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Soil Physicochemical Properties, Water Use Efficiency and Productivity of Wheat - Maize Yields under Clay Soil Conditions as Affected by Rice Straw and Compost Application

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ABSTRACT

Two field experiments were implemented at El-Gemmieza Agric., Res. Station, Agric., Res., Center in El Gharbiah Governorate, Egypt through (2017/2018) seasons to investigate the impact of rice straw and compost application on soil physicochemical properties, water use efficiency and production of both wheat and maize yields. The design of experiment was complete randomized blocks design with three replicates, the experiment comprises the following treatments: T_1: (control), T_2: 2.50 t ha^{-1} (RS), T_3: 5.00 t ha^{-1} (RS), T_4: 5.00 t ha^{-1} (C), T_5: 2.50 t ha^{-1} (RS) + 5.00 t ha^{-1} (C) and T_6: 5.00 t ha^{-1} (RS) + 5.00 t ha^{-1} (C). Results showed that the applied of all organic treatments improved organic carbon, total N, C/N ratio and pH in soil when in all sample that was taken monthly at (30, 60, 90, 120, 150, 180,210, 240, 270, 300, 330 and 360 days from incubation rice straw and compost as compared to control treatment. Results show that applied T_6 gave the best values of total porosity and hydraulic conductivity but the bulk density decreased than other treatments. The same trend was noticed concerning application T_6 treatment which improved crops and water use efficiency of both wheat and maize as well as increased content (%) and uptake (Kg ha^{-1}) of nitrogen, Phosphors, and potassium of grains and straw of both wheat - maize crops as compared to other treatments. It seems that the characteristics parameters of soil and plants has followed the sequence $T_6 > T_5 > T_4 > T_3 > T_2 > T_1$.

Keywords: Wheat yield, maize yield, rice straw, compost, chemical properties and physical properties, water use efficiency

INTRODUCTION

Rice straw residue has been really significant issue in Egypt because of the large production of rice straw nearly twenty million ton by year. Bahnasawy *et al.* (2002) Being an appropriate material for pests and insects. Rice straw is considered as problem for the farmers, it near their houses and fields. Then farmers burn the rice straw causing black clouds and pollution within the atmosphere of Egypt. Goyal *et al.* (2009) reported that rice straw residue during the rice straw incorporation is related to many problems like immobilization of nutrients particularly nitrogen, and contributes to decrease germination of subsequent crops.

Making compost from rice straw is an alternate to direct incorporation and burning in soil. Rice straw management during composting will avoid pollution made from residue burning also as loss of organic matter and nutrients. It is important to use rice straw residue as a source of nutrients and organic carbon to improve soil fertility.

However, many researchers showed the low organic matter of the soils (0.5 - 2%). It is documented that OM, particularly in clay soil, improves the soil structure, increases the water and fertilizer retention capacity at the root zone and increases the microbial activity of the soil, in addition, useful plant nutrients are lost when about 5 million t of rice straw are disposed annually by burning Saied *et al.* (2010). Also, the decrease of soil nutrients and low soil organic matter of some Egyptian soils are often reusing by adding compost of rice straw. Esawy *et al.* (2009).

Moreover, the application of organic matter could raise the gas exchange and transpiration of plants owing to the improvement in leaf area index and plant growth increase the possibility of using by transpiration. Adamtey *et al.* (2010). On the other hand, the applying of compost catalyzing growth of root and size (Ozenc, 2008; Johnson *et al.* 2009), which may rising up the power for plants that take more water (Curtis and Claassen (2005).

Wheat and maize are considered because the foremost two important cereal crops in Egypt, there is an excellent gap between the consumption and production of wheat FAO (2011). The amount needed is bigger than that locally produced. Therefore, increasing its productivity also as cultivated area is very recommended. Because of the continuous grain planting system, unbalanced use and mineral fertilizer not available Shah *et al.* (2003) and therefore the intensive farming practices and soil fertility in wheat-growing areas are rapidly decreasing Mohammad *et al.* (2008).

Also, Maize (*Zea maize L.)* is taken into account together of the foremost important grain crops in Egypt are for widespread use in livestock, industrial aspects and human nutrition. It classifies the second crop after wheat, where it grows in the summer season. The total annual maize cultivated area was estimated at a total 1.52.0 million feddans. The total national maize production crops

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approximately 5.43 million ts, while, demand for at least 7.0 million ts. El-Atawy and Eid (2010). This reverses the dimensions of the problem and efforts needed to increase production of corn. This will be achieved through the education of high-yielding varieties and by the appliance of improved agricultural techniques. Hemalatha and Chellamuthu (2013) showed that available N value was greatest in plots receiving balanced application of fertilizers and was the minimum value in the unfertilized control. The lowering of available N in unfertilized control plot was because of the continuous removal of native soil nitrogen within the absence of external supplies of nitrogen through organic and inorganic fertilizers.

The present work aims to study the effect of applied rice straw and/or compost alone or in together on soil chemical and physical properties, water use efficiency along with productivity of both wheat - maize which cultivated in clay soil.

