT: no tillage, CT: conventional tillage, C_0 and C_1: non and 240 Mgha^{-1}, N_0, N_{50} and N_{100}: 0, 50 and 100 % from Nitrogen index recommended dose. n.s: non-significant at the 5% levels of probability at L.S.D test

Conclusion

From previous discussion it can be concluded that conventional tillage and compost application had a positive effect on physical properties of calcareous soil. Both conventional tillage and compost application decreased the soil bulk density as well as, increased the total porosity, saturated hydraulic conductivity. Also CT along with applied of compost increase the percentages of RDP, SDP, and WHP as well as, decreasing FCP.

Application of 50% recommended dose of mineral N combined with addition of compost under CT had positive effect on yield of wheat plant with non-significant trend with C_0 x N_{100} under CT treatment.Thus, can be reduced the used amount of mineral fertilizer in soil and consequently the hazards of use many chemical fertilizers in soil and expenses of production will be reduced.

References

1. Abbas, H. H.; F. M. Habib; I. M. Farid and M. M. E. Ali 2007. Implications of adding mineral nitrogen, chicken manure or compost and bio-fertilization on wheat plant grown on a light textured soil under different water stress levels. The third Conf. of Sustain Agric. And Develop., Fac. Agric., Fayoum Univ., 12-14 Nov.,2007:547-562.
2. Abbasi, M.K and M. Yousra 2012. Synergisticeffects of bio-fertilizer with organic and chemical N sources in improving soil nutrient status and increasing growth and yield of wheat grown under greenhouse conditions. Plant Bio Syst. 146: 181-189.
3. Alaoui, A. and B. Goetz. 2008. Dye tracer and infiltration experiments to investigate macropore flow, Geoderma 144: 279–286.
4. Ali Laila, E. M.; M. H. Abd El-Salam and N. R. Habashy 2005. Effect of soil amendments on some properties of calcareous soil and productivity. Minufiya J. Agric. Res., 30 (2):735-749.
5. Ali, M. E.; A. I. Fathi; O. H. Mohamed and Y. M. El-Edfawy 2011. Response of Canola Productivity and Quality to Bio- Organic and Inorganic N – Fertilizers. Inter. J. of Soil. Sci. 2(12): 1255-1272.
6. Antoun, L. W.; S. M. Zakaria and H. H. Rafla 2010. Influence of compost, N-mineral and humic acid on yield and chemical composition of wheat plant. J. Soil Sci. and Agric. Engineerring., Mansoura Univ.1 (11): 1131- 1143.
7. Aref, S.; M. and M. Wander 1998. Long-term trends of corn yield and soil organic matter in different crop sequences and soil fertility treatments on the morrow plots. Adv. Agron. 62, 153–197.
8. Arriaga, F. J.; B. Lowery. 2003. Soil physical properties and crop productivity of an eroded soil amended with cattle manure. Soil Sci. 168, 888–899.
9. Azarpour, E.; M. K. Motamed; H. A. Bozorgi and M. Moraditochaee 2011. Effects of tillage systems and nitrogen fertilizer on yield and yield components of faba bean. World Appl. Sci. J. 13(9): 2037-2041.
10. Baki, M. Z. I.; M. A. Matin; M. F. Jubayer; T. K. 1Roy and A. Wadud 2015. Effect of depth of tillage and manuring on soil physical properties, water conservation, and yield of aman rice (Brri Dhan49) in Bangladesh. Inter. J. of Info. Res. and Rev. 2(1): 274-283.
11. Balba, A. M. 1987. Soil Reclamation and Improvement. Alex., Egypt. J. Agric. Pp. 189-218.
12. Bauder, J. W.; G. W. Randall and J. B. Swann 1981. Effect of four continuous tillage systems on mechanical impedance of a clay loam soil. Soil Sci. Soc. Am. J. 45: 802-806.
13. Bhattacharyya R.; V. Prakash; S. Kundu; and H. S. Gupta 2006. Effect of tillage and crop rotations on pore size distribution and soil hydraulic conductivity in sandy clay loam soil of the Indian Himalayas, Soil Till. Res. 86: 129–140.
14. Bilalis, D.; A. Karkanis; A. Efthimiadou; A. Konstantasand and V. Triantafyllidis 2009. Effects of irrigation system and green manure on yield and nicotine content of Virginia (flue-cured) organic tobacco (*Nicotianatabacum*), under Mediterranean conditions. Ind. Crops Prod., 29: 388-394.
15. Blanco-Canqui, H., Schlegel, A.J., 2013. Implications of inorganic fertilization of irrigated corn on soil properties: lessons learned after 50 years. J. Environ. Qual. 42, 861–871.
16. Bronick, C. J.; and R. Lal 2005. Soil structure and management: a review. Geoderma 124, 3–22.
17. Caravaca, F.; G. Masciandaro and B. Ceccanti 2002. Land use in relation to soil chemical and biochemical properties in a semiarid Mediterranean environment. Soil Till. Res. 68(1):23-30.
18. Celik, I., I. Orcas; S. Kilic 2004. Effects of compost, mycorrhiza, manure and fertilizer on some physical properties of a Chromoxerert soil. Soil Till. Res. 78, 59–67.
19. Chapman, H. D. and P. F. Pratt 1961. Methods of Analysis for Soil, Plant and Water. DIV. Agric. Sci., Univ. of Calif.

