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Integrated Impact of Organic and Inorganic Fertilizers on Growth, Yield of Maize (*Zea mays* l.) and Soil Properties under Upper Egypt Conditions

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ABSTRACT

A field study was carried out during the two consecutive summer seasons of 2015 and 2016 at the Experimental Farm, Faculty of Agriculture, Al-Azahar University, Assiut Governorate located 375 km south of Cairo, Egypt (27° 12ˉ 16.67˭ N latitude and 31° 09ˉ 36.86˭ E longitude). The experiment aims to study the effect of useing different fertilizers including (NPK), ureaform (UF), compost (C), Sheep manure (S), humic acid (HA), and yeast extract (YE) on growth, productivity and quality of Maize yield (*var.,* Hi-Tech 1100). The experiment was a Randomized complete Block design (RCBD) with three replicates. The treatments were six: (T_1) Check treatment full recommended NPK (Control), (T_2) = (CS + UF), (T_3) = (YE + UF), (T_4) = (HA + UF), (T_5) = (CS + YE) and (T_6) = (CS + HA). In both seasons, the combination of 10 tons fed^{-1} of compost and sheep manure plus 50 kg fed^{-1} of ureaform (T2) resulted in the highest growth, yield and yield components and quality of maize as compared to the others treatments. The effect of different combination from the used fertilizers could be arranged in the following descending order $T_2 > T_6 > T_5 > T_4 > T_1 > T_3$. Treatment ($T_2$) gave the highest grain yield (3494 and 3676 kg fed^{-1}) with an increase of (29.31 and 21.84%) as compared to T_3 (2702 and 3017 kg fed^{-1}) during 1st and 2nd seasons, respectively. The NPK maize grain content as affected by different combination could be arranged in the following descending order $T_3 < T_1 < T_4 < T_5 < T_6 < T_2$. Also, compost and sheep manure addition improved soil properties since they increased organic matter content and decreased soil reaction (pH). Finally, it could be concluded that the integration of organic and inorganic fertilizers was better than using organic or inorganic fertilizer separately. Using the high amount of organic fertilizers (10 ton fed^{-1} CS) with ureaform (50 kg fed^{-1} UF) was the best treatment for producing high quality and increasing yield of maize crop under Upper Egypt conditions in Assiut.
Keywords: *Maize*, NPK, Compost, Sheep manure, Humic acid, Yeast extract, Ureaform.

INTRODUCTION

Maize or corn (*Zea mays* L.) belongs to the family Poaceae. It is a C_4 plant, short duration and quick growing crop. It is globally ranks the third position among cereal crops after wheat and rice and it is important staple food in many countries. Grains of maize contains 13% moisture, 10% crude protein and 70.3 carbohydrate (Martin et al., 2006). In Egypt, the area of maize (new and old land) in 2015 was 1740779 fed., it produced 5509566 ton, with an average productivity of 3.165 ton fed^{-1} (Agriculture Statistics, 2015). Increasing maize production is one of the most important goals for the Egyptian agricultural policy to face the human and animal demands. Sustainability of the agriculture production systems is the most crucial issue as our natural resources are continuingly being degraded. Furthermore, the possibility of mixing maize with wheat for bread making has also increased the demand of maize in Egypt. The increasing population and food demand has forced farmers to use high doses of chemical fertilizers. The unscientific use of fertilizers (nutrient imbalances, incorrect amount) is a serious threat to the sustainable agriculture production system (Kumar *et al*., 2014).