MATERIALS AND METHODS

The present investigation was administered at El-Gemmieza Agricu., Resea., Station of the ARC in El Gharbiah Governorate (Middle Delta region 30◦ 43- latitude and 31◦ 47- longitude), through two consecutive seasons, winter season (2017-2018), summer season 2018 to study the impact of applied rice straw (RS) and compost(C) on soil Physicochemical characteristics in the late of the two successive seasons. Wheat (*Triticum aestivum L.*)-maize (*Zea mays L.*) crops were used as indicator plant. The experimental site was ploughed triple, settled, ridged and divided into plots (4 m length x 3 m width) during soil preparation. The design of experiment was complete randomized blocks, with three duplicative, the experiment comprises the following treatments: T_1: (control), T_2: 2.50 t ha^{-1} (RS), T_3: 5.00 t ha^{-1} (RS),T_4: 5.00 t ha^{-1} (C), T_5: 1 t ha^{-1} (RS) + 5.00 t ha^{-1} (C) and T_6: 5.00 t ha^{-1} (RS) + 5.00 t ha^{-1} (C). (RS) and (C) were thoroughly mixed with the surface soil layer (0-30 cm) of the concerned plots before wheat planting at (15/10/2017) and irrigated the soil. Wheat (*Triticum aestivum L. Giza 168*) sown on 15th November 2017. Super phosphate has been added as a single dose (15%, P_2O_5) at the ratio of 36 kg P_2O_5 ha^{-1} and the mixed with surface soil layer. N fertilizer (as NH_4NO_3, 33.0%N) at rate 180 kg N ha^{-1} was added the treatment in three equal parts, i.e. when applied rice straw and compost in soil, before tillering and at heading stages. Also, K fertilizer (as K_2SO_4, 48% K_2O) was applied at a ratio of 120 kg K_2O ha^{-1}. Wheat harvested in 15th May. The second grown season at 2018 was planted by Maize (*Zea mays L., 321 TWC hybrids)* at 15th June. All plots, received the mineral P-K fertilizers at recommended doses for maize crop before cultivation. P-K fertilizer were applied at rates of 36 kg ha^1 and 120 kg ha^{-1} as superphosphate (15%,P_2O_5) and (K_2SO_4,48% K_2O), respectively. N was added at a rate of 288 kg N ha^{-1} as (NH_4NO_3, 33.0%N) at three equal parts (15, 45 and 60 days) from planting maize harvested at 20th September 2018.

Soil analyses: the samples of soil were taken from surface soil layers, following depths (0-30cm), monthly and after harvested wheat and maize. Soil samples were collected periodically at 30, 60, 90, 120, 150, 180,210, 240, 270, 300, 330 and 360 days from applied both rice straw and compost to the soil. The soil samples were developed for physicochemical analyses in accordance with the standard patterns. Soluble ions, soil pH, EC, total $CaCO_3$ and total N were defined consistent with Land and Development Department (2010).Organic matter content was standardized using the Walkley Black method by Rayan *et al.* (2001). At an equivalent time, soil samples were taken undisturbed to determine the bulk density (Bd) consistent with Black and Hartge (1986), hydraulic conductivity (Hc) was measured by auger the analytical method used by Rowel (1994). Soil Physicochemical specificities of the pilot site before cultivation are set out in Table (1). Rice straw-compost samples were subject to identifies the chemical composition according to Page *et al.* (1982) as shown in Table (2).

Table 1. Soil Physicochemical Properties of the experimental site.

pH (1:2.5) in Sup.	EC ds m^{-1} in soil paste	Soluble cations (meq L^{-1})				Soluble anaions (meq L^{-1})				OM (%)	Total $CaCO_3$ (%)
		Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	CO_3^{--}	HCO_3^-	SO_4^-		
8.18	1.25	2.55	3.45	5.92	0.18	2.2	ND	3.68	6.22	1.45	2.05

Particle -size distribution				Texture	Bd g cm^{-3}	Tp (%)	Hc cm hr^{-1}
Coarse-sand	Fine- sand	silt	clay				
5.72	17.81	25.25	51.22	clay	1.21	54.34	0.98

Bulk density (Bd), Total porosity (Tp) and Hydraulic conductivity (Hc).

Table 2. Chemical composition of the tested rice straw and compost.

organic amendments	OC (%)	OM (%)	Total nitrogen (%)	Total Phosphors (%)	Total potassium (%)	C/N ratio
Rice straw	9.55	16.46	0.34	0.38	1.25	28.09
Compost	16.45	28.36	1.29	0.58	1.62	12.52

OM= organic matter, OC= organic carbon

At harvesting, plant samples from each plot were collected as well as grain-straw yields were registered on the basis of plot, at the time was calculated as t ha^{-1}.

Plant analysis: grain and straw were wet digested by a mix of $HClO_4$ and H_2SO_4 acids the digest later exposed to identify NPK by Cottenie *et al.* (1982).

Plant uptakes of macronutrients were obtained by multiplying the nutrient % by the plant dry matter weight. All data collected have been subjected to statistical analysis as specified by Gomez and Gomez (1984). For means comparison ($LSD_{0.05}$) was applied. The mean treatment values are compared according to the multiple range test done by Duncan (Duncan, 1955).