20. Dam, R. F.; B. B. Mehdi; M. S. E. Burgess; C. A. Madramootoo; G. R. Mehuys and I. R. Callum 2005. Soil bulk density and crop yield under eleven consecutive years of corn with different tillageand residue practices in a sandy loam soil in central Canada. Soil Till. Res. 84: 41--53.
21. El-Hady, O.A. and S.A. Abo-Sedera 2006. Conditioning effect of composts and Acrylamide Hydrogels on a sandy calcareous soil. II-Physico-biochemical Properties of the Soil. It. J. Agri. Biol., 8(6):876-884.
22. El-Kotb, H.M. A.; M. M.Harvey, and Y. M. El-Edfawy 2016. Effect of tillage methods and phosphorous fertilizer treatments on some physical properties and productivity of maize crop in calcareous soil. Annals of Agric. Sci., Moshtohor 54(4): 999-1008.
23. Ellmer, F.; H. Peschke; W. Kohn; F. M. Chmielewski; and M. Baumecker 2000. Tillage and fertilizing effects on sandy soils. Review and selected results of long-term experiments at Humboldt-University Berlin. J. Plant Nutr. Soil Sci. 163, 267–272.
24. El-Maghraby, S. E. 2002. Influence of tillage depth and organic residue placement on calcareous soil productivity under irrigation frequencies with high saline water. Egypt. J. Appl. Sci., 7: 331-349.
25. El-Maghraby, T. A. and S. M. Shaaban 2011. Ameliorating calcareous soil properties and agriculture methods for achieving the sustainable agriculture aspect. J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (5): 541 – 554.
26. El-Sherbiny, W. A. 2007. Fodder beet production from Maryut Calcareous soil treated by organic manure. Egypt J. Soil. Sci. 47 (4): 419-434.
27. El-Sherbiny, W.A.A. 2002. A study on some management practices in calcareous soils and their reflection on soil physical, mechanical properties and crop production. Ph.D. Thesis. Fac. of Agric. Moshtohor,, Benha Univ., Egypt.
28. Enke Liu; Y. Changrong; M. Xurong; H. Wenqing; S. H. Bing; D. Linping; L. Qin; L. Shuang and F. Tinglu 2010. Longterm effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China. Geoderma 158, 173–180.
29. Gong, W.; X. Yan; J. Wang; T. Hu; Y. And Gong 2009. Long-term manure and fertilizer effects on soil organic matter fractions and microbes under a wheat–maize cropping system in northern China. Geoderma 149: 318–324.
30. Halvorson, A. D.; A. R. Mosier; C. A. Reule and W. C. Bausch 2006. Nitrogen and tillage effects on irrigated continuous corn yields. Agron. J. 98, 63-71.
31. Harvey, M. M. 2012. Effect of different soil managements on some chemical and physical properties of El-Nubaria soils. Ph.D. Thesis Agric. Sci. Dep. of Soils Fac. Of Agric. Benha Univ.
32. Hati, K.A.; A. Swarup; A. K. Dwivedi; A. K. Misra; and K. K. Bandyopadhyay 2007. Changes in soil physical properties and organic carbon status at the topsoil horizon of a vertisol of central India after 28 years of continuous cropping, fertilization and manuring. Agric. Ecosyst. Environ. 119: 127–134.
33. Haverkamp R.; F. J. Leij; C. Fuentes; A. Sciortino and P. J. Ross 2005. Soil water retention. Soil Sci. Soc. Am J. 69: 1881--1890.
34. Haynes, R. J. and R. Naidu 1998. Influence of lime, fertilizer and manure applications on soil organic matter content and soil physical conditions: a review. Nutr. Cycl. Agroecosyst. 51, 123–137.
35. Horel, A; E. Tóth; G. Gelybó; I. Kása; Z. Bakacsi, and C. Farkas 2015. Effects of land use and management on soil hydraulic properties. Open Geo Sci. 1:742–754.
36. Howard, D. D.; M. E. Essington and J. Logan, 2002. Long-term broadcast and banded phosphorus fertilization of corn produced using two tillage systems. Agron. J. 94, 51-56.
37. Iqbal M.; A. G. Khan; A. Hassan and K. R. Islam 2013. Tillage and nitrogen fertilization impact on irrigated corn yields, and soil chemical and physical properties under semiarid climate. J. of Sustainable Watershed. Sci. and Manage. 1 (3): 90–98.
38. Jabro J. D.; W. B. Stevens; R. G. Evans; W. M. Iversen 2009. Tillage effects on physical properties in two soils of the Northern Great Plains. Applied. Engineering. in Agric.25, 377-382.
39. Jabro, J. D.; W. B. Stevens; W. M. Iversen; and R. G. Evans. 2010. Tillage effects on bulk density and hydraulic properties of a sandy loam soil in the Mon-Dak Region, USA. World Congress of Soil Science, Soil Solutions for a Changing World 1 – 6 August, Brisbane, Australia.
40. Jackson, M. L. 1973. Soil chemical analysis. Prentice-Hall, Englewood Cliffs, N. J. Library of Congress, USA.
41. Javeed, H. M. R.; M. S. I. Zamir; A. Tanveer and M. Yaseen 2013. Soil physical properties and grain yield of spring maize (*zea mays* L.) as influence by tillage practices and mulch treatments Cercetări Agronomiceîn Moldova. 1 (XLVI) 153.