The use of both organic and inorganic fertilizer by farmers has been reported to increase yield, sustain productivity and improved soil chemical properties (Oyedeji, 2016). Application of mineral fertilizer in combination with locally available organic fertilizer is important to maintain soil fertility that achieve balance nutrient supply in order to increase crop yield. It is one of the best practices for plant nutrient management to optimize social, economic, and environmental benefits of crop production. Integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints. Combined organic/ inorganic fertilization both enhanced carbon storage in soils and reduced emissions from nitrogen fertilizer use while contributing to high crop productivity in agriculture (Abbasi and Yousra, 2012). The use of inorganic fertilizers alone has not been helpful under intensive agriculture because it aggravates soil degradation. Maintaining and improving soil quality is crucial if agricultural productivity and environment quality are to be sustained for future generations. Intensive agriculture has had negative effects on the soil environment over the past decades (e.g. loss of soil organic matter, soil erosion and water pollution). Management methods that decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts. (Zhao *et al*., 2009). Afe *et al.* (2015) and Abdelzaher et al. (2017) they observed that combined application of organic and inorganic fertilizer increased the growth and yield of maize than when any of the fertilizer was used alone. Tolessa and friesen (2001) reported that maize growth and yield were significantly increased by formyard manure (FYM) application enriched with chemical fertilizers. The role of organic fertilizers (compost) is improving soil organic matter, nitrogen content and phosphorus concentration. Furthermore decreasing soil pH, which result in increasing solubility of nutrients and nutrient availability to the plants, hence enhancement plant growth and development as well as gradually increase maize grain yield. (Ali *et al*., 2003).

The combined application of FYM with inorganic nitrogen fertilizers exerted a favorable effect on maize productivity and NPK uptake (Artar *et al*., 2006). Prabu and Uthaya (2006) concluded that organic manures play a vital role in maintaining physical, chemical and biological conditions of soil and supply of macro and micronutrients to crops besides maintaining humic substances in soil and also the wastes are effectively utilized for crop production. The addition of organic sources could increase corn yields through increased soil productivity and higher fertilizer use efficiency. Organic matter plays an important role in nutrient recycling. It has been shown that addition of organic materials caused an increases in plant dry matter yield and its uptake of the macro and micro nutrient elements (Abdas *et al*., 2009).

Humic acid is a water-soluble organic acid, naturally, presented in soil organic matter that has many beneficial effects on soil structure and soil microbial populations as well as it modify the mechanisms involved in plant growth stimulation, cell permeability and nutrient uptake and increasing yield. Mayhew (2004) found that humic substances may possibly enhance the uptake of minerals through the stimulation of microbiological activity. Aisha *et al*., (2014) reported that increasing humic acid increased growth characters, yield characters and protein percentage. The highest mean values of growth or, root characters and protein percentage were associated with plants which received a higher level of humic acid (14.40 L ha^{-1}) compared to compost. Gomaa *et al*. (2014) reported that there is a significant increase in maize growth analysis, grain yield, and its components due to the humic acid application of 14.4 kg ha^{-1}.

Biological fertilizers would play the key role in productivity and sustainability of soil and also protect the environment as eco-friendly and cost effective inputs for the farmers. Bio-fertilizer helps in increasing crop productivity by increasing nutrients availability uptake through solubilization, absorption, stimulation hormonal action or antibiosis and decomposition of organic residues (khosro and Yousef, 2012). Soleimanzadeh and Ghooshchi (2013) reported that the high input cropping system was the most productive treatment but organic cropping system with biofertilizers was the most economical treatment with respect to increasing net profit.

The aim of this investigation is to study the effect of combined organic fertilizer, humic acid, biofertilization "yeast" and ureaform (50% N as a slow release nitrogen) on soil properties, improving growth, yield, quality and its attributes and chemical constituents of maize plants (*var*., Hi-Tech 1100).

MATERIALS AND METHODS

A field study was carried out during the two consecutive summer seasons of 2015 and 2016 at the Experimental Farm, Faculty of Agriculture, Al-Azahar University, Assiut, located 375 km south of Cairo, Egypt (27° 12^{-} $16.67^{=}$ N latitude and 31° 09^{-} $36.86^{=}$ E longitude). Soil samples were collected to determine some soil physical and chemical properties according to Page *et al*. (1982) and presented in Table 1.

Table 1. Some physical and chemical properties of the experimental soil during 2015 and 2016 seasons.