Crop - water relationships:

1- Water consumptive use (CU)

In establishing the crop (CU), the samples of soil were taken before-after 48 hours for all irrigation, as well as in the harvest time increase 15 to 60 cm from the shape of the soil. The consumption of crop water between two consecutive irrigation was calculated with the equation given (Israelsen and Hansen, 1962) as follows:

$$CU\ (cm) = \frac{Q2 - Q1}{100}\ X\ Bd\ X\ ERZ$$

Where:

Cu = Water Consumptive use (cm).
ERZ = Effective root zone depth (cm).
Bd = Bulk density of soil layer (g cm^{-3}).
Q2 = Soil moisture content (%, wt/wt) 48 hrs after irrigation.
Q1 = Soil moisture content (%,wt/wt) just before the next irrigation

Table 3. Bulk density and some hydrodynamic constants of the studied soil.

Soil depth (cm)	Fc (%,wt/wt)	WP (%,wt/wt)	Bd (gcm^{-3})	Aw mm depth
00 - 15	45.60	24.30	1.10	35.15
15 - 30	42.30	22.10	1.20	36.36
30 - 45	39.50	21.00	1.31	36.35
45 - 60	36.90	18.60	1.38	37.88
Mean	41.10	21.50	1.18	∑ 145.74

Field capacity (Fc) Wilting Point (Wp) Bulk density (Bd) Available water (Aw).

2. Water use efficiency (WUE)

Water use efficiency was calculated accordance with Jensen (1983) as follows:

$$WUE = \frac{Y}{CU}$$

Where:

WUE = Mg grain m^{-3} water consumed.
Y = grain yield (Mg ha^{-1}).
CU= water consumptive use (m^3 ha^{-1})

RESULTS AND DISCUSSION

A- Influence of rice straw- compost application on soil physical parameter.

Data in Table 4 reveal that soil hydraulic conductivity (Hc), bulk density (Bd) and total porosity (Tp) were improved due to rice straw and compost applications and / or their combination. Data also indicated that there was highly significant influence on soil physical characteristics due to applications of tested treatments.

Table 4. Impact of rice straw - compost treatments on some soil physical properties.

Treatments	After wheat harvest			After maize harvest		
	Hc (cm hr^{-1})	Bd (g cm^{-3})	Tp (%)	Hc (cm hr^{-1})	Bd (g cm^{-1})	Tp (%)
T_1	1.16^{d}	1.22^{a}	53.96^{c}	1.31^{e}	1.19^{a}	55.09^{d}
T_2	1.49^{c}	1.15^{b}	56.60^{b}	1.73^{d}	1.12^{b}	57.73^{c}
T_3	1.80b	1.11^{c}	58.11^{ab}	2.13^{c}	1.10^{bc}	58.49^{bc}
T_4	1.77^{b}	1.13^{bc}	57.36^{ab}	1.89^{cd}	1.10^{bc}	58.49^{bc}
T_5	1.97^{b}	1.10^{c}	58.49^{a}	2.72^{b}	1.07^{c}	59.62^{b}
T_6	2.31^{a}	1.09^{c}	58.87^{a}	3.23^{a}	0.98^{d}	63.02^{a}
LSD $_{0.05}$	0.25	0.044	1.67	0.30	0.044	1.66

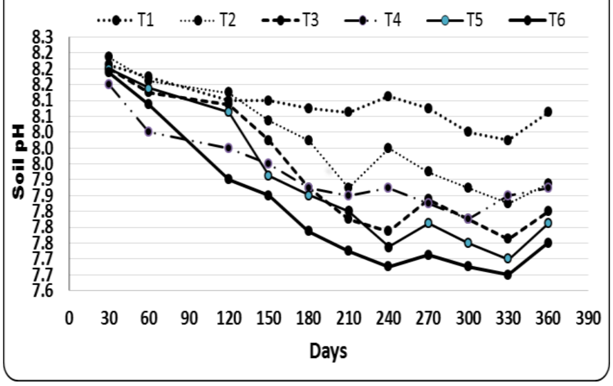
The increase in HC was 28.45, 55.17, 55.59, 69.83 and 99.14% with, T_2, T_3, T_4, T_5 and T_6, severally, over the non-treatment (T_1) after wheat harvested, and 32.06, 62.60, 44.27, 107.60 and 146.56% over the control with T_2, T_3, T_4, T_5 and T_6, consecutively, after maize harvested. The percentage of the excess in total porosity reached to 4.90, 7.69, 6.30, 8.39 and 9.10 % comparing to control (T_1) after wheat harvested, and 4.79, 6.17, 6.17, 8.22 and 14.39% than control with, T_2, T_3, T_4, T_5 and T_6, sequentially, after maize yield harvested. Also, data in Table 4 show that significant changes in bulk density (Bd) as compared with control treatment after crop harvested. Maximum decrease in Bd was observed when applied 5.00 t ha^{-1} RS + 5.00 t ha^{-1} C (T_6) and minimum decrease was observed in control (T_1). This decrease in (Bd) was about 5.74, 9.02, 7.38, 9.84 and 10.08% after wheat yield harvested as well as 5.88, 7.56, 7.56, 10.08 and 17.65% after maize yield harvested for T_2, T_3, T_4, T_5 and T_6, sequential, as compared to zero control. These findings are in line with those who reported them Nie *et al. (2007)* showed that the decrease of bulk density in soil with rice straw treatment was lowest, which was helpful for soil preparation, diminish tillage and enhance air circulation in soil. Saothongnoi *et al.* (2014) reported that the decrease of (Bd) has been observed in soil with rice straw applied at 13.15 kg m^{-2} in clay soil. Additionally, bulk density (Bd) is reduced as a results of the expansion of the mineral fraction of the denser soil and venting increases due to the rising in Tp. This growth trend has likewise been conspicuous pronounced for the highest rates of compost at the finish of the experimental period and was previously reported by Tejada and Gonzalez (2007). Yang *et al.* (2010) found that through the soil physical parameter, soil hardness and bulk density (Bd) were reduced and total porosity (Tp) was rise with rice straw applied. Application of rice straw improves physical characteristics (Bd and Tp).Yang *et al.* (2016) and Zhao *et al.* (2019) mentioned that straw return also can improving the physical characteristics of the soil, such as increased hydraulic conductivity (Hc) and lake of bulk density (Bd).