42. Karunatilake U.; H. M.V.Es and R. R. Schindelbeck 2000. Soil and maize response to plow and no tillage conversion on a clay loam soil in New York. Soil Till. Res. 55(1- 2):31-42.
43. Khurshid, K. M.; M. Iqbal, S. Arif, and A. Nawaz 2006. "Effect of tillage and mulch on soil physical properties and growth of maize. Inter. J. of Agric. and Biol. 8, 593–596.
44. Klute, A. 1986. "Methods of soil analysis part I. physical and mineralogical methods". 2nd ed., Agron. Madison, Wisconsin, U.S.A.
45. Kushwaha, C. P.; S. K. Tripathi and K. P. Singh 2001. Soil organic matter and water-stable aggregates under different tillage. Department of Botany, Banaras Hindu Univ. Varanasi 221 005, India.
46. Lal, R. and B. A. Stewart 2013. Principle of sustainable soil management in agroecosystems. CRC Press, 1 edition.
47. Lampurlanés, J., C. and C. Martinez 2003. Soil bulk density and penetration resistance under different tillage and crop management systems and their relationship with barley root growth. Agron. J.95: 526--536.
48. Leij, F. J. and T. A. Ghezzehei 2002. Modeling the dynamics of the soil pore-size distribution. Soil Till. Res. 64: 61--78.
49. Logsdon, S. D. and D. B. Jaynes 1996. Spatial variability of hydraulic conductivity in a cultivated field at different times. Soil Sci. Soc. Amer. J.60: 703--709.
50. Martin, P. J. and W. Stephens 2001. The potential for biomass production on restored landfill caps. Bullard, M.J., Christian, D.G., Knight, J.D., Lainsbury, M.A., Parker, S. R. (Eds.), Aspects Appl. Biol. 65, 337–344.
51. Masoud, B.; R. Abdolshahi; G. M. Nejad; K. Yousefi and S. M. Tabatabaie. 2012. Effect of different microelement treatment on wheat (*Triticumaestivum* L.) growth and yield. Intl. Res. J. Appl. Basic. Sci., 3 (1): 219-223.
52. Memon, S. Q.; M. Zakria; G. R. Mari; M. H. Nawaz and M. Z. Khan 2011. Effect of tillage methods and fertilizer levels on maize production. Pak. J. Agri. Sci., 48(2):115-117.
53. Moreno, F.; J. M. Murillo; F. Pelegrín, I. F. Girón 2006. Long-term impact ofconservation tillage on stratification ratio of soil organic carbon and loss oftotal and active CaCO3. Soil Till. Res. 85, 86–93.
54. Murphy, B.W.; T. B. Koen; B. A. Jones and L. M. Huxedurp 1993. Temporal variation of hydraulic-properties for some soils with fragile structure. Aust. J. Soil Res. 31, 179–197.
55. Osunbitan, J. A.; D. J. Oyedele and K. O. Adekalu 2005. Tillage effects on bulk density, hydraulic conductivity and strength of a loamy sand soil in southwestern Nigeria. Soil Till. Res. 82: 57--64.
56. Page, A. L.; R. H Miller and D. R. Keeny, 1982. "Methods of soil analysis part II: chemical and microbiological properties. 2nd Ed. Am. Soc.Agron. Madison, Wisconsin, U.S.A.
57. Pierce, F. J.; M. C. Fortin and M. J. Staton 1992. Immediate and residual effects of zone-tillage in rotation with no-tillage on soil physical properties and corn performance. Soil Till. Res., 24, 149-164.
58. Prieksat, M. A.; T. C. Kaspar and M. D. Ankeny 1994. Positional and temporal changes in ponded infiltration in a corn field. Soil SciSoc Am J. 58: 181--184.
59. Raiesi, F. 2006. Carbon and N mineralization as affected by soil cultivation and crop residue in a calcareous wetland ecosystem in Central Iran. Agric. Ecosyst. Environ. 112, 3–20.
60. Rasool, R.; S. S. Kukal and G. S. Hira 2008. Soil organic carbon and physical properties as affected by long-term application of FYM and inorganic fertilizers in maize– wheat system. Soil Till. Res. 101, 31–36.
61. Samuel I. H.; H. A. Stephen; V. N. Nsalambi and Z. Syaharudin 2017. Soil Hydraulic Properties: Influence of Tillage and Cover Crops. Pedosphere ISSN 1002-0160/CN 32-1315/P.
62. Sarwar G, 2005. Use of compost for crop production in Pakistan. Okologieabd Umweltsicherung, 26/2005. Universitat Kassel, Fachgebiet Landschaftsokologie and Naturschutz, Witzenhausen, Germany.
63. Schjønning, P.; B. V. Iversen; L. J. Munkholm; R. Labouriau and O. H. Jacobsen, 2005. Pore characteristics and hydraulic properties of a sandy loam supplied for a century with either animal manure or mineral fertilizers. Soil Use Manag. 21, 265–275.
64. Shamsul Hoque, A. K. M. 2009. Long-term manuring and nitrogen fertilization effect on soil properties and performance of wheat in a rice-wheat cropping sequence. Ph. D. Bangabandhu Sheikh Mujibur Rahman Agric. Univ. Bangladesh.
65. Shukla, M. K. 2013. Soil physics: An introduction. CRC Press.
66. Singh, S.; R. Mishra; A. Singh; N. Ghoshal and K. P. Singh. 2009. Soil physicochemical properties in a grassland and agroecosystem receiving varying organic inputs. Soil Sci. Soc. Am. J. 73(5):1530-1538.
67. Walczak, R. T.; F. Moreno; C. Sławiński; E. Fernandez, J. L. Arrue 2006. Modeling of soil