Seasons	Particle size distribution (%)				Texture class	Bulk density (g cm^{-3})	EC (dSm^{-1}) (1:2.5)	pH (1:2.5)
	Sand	**Silt**	**Clay**					
2015	52.95	23.11	23.94		**Sandy Clay Loam**	1.49	0.911	8.25
2016	51.73	22.98	25.29			1.52	1.110	8.21
Seasons	Field Capacity %	$CaCO_3$ (%)	O.M (%)		C.E.C(cmol kg^{-1})	Total-N (%)	Total-P (%)	Total-K (%)
2015	24.53	1.15	1.38		18.78	0.15	0.05	0.09
2016	25.81	1.33	1.43		19.22	0.21	0.06	0.11
Seasons	Cations (cmol kg^{-1} soil)				Anions (cmol kg^{-1} soil)			
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
2015	0.67	0.59	0.29	0.28	---	0.58	0.59	0.63
2016	0.83	0.67	0.32	0.39	----	0.67	0.65	0.78

Experimental design:

The experiment was conducted in a completely randomized block design, including 6 treatments with 3 replicates. The field was carefully prepared and divided into plots 4 x 2.8 = 11.2 m^2, four ridges for each plot at 70 cm between ridges. Maize *(Zea mays* L.) three ways cross Hi-Tech 1100 variety was cultivated at 30 cm distance between plants at the rate of 2-3 grains $hill^{-1}$ using dry method (Afeer) on 20th of May 2015 and 2016. The plants were thinned to one plant $hill^{-1}$ at 3-4 leaf stage. The preceding winter crop was wheat in both seasons. All other agriculture practices were done for all treatments as recommended for maize production in Assiut Governorate.

Organic materials:

Two doses of Humic acid were added, the first one before cultivation, while the second one was after the first tillage. The organic sources were sheep manure from the Animal Production Farm, Faculty of Agriculture, AL-Azhar University and compost from the Farm, Faculty of Agriculture, Assiut University. They mixed equally then added during soil preparing before cultivation, its chemical analyses are presented in Table 2.

Yeast extract was prepared from brewer's yeast (*Saccharomyces cerevisiae*), dissolved in water followed by adding sugar at a ratio of 1:1 and kept 24 hours in a warm place for reproduction according to the methods of Morsi *et al.* (2008).

The fertilization treatments were as follows:

1-(T_1) Check Treat. = The recommended dose of NPK fertilizers (100 kg N, 50 kg P_2O_5 and 50 kg K_2O fed^{-1}), nitrogen was applied as ammonium nitrate at two equal doses with the 1st and 2nd irrigation. Meanwhile, K (50 kg fed^{-1}) in the form of potassium sulphate (48% K_2O) was added before the 1st irrigation. Calcium Superphosphate fertilizer (P_2O_5 15.5%) was added during soil preparation.

2-(T_2) CSU. = 10 ton fed^{-1} (Compost+ Sheep manure) + 50 kg fed^{-1} Ureaform.

3-(T_3) YU. = 10 L fed^{-1} Yeast extract + 50 kg fed^{-1} Ureaform.

4-(T_4) HU. = 6 kg fed^{-1} Humic asid + 50 kg fed^{-1} Ureaform.

5-(T_5) CSY. = 5 ton fed^{-1} (Compost+ Sheep manure) + 10 L fed^{-1} Yeast extract.

6-(T_6) CSH. = 5 ton fed^{-1} (Compost+ Sheep manure) + 6 kg fed^{-1} Humic asid.

Table 2. The chemical composition of sheep manures and compost used in the experiments (on dry weigh basis) during 2015 and 2016 seasons.

Organic material	Seasons	Macro elements (%)			Micro elements (mg kg^{-1})				Chemical analysis		
		Total -N	Total -P	Total -K	Fe	Mn	Zn	Cu	Organic matter %	pH (1:2.5) Susp.	EC (dSm-1) (1:2.5)
Sheep manure	2015	3.83	2.15	2.28	4133	132	85	21	39.42	7.88	3.65
	2016	3.99	2.01	2.35	4077	141	72	19	41.22	7.81	3.73
Compost	2015	2.35	1.19	3.11	4465	210	97	62	33.75	7.69	1.09
	2016	2.18	1.28	3.37	4481	199	82	59	35.31	7.72	1.12

Recorded Data:

A- Measurement of growth characteristics:

At 7, 10 and 13 weeks after sowing (WAS), 5 plants were chosen at random from the middle ridges of each plot to study the following characters:

1- Average Plant height (cm) was measured as the distances from the base to the top at 7, 10 and 13 WAS.