It's been shown that organic amendments application to soil has improved bulk density (Bd) Mousavi *et al.* (2012). Pravin *et al.* (2013) found that a negative correlation between organic matter (rice straw) and bulk density (Bd) of soil.

B- Influence of rice straw-compost treatments on soil chemical properties.

Soil pH: Soil pH may be one of the foremost important parameters that indicate overall changes in soil chemical properties. The values of soil pH were decreased by applied organic fertilizer. Response to rice straw in combination with compost addition was more pronounced the pH response to soil might be explained by the degradation of compost that produces organic acid that reduces soil pH. Results in Fig 1 reported that soil pH values of the all experimental units were characterized by alkaline direction, where soil pH values around 8.05 to 7.60. The maximum pH was recorded in treatment T_1 (control) as well as minimum pH value was associated with treatment T_6 which received (5.00 t ha^{-1} RS + 5.00 t ha^{-1} C).

Fig. 1: Impact of rice straw-compost treatments on soil pH

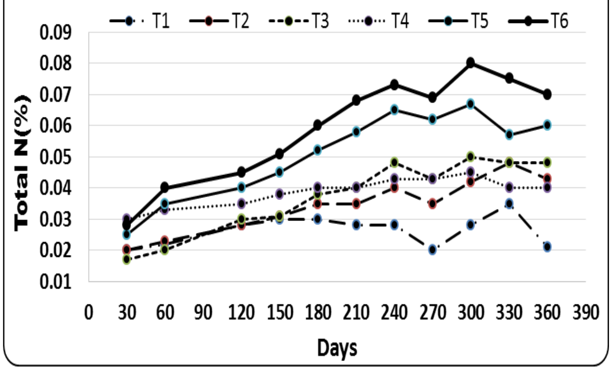


These decreased in soil pH were noticed with increased incubation periods of both rice straw combinations with compost in soil before cultivation. Decomposition of rice straw and compost leads to production of organic acids that has reduced the pH. Also, CO_2 released into soil atmosphere due to decomposition of organic amendments are often converted into carbonic acid (H_2CO_3) by reacting with water (H_2O) and decreased soil pH. These results correspond to the results obtained previously (Kumar *et al.*, 2012) showed that application of rice straw along with inorganic fertilizer in wheat plants reduced soil pH as compared to the fertilizers alone.

Also, the decreased of pH in soil with applied of different organic fertilizers compared to without control. The decrease in pH may be caused by the accumulation of organic matter over time in fertilizer pieces. Benbi and Brar (2009). These findings were in agreement with the reported findings of Shaban *et al.* (2012), Ayinla *et al.* (2016) and Yadav *et al.* (2019), found that compost application (5 Mg fed^{-1}) with nitrogen fertilizer led to reduce the pH of the soil in both seasons of the experiment. These results might be explained by the production of organic acids such as amino acid, humic acid, cysteine and glycine, during mineralization (ammonization and ammonification) of the organic materials which would have led to this decrease in pH of soil.

Total N: Result in Fig 2 revealed that total N was increased by rice straw and compost compared with control treatment. Total N was recorded at 30, 60, 90, 120, 150, 180,210, 240, 270, 300, 330 and 360 days from wheat-maize planting. Results illustrated that the application of T_6: (5.00 t ha^{-1} RS + 5.00 t ha^{-1} C) recorded the very best value of total N followed by $T_5 > T_4 > T_3 > T_2 > T_1$. This increase was obtained with increasing incubation periods and should flow from to mineralization of compost and mineralize slowly forms of N led to the influences of many organic acids produced through compost degradation. These results are consistent with results of Sofidkoohi *et al.* (2012) elucidated that the biomass of microorganisms would increase significantly after the appliance of a high-quality organic manure as a results of the integration of specific micro flora and substrate. The brink extinction, this soil biomass is a really rich resource of elements, especially nitrogen. It's called an interactive part of the soil organic component that is mineralized within a couple weeks or months under suitable conditions. The results matched with El-Ghamry *et al.* (2015) and Zhao *et al.* (2019). The organic forms of nitrogen that is present in a form of macromolecules gets slow release to a non-organic form, these plants were higher in soils amendments with compost rice straw alone or in addition to mineral fertilizers.

Fig.2:Impact of rice straw, and compost treatments on total N



Organic carbon(OC) and C/N ratio: Soil total organic carbon and C/N ratio in soil surface (0-30 cm) at different periods 30, 60, 90, 120, 150, 180,210, 240, 270, 300, 330 and 360 days after wheat-maize planting as influenced by organic amended addition is parented in (Fig, 3 and 4).