water retention curve using soil solid phase parameters. J. Hydrol. 329: 527–533.

68. Wilson, G. W. T.; C. W. Rice; M. C. Rillig; A. Springer and D. C. Hartnett. 2009. Soil aggregation and carbon sequestration are tightly correlated with the abundance of arbuscularmycorrhizal fungi: Results from long-term field experiments. Ecol. Lett. 12(5):452-461.
69. Xin, X.; J. Zhang; A. Zhu and C. Zhang 2016. Effects of long-term (23 years) mineral fertilizer and compost application on physical properties of fluvo-aquic soil in the North China Plain. Soil and Till. Res. (156) 166–172.
70. Yaduvanshi, N.P.S. and D.R. Sharma 2008. Tillage and residual organic manures/chemical amendment effects on soil organic matter and yield of wheat under sodic water irrigation. Soil and Till. Res. 98: 11–16.
71. Yang, R.; S. U. Yong-zhong; W. Tao and Y. Qin 2016. Effect of chemical and organic. fertilization on soil carbon and nitrogen accumulation in a newly cultivated farmland. J. of Integrative Agric. 15(3): 658–666.
72. Yang, X. Y.; S. L. Zhang; B. H. Sun and X. P. Chen 2011. Longterm- fertilization effects on soil organic carbon, physical properties, and wheat yield of a loess soil. J. of Plant Nutrition and Soil Sci., 174, 775–784.
73. Zaki, N.; M. Hassanein and K. M. Gamal El-Din 2007. Growth and yield of some wheat cultivars irrigated with saline water in newly cultivated land as affected by bio-fertilization. J. Appl. Sci. Res., 3 (10): 1121- 1126.
74. Zarea, M.J., 2011. Conservation tillage and sustainable agriculture in semi-arid dry land farming. In: Lichtfouse, E. (Ed.), Biodiversity, Biofuels, Agroforestry and Conservation Agriculture, Sustainable Agriculture Reviews. Springer Science +Business Media. pp. 195–238.

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