2- Number of green leaves plant^{-1}.

3- Leaf area index (LAI) was calculated as reported by Diwaker and Oswalt (1992).

$$LAI = \frac{\text{Mean leaf area plant}^{-1}}{\text{ground area plant}^{-1}}$$

4- Stem diameter (cm).

B- Measurement of agronomic traits:

The maize plants were harvested at full maturity (*i.e.* after 16 weeks), ten plants were randomly taken from each plot to record the average of the following traits:

1. Ear length (cm)
2. Number of ears plant^{-1}.
3. Weight of ear (g).
4. Weight of ears plant^{-1} (g).
5. Number of grains row^{-1}.
6. 100-grain weight (g) adjusted to 15.5% moisture content.
7. Grain yield and biological yield were determined for each plot then converted to Kg fed^{-1}.

C- Measurement qualitative traits:

1- Crude grain protein content % and yield (Kg fed^{-1}): Micro-Kjeldhal method was used to determine N content of maize grain (Anonymous, 1990). Crude protein % was calculated by using the following formula:

Crude protein % = Nitrogen × 5.75

2- Crude grain oil content % and yield (kg fed^{-1}): The oil content in grains was determined by Soxhlet fat extraction method (AOAC, 1990).

D- Measurement laboratory analysis:

Soil analysis:

1- pH of the soil was measured in a soil-water suspension (1:2.5) using the pH meter (Hanna, model: 211) as described by Jackson (1973).

2- The electrical conductivity (EC) was measured in a soil-water extract (1:2.5) using electrical conductivity meter as described by Jackson (1973).

3- Organic matter of the soil was determined according to Walkley and Black's rapid titration method as described by Jackson (1973).

Plant analysis:

Half gram of maize plant was digested in 10 ml of H_2SO_4 and 2 ml perchloric acid in a conical flask as described by Chapman and Pratt (1961). The digested maize material was used to determine total nitrogen, phosphorus and potassium, as follows:

- The total nitrogen was determined in the plant digests using the Kjeldahl apparatus as described by Jackson (1973).
- The total phosphorus was determined in the plant digests using the molybdenum blue method as described by Jackson (1973).
- The total potassium was measured in the plant digests using the Flame photometer as described by Jackson (1973).

Data analysis:

The collected data were subjected to statistical analysis using analysis of variance and LSD at 5% level with MSTAT computer programme according to, Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Growth parameters:

Plant height (cm):

Data in Table 3 showed that plant height was increased greatly during the period from 7 to 10 WAS.

This may be attributed mainly to the elongation of new cells formed by intercellary meristem at the base of internodes. Plant height was affected significantly by different types of fertilizers at different ages of the plant in both seasons. The treatments (T_2, T_6, T_5 and T_4) recorded maximum plant height than other treatments. The tallest plant heights were obtained in treatment T_2, which received 10 ton fed^{-1} CS + 50 kg fed^{-1} Ureaform (177.4 and 157.0 cm), (277.7 and 209.6 cm) and (284.6 and 251.3 cm) at 7, 10 and 13WAS, in 1st and 2nd seasons, respectively. The minimum plant height was recorded in treatment T_3 which received 10 L fed^{-1} yeast extract + 50 kg fed^{-1} Ureaform. The increase in plant height with increasing organic and inorganic fertilizers might be due to balanced nutrient provision from sheep manure, when improved soil properties and N availability to crop. This might result in rapid cell production and enlargement which resulted in taller plants (Boomsma *et al*., 2009). The results of this study are in accordance with Khan et al. (2016) they reported that a maximum plant height of maize from combined application of sheep manure and inorganic fertilizer.