Fig. 3: Influence of rice straw-compost treatments on soil organic carbon

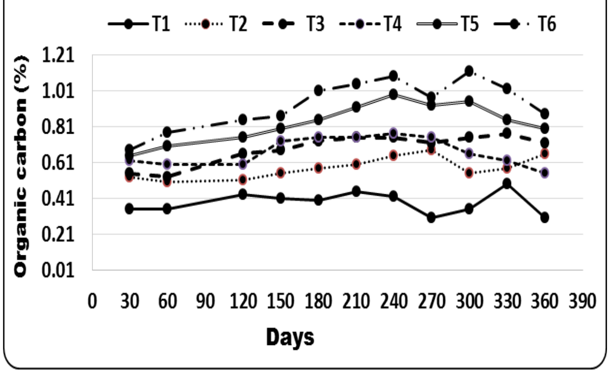
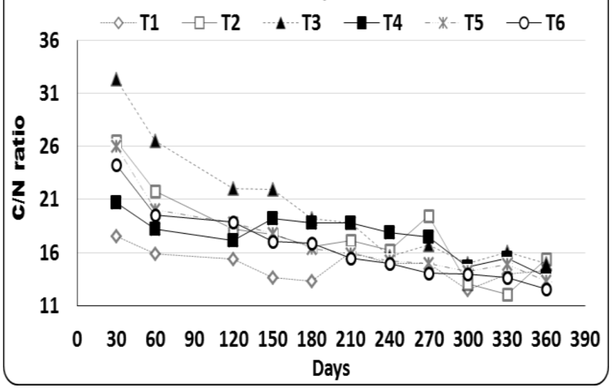


Fig. 4: Influence of rice straw-compost treatments on the C/N ratio



Data obtained indicate that all the treatments excess the OC content and improved C/N ratio, especially with increased incubation periods of rice straw and compost. Similar interpretation were in agreement with Goyal *et al.* (2009) found that rice straw-compost (5.00 t ha^{-1}) alone or alongside mineral fertilizers resulted in an increase in soil organic C content from 0.471 to 0.551 %. Increasing the OC values by the appliance of mineral and organic fertilizers are due to improved plant growth, which has resulted in an increase in terrestrial plant biomass from biomass. The excess in OC in treatments that receive rice straw-compost alone or along with mineral fertilizers is additionally attributed to the input of organic matter in the form of rice straw-compost material. Dhull *et al.* (2004), Saothongnoi *et al. (*2014) and Brar *et al.* (2015) reported increase in soil EC and SOM by application on organic manure but bulk density, and pH were decreased. It showed that an organic amendment is an efficient organic fertilizer to extend the carbon source of food and stimulate microbial activity.

C- Influence of applied rice straw-compost treatments on wheat and maize yields along with chemical composition.

Wheat and maize yields: The beneficial influences of rice straw-compost on wheat-maize yields in the studied soil were presented in Tables (5 and 6). Results showed that the significant increase in wheat-maize grain and straw yields in both seasons with the application of organic amendments in clay soil. According to the obtained data show that relative increased in wheat and maize yield for both seasons, it could be categorized into the following orders: $T_6 > T_5 > T_4 > T_3 > T_2 > T_1$. The rate T_6 (5.00 t ha^{-1} RS + 5.00 t ha^{-1} C) gave the very best value of grain (9.08 Mg ha^{-1}) and straw (16.82 Mg ha^{-1}) for the wheat plant, respectively, as well as grain (7.84 Mg ha^{-1}) and straw (16.95 Mg ha^{-1}) for maize yield respectively. The lowest values were wheat grain (6.57 Mg ha^{-1}), wheat straw (10.72 Mg ha^{-1}), maize grain (4.95 Mg ha^{-1}) and maize straw (11.43 Mg ha^{-1}) with the control treatment (T_1). These increases were attributed to improve the availability of nutritious in soil consequently increasing plant growth and yield. The beneficial effect of rice straw and compost on wheat and maize yields may be attributed to its positive impact on grain yields and/or to enhanced efficiency of roots absorption. In addition, the catalytic effect of organic amendments can be attributed to their function in plant metabolism as they are a major component of nucleic acids, phospholipids, amino acid and protein. In this attention, *Magda et al.* (2010). Sarwar *et al.* (2013) indicated that the rice straw mulch application of rate at 4 t ha^{-1} led to increase wheat yield. Dzomeku and Illiasu (2018) showed that integrated use to the amendments of groundnut shells, rice husk and rice straw with mineral fertilizer increased maize grain, and straw yield.

Table 5. Influence of rice straw-compost treatments on wheat yield and macronutrients contents (N, P and K).