Number of green leaves plant^{-1}:

The combination between treatments had a significant effect on No. of green leaves plant^{-1} in both seasons Table 3.

Table 3. Effect of different types of fertilizers on plant height and number of green leaves plant^{-1} of maize (*Zea mays* L.) during 2015 and 2016 seasons.

Characters	Plant height (cm)						No. of green leaves plant^{-1}					
Treatments	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
	7 WAS		10 WAS		13 WAS		7 WAS		10 WAS		13 WAS	
T1:Check treatment (NPK)	168.7	146.7	265.1	194.1	273.3	235.2	11.1	13.2	13.9	12.4	10.6	11.2
T2:CS.(10ton fed^{-1})+UF.(50kg fed^{-1})	177.4	157.0	277.7	209.6	284.6	251.3	13.0	15.2	15.0	13.7	12.2	12.1
T3: YE. (10L fed^{-1})+UF.(50kg fed^{-1})	165.1	143.5	264.5	191.0	270.9	231.9	10.9	12.9	13.7	12.0	10.3	10.6
T4: HA.(6 kg fed^{-1})+UF.(50kg fed^{-1})	170.0	151.2	270.1	200.7	274.2	242.7	11.7	13.7	14.2	12.6	10.8	11.5
T5:CS.(5 ton fed^{-1})+YE. (10 L fed^{-1})	171.9	153.5	273.2	203.2	278.2	246.5	12.0	14.3	14.3	12.9	11.0	11.8
T6:CS.(5 ton fed^{-1})+HA. (6 kg fed^{-1})	174.9	155.3	275.2	206.2	280.3	249.2	12.4	14.5	14.7	13.1	11.3	12.0
LSD at 0.05	3.31	1.75	3.84	1.77	1.50	1.88	0.86	0.52	0.41	0.52	0.37	0.55

***Check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O_2 and 50 kg K_2O fed^{-1}) , CS.=(Compost + Sheep) , UF.= Ureaform , YE.= Yeast extract , HA.= humic acid * The present value is the mean of 3 replicates.**

The data in table 3 show that the application of T_2 was much effective in recording more No. of green leaves plant^{-1} (13.0 and 15.2), (15.0 and 13.7) and (12.2 and 12.1 green leaves plant^{-1}) at 7, 10 and 13 WAS, in 1st and 2nd seasons, respectively, follow T_6 of 5 ton fed^{-1} CS + 6 kg fed^{-1} humic acid. The greater No. of leaves plant^{-1} in maize was occurred due to higher rates of sheep manure plus compost. These results may be attributed to the essential nutrient elements contained in the organic and inorganic fertilizers that are associated with increasing photosynthetic efficiency and improving meristematic and physiological activities in the plants. This finding corroborate with those reported of Akongwubel *et al*. (2012) they observed that a significant increase in No. of green leaves plant^{-1} in maize with successive increases in organic manure rates.

Leaf area index (LAI):

Leaf area index is very important plant growth character because effectiveness of photosynthesis depends on large and deficient assimilating area, an adequate supply of solar and CO_2 and favorable environmental conditions (Jain and Misra, 1966). Integrated application of different types of fertilizers significantly affected the LAI in the two seasons (Table 4). Application of T_2 was superior in LAI as compared to other treatments in 2015 and 2016 seasons. Similarly, Masresha (2014) reported that highest LAI on the integrated rates of compost with inorganic fertilizers. These findings are in agreement with those obtained by Laekemariam and Gidago (2012)

Table 4. Effect of different types of fertilizers on Leaf area index and stem diameter of maize (*Zea mays* L.) during 2015 and 2016 seasons.