Treatments	Wheat yield		Macronutrients contents (%)					
			Grain			Straw		
	Grain (Mg ha^{-1})	Straw (Mg ha^{-1})	N	P	K	N	P	K
T_1	6.57^{e}	10.72^{e}	1.82^{e}	0.19^{d}	1.04^{d}	1.22^{e}	0.12^{c}	2.18^{d}
T_2	6.93^{e}	11.90^{d}	2.03^{d}	0.27^{c}	1.23^{c}	1.41^{d}	0.20^{b}	2.29^{cd}
T_3	7.21^{d}	13.29^{c}	2.22^{bc}	0.30^{c}	1.32^{c}	1.50^{cd}	0.23^{b}	2.60^{bc}
T_4	7.61^{bc}	14.02^{c}	2.31^{bc}	0.35^{b}	1.53^{b}	1.60^{bc}	0.30^{a}	2.85^{ab}
T_5	8.00^{b}	15.50^{b}	2.43^{ab}	0.35^{ab}	1.65^{b}	1.67^{ab}	0.32^{a}	2.93^{ab}
T_6	9.08^{a}	16.82^{a}	2.58^{a}	0.39^{a}	1.80^{a}	1.73^{a}	0.34^{a}	3.17^{a}
LSD $_{0.05}$	0.51	0.81	0.17	0.04	0.13	0.10	0.046	0.34

Table 6. Influence of rice straw-compost treatments on maize yield and macronutrients contents (N, P and K).

Treatments	Maize yield		Macronutrients content (%)					
			Grain			Straw		
	Grain (Mg ha^{-1})	Straw (Mg ha^{-1})	N	P	K	N	P	K
T_1	4.95^{d}	11.43^{e}	1.58^{f}	0.20^{d}	0.86^{d}	1.06^{d}	0.11^{d}	1.77^{d}
T_2	5.53^{c}	13.19^{d}	1.92^{e}	0.30^{c}	1.07^{c}	1.22^{cd}	0.20^{c}	1.85^{cd}
T_3	6.82^{b}	15.98^{b}	2.48^{c}	0.34^{b}	1.20^{c}	1.35^{c}	0.24^{bc}	1.91^{c}
T_4	6.07^{c}	14.86^{c}	2.25^{d}	0.33^{bc}	1.21^{c}	1.29^{cd}	0.22^{c}	2.10^{b}
T_5	7.20^{b}	16.52^{ab}	2.78^{b}	0.36^{b}	1.47^{b}	1.75^{b}	0.29^{ab}	2.16^{b}
T_6	7.84^{a}	16.96^{a}	3.06^{a}	0.41^{a}	1.68^{a}	2.17^{a}	0.31^{a}	2.28^{a}
LSD 0.05	0.56	0.70	0.21	0.041	0.17	0.23	0.051	0.11

Application organic matter could play a more significant influenced in enhancing, and replenishing soil nutrients and sustained maize production. Shehzadi *et al.* (2017) pointed out that applying organic amended alone and integrated with mineral fertilizers led to increase the organic matter. It is also possible to note a significant increase in wheat grain straw yield with applied organic amended.

Nitrogen(N), phosphors (P) and potassium (K) contents (%) of wheat - maize: Data in Tables (5 and 6) demonstrated clearly that using rice straw and compost had a significant differences on NPK contents of wheat and maize grains and straw in both tested seasons. All these increases in NPK contents in wheat-maize grains and straw attributed to response to the applied treatments, it were increase significant higher than the control treatment that received the recommended amounts of NPK fertilizers only. Data of N content increased by 11.54, 21.97, 26.92, 33.52 and 41.75% for wheat grains as well as15.57, 22.95, 31.15, 36.88 and 41.80% for wheat straw along with 21.52, 56.96, 42.40, 75.95 and 93.67% for maize grains 15.09, 27.36, 21.70, 65.09 and 104.72% for maize straw caused by T_2, T_3, T_4, T_5 and T_6, sequentially as compared to control (T_1). The relative increases in P content reached 42.10, 57.90, 84.21, 84.21 and 105.26% for wheat grains as well as 66.67, 91.67, 150.00, 166.67 and 183.33% for wheat straw also, 50.00, 70.00, 65.00, 80.00 and 105.00% for maize grains 81.82, 118.18, 100.00, 163.64 and 181.82% for maize straw with T_2, T_3, T_4, T_5 and T_6, consecutively as compared to control (T_1).

The corresponding increments in K were 18.27, 26.92, 47.11, 58.65 and 73.08% for wheat grains 5.04, 19.27, 30.73, 34.40 and 45.41% for wheat straw, 24.42, 39.53, 40.70, 70.93 and 152.32% for maize grains 4.52, 7.91, 18.64, 22.03 and 28.81% for maize straw caused by T_2, T_3, T_4, T_5 and T_6, sequentially as compared to NPK Fertilizer only (T_1). These motivational effects of organic amendments can be the result of the influence of large nutrients and growth organizers in organic fertilizer that may have which activated cell division as well as a pathological activity in the nucleus as described by Sarwar (2005), it has shown that adding compost improves the availability of soil nutrients to plants as well as various production components has been positively affected, and ultimately these ingredients have contributed to increased grain and straw productivity.

NPK uptake: The effect of the application of rice straw and compost on NPK uptake by both wheat-maize grain and straw are presented in (Figs, 5 and 6).

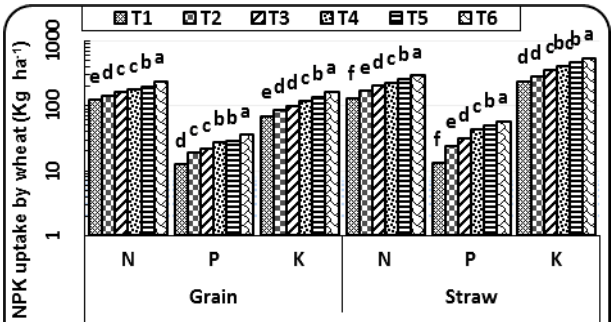


Fig.5:Impact of rice straw and compost treatments on wheat macronutrient uptake by wheat

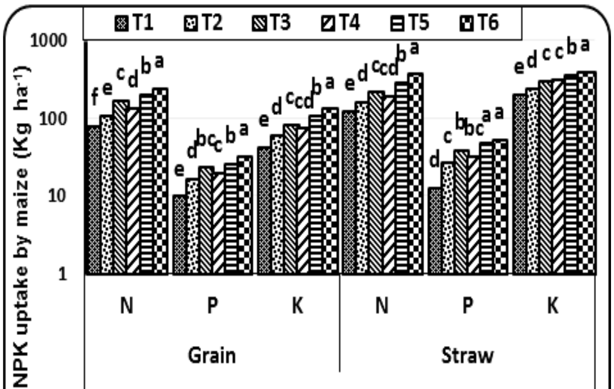


Fig.6: Influence of rice straw compost treatments on maize macronutrients uptake by maize

Results declared that the addition of rice straw-compost led to increasing significantly N, P and K uptake by wheat-maize grain and straw in both tested seasons. Moreover, the increases of NPK uptake in wheat-maize grains and straw in both tested seasons can be ranked as $T_6 > T_5 > T_4 > T_3 > T_2 > T_1$ successively, in both seasons. In this regard, relative increases in N uptake compared to without treatment reached to 17.65, 33.86, 47.02, 62.58 and 95.92% for wheat grains and 28.30, 52.43, 71.52, 97.93 and 122.50% for wheat straw along with 35.76, 116.26, 74.63, 155.93 and 208.73% for maize grains and 32.82, 78.05, 58.21, 138.61and 203.75% for maize straw with T_2, T_3, T_4, T_5 and T_6, sequentially. The obtained increases in quantity of P uptake with addition of organic amendments were higher than those obtained without it, these increases were 49.91, 73.31, 113.46, 124.36 and 183.73% for wheat grains 85.07, 137.71, 227.06, 285.69 and 344.71% for wheat straw, 67.57, 132.62, 102.32, 161.82 and 224.65% for maize grains 109.86, 205.09, 160.06, 281.14 and 318.30% caused by T_2, T_3, T_4, T_5 and T_6, respectively. Such enhancing effect of organic amendments on K uptake increased as compared with unamend plants of up to 24.75, 39.28, 70.39, 93.18 and 139.19% for wheat grains, 16.61, 47.86, 70.98, 94.33 and 128.15% for wheat straw, 38.99, 92.25, 72.54, 148.62 and 209.40% for maize grains, 20.62, 50.87, 54.25, 76.37 and 91.14% for maize straw caused by T_2, T_3, T_4, T_5 and T_6, consecutively.

The promoting impact of rice straw-compost on quality of grain is mainly due to a good supply and positive impact of wheat N uptake, which encourages further uptake of other large macronutrients available. These findings are consonant with the findings reported by *EL-Sayed (2012).* Improved soil physical conditions and increased in OC may have led to increased maize-wheat yields. The nutrient uptake of N, P and K significantly higher in organic amended compared to the non-treatment. It's often concluded that the balanced NPK fertilizers application with the organic matter was the best choice for increasing crop productivity in the rotation of corn-wheat.

D- Impact of rice straw and compost application on water use efficiency (WUE).

WUE and the productivity of grains wheat- maize as (Mg m^{-3}) were obtained from each cubic meter water consumed in both seasons (2017/2018) were recorded in Table 7. WUE values ranged between 1.73 and 1.90 Mgm^{-3} for wheat crop and ranged between 1.15 and 1.46 for maize crop.

The greatest values of WUE were observed from the application rate of T_6 (5.00 t ha^{-1} RS + 5.00 t ha^{-1} C) treatment for wheat crop (1.90 Mg m^{-3}) and (1.46 Mg m^{-3}) for maize crop, respectively. Regarding, the effect of the application of T_6 (5.00 t ha^{-1} RS + 5.00 t ha^{-1} C, treatment rates on water use efficiency, the plants with the highest compost treatment gave significantly highest WUE in both seasons (Table, 7).

Table 7. Impact of rice straw, and compost treatments on water use efficiency (Mg m^{-3}) for wheat and maize.

Treatments	Wheat yield			Maize yield		
	Grain	CU	(WUE)	Grain	CU	(WUE) (Mgm-
T_1	6.57^e	3785.1	1.73	4.95^d	4279.9	1.15
T_2	6.93^e	3949.8	1.75	5.53^c	4390.8	1.25
T_3	7.21^d	4072.1	1.77	6.82^b	4730.6	1.44
T_4	7.61^{bc}	4185.4	1.81	6.07^c	4573.3	1.32
T_5	8.00^b	4345.5	1.84	7.20^b	4984.3	1.44
T_6	9.08^a	4760.2	1.90	7.84^a	5364.9	1.46
Mean	7.56	4183.0	1.80	6.40	4720.6	1.34

Water Consumptive Use (CU) water use efficiency (WUE)

This might flow from to the role of rice straw compost as organic fertilizer on better holding the water in the root zone Ali *et al.* (2006). In this respect, Ali *et al.* (2006) added that the applied of rice straw-compost for tomatoes increased (WUE) water use efficiency. These results were consonant with those reported by Mohammad *et al.* (2003), Yoshida *et al.* (2004), Brady and Weil (2005), Curtis and Claassen (2005), Ozenc, (2008) Esawy *et al.* (2009), Johnson *et al* (2009) and Adamtey *et al.* (2010).

CONCLUSION

Results which obtained indicated that bulk density and soil pH decreased found in this study to peak when application rate of 5.00 t ha^{-1} rice straw + 5.00 t ha^{-1} compost, whereas soil porosity, water use efficiency, soil organic carbon content grain, straw yield and macronutrients (nitrogen, Phosphors and potassium) uptake of wheat-maize become increasingly compared to the non-treatment control and improve the C/N ratio. Organic amendments like rice straw and compost have the ability to make soil perform better and improve the characteristics of the soil, especially on soil fertility and its productive capacity. In conclusion, the study shows the possibility to add rice straw and compost in clay soil to improve the soil physicochemical properties, which in turn leads to obtain the good quantity and quality yield of wheat and maize.

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تأثير إضافة قش الأرز والكمبوست علي الخواص الطبيعية الكيميائية للتربة وكفاءة مياة الري وإنتاجية كل من محصول القمح والذرة الشامية تحت ظروف الأراضى الطينية

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معهد بحوث الأراضي والمياة والبيئة ـ مركز البحوث الزراعية ــالجيزةـ مصر.

أقيمت تجربتان حقليتان خلال موسمي شتوي (2017) وصيفي (2018) بمحطة البحوث الزراعية بالجميزة التابعة لمركز البحوث الزراعية لدراسة تاثير أضافة كل من قش الأرز والكمبوست علي الخواص الطبيعية والكيميائية وكفاءة إستخدام المياه وانتاجية محصولي القمح والذرة والتركيب الكيميائي لهما ولتحقيق ذلك تم تصميم تجربة قطع تامة العشوائية في ثلاث مكررات. حيث كانت المعاملات كالتالى:T_1 - (كنترول) و T_2-(أضافة 2.50طن قش الأرز للهكتار و T_3- (أضافة 5.00 طن قش الأرز للهكتار) و T_4- (أضافة 5.00 طن كمبوست للهكتار) و T_5-(أضافة 2.50 طن قش الأرز للهكتار +5.00 طن كمبوست للهكتار) وT_6- (أضافة 5.00 طن قش الأرز للهكتار +5.00 طن كمبوست للهكتار). أهم النتائج التي تم الحصول عليها:وجد أن أضافة المحسنات العضوية الي التربة أدت الي تحسين الخواص الطبيعية للتربة مثل زيادة قيم المسامية الكلية والتوصيل الهيدوليكي ونقص في قيم الكثافة الظاهرية وكان هذا ظاهراً بوضوح عند أضافة المعاملة T_6- (أضافة 5.00 طن قش الأرز للهكتار +5.00 طن كمبوست للهكتار) وتصل هذه الزيادة في التوصيل الهيدوليكي بنسبة 99.14 و 146.56% و المسامية الكلية زادت بنسبة 9.10 و 14.39% والكثافة الظاهرية نقصت بنسبة 10.08 و 17.65% مقارنة بالكنترول T_1 بعد حصاد كل من محصولي القمح والذرة الشامية علي التوالي . أدت إضافة كل من قش الأرز والكمبوست الي نقص في قيم الpH وزيادة في قيم النيتروجين الكلي والكربون العضوي وتحسين في نسبة C/N مع زيادة فترة تحضين كل من قش الأرز والكمبوست بالتربة وكانت التحسين في خواص التربة مع المعاملات. $T_6 > T_5 > T_4 > T_3 > T_2 > T_1$ علي التوالي.أدت أضافة المحسنات العضوية الي زيادة معنوية في محصول القمح والذرة الشامية وكفاءة إستخدام المياه وكانت هذة الزيادة واضحة مع المعاملة T_6. وتصل هذه الزيادة فى محصول الحبوب والقش لمحصول القمح بنسة 38.20 و 56.90% بينما تصل هذه الزيادة في الحبوب والقش لمحصول الذرة بنسة 58.38 و 48.38% علي التوالي مقارنة بالكنترول. أدى استخدام معاملات قش الأرز والكمبوست والخلط بينهما الى زيادة تركيز وإمتصاص العناصر الكبرى (النيتروجين والفوسفور والبوتاسيوم) وكانت أفضل معاملة T_6 حيث كان لها تأثيرا معنويا مقارنة بباقى المعاملات والكنترول .توصي الدراسة بتحضين التربة بمعدل (5.00 طن قش الأرز للهكتار +5.00 طن كمبوست للهكتار) قبل زراعة محصول القمح بشهر وذلك يودي الى تحسين الخواص الطبيعية (الكثافة الظاهرية و المسامية الكلية والتوصيل الهيدوليكي) والخواص الكيميائية (الpH والنيتروجين الكلي والكربون العضوي ونسبة C/N) وزيادة انتاجية كل من محصول القمح والذرة الشامية وكذلك كفاءة إستخدام المياه وزيادة تركيز وامتصاص العناصر الكبرى (النيتروجين والفسفور والبوتاسيوم).