Characters	Leaf area index						Stem diameter (cm)					
Treatments	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
	7 WAS		10 WAS		13 WAS		7 WAS		10 WAS		13 WAS	
T1:Check treatment (NPK)	3.8	4.0	4.5	4.3	3.4	3.8	2.4	2.1	2.4	2.2	2.2	2.1
T2:CS.(10tonfed^{-1})+UF.(50kg fed^{-1})	4.8	4.9	5.4	5.2	4.7	4.8	2.6	2.4	2.7	2.4	2.4	2.3
T3:YE.(10L fed^{-1})+UF.(50kg fed^{-1})	3.6	3.8	3.9	3.8	3.1	3.4	2.2	2.1	2.3	2.0	2.0	2.0
T4:HA.(6 kg fed^{-1})+UF.(50kg fed^{-1})	3.9	4.0	4.6	4.4	3.6	3.9	2.4	2.2	2.4	2.2	2.3	2.1
T5:CS.(5ton fed^{-1})+YE.(10 L fed^{-1})	4.1	4.2	4.9	4.8	4.1	4.1	2.4	2.2	2.5	2.2	2.3	2.2
T6:CS.(5ton fed^{-1})+HA.(6 kg fed^{-1})	4.4	4.7	5.1	5.0	4.3	4.5	2.4	2.3	2.5	2.3	2.4	2.2
LSD at 0.05	0.26	0.26	0.45	0.32	0.37	0.18	0.06	0.10	0.05	0.06	0.10	0.10

***Check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O_2 and 50 kg K_2O fed^{-1}) , CS.=(Compost + Sheep) , UF.= Ureaform , YE.= Yeast extract , HA.= humic acid * The present value is the mean of 3 replicates.**

Stem diameter (cm):

Stem diameter of maize variety (Hi-Tech 1100) was significantly affected by the application different types of fertilizers in both seasons (Table 4). The treatment received 10 ton fed^{-1} CS + 50 kg fed^{-1} Ureaform (T_2) recorded the maximum stem diameter

(2.7 and 2.4 cm) at 7, 10 and 13 WAS, in 1st and 2nd seasons, respectively. Treatment T_3 recorded the minimum stem diameter (2.0 cm) at 13 WAS, in both seasons. Results of this study confirm the finding of Gonzalez *et al*. (2001), who reported that organic manure and chemical fertilizer which was supplied as essential nutrition at initial establishment stage of growth recorded the best results of the measured variables such as width of the stem and height of the plant. Combination of organic and inorganic fertilizers increased the thickness of the stem (Oad *et al*., 2004)

2- Yield attributes:

Ear length:

The ear length was significantly affected by the studied treatments in both seasons (Table 5). The highest values of ear length (19.42 and 18.83 cm) were recorded in T_2 treatment (10 ton fed^{-1} CS+ 50 Kg fed^{-1} Ureaform) followed by T6 (18.43 and 18.60 cm) during 2015 and 2016 seasons, respectively. This result may be attributed to the more photosynthetic activities of the plant on the account of adequate supply of nitrogen since it is an essential requirement for ear growth. (Khan *et al.,* 2008 and Fanuel and Gifole 2013).

Number of ear plant^{-1}:

Experimental treatments significantly affected the No. of ear plant^{-1} as compared to the check one in both seasons (Table 5). The highest numbers of ear plant^{-1} (1.93 and 1.90) were recorded from T_2 in respective seasons. On the other hand the lowest values of the same trait (1.01 and 1.07) were recorded by T_3 in both seasons. This result might be due to the (CS) application which improves soil physicochemical properties and increase the availability of major nutrients then enhancing factors for maize crop production. These results are in line with those obtained by chapagain (2010) and Baloch *et al.* (2015).

Weight of ear:

Data presented in Table 5 show the effect of different treatments of organic and inorganic fertilizers with various combinations on the ear weight of maize. T_2 gave the highest weight of ear (269.29 and 259.85 g) in the corresponding seasons. Treatment T_3 had the lowest values of 226.50 and 241.51 g in respective seasons. It is noticed clearly that applying of organic and inorganic fertilizer significantly improves the growth and yield of maize. Similar results were obtained by T_2 for ear length, No. of grains rows^{-1} which reflected on weight of ear plant^{-1}.

Table 5. Effect of different fertilizer treatments on ear characteristics of maize (*Zea mays* L.) during 2015 and 2016 seasons.

Characters of ear	Ear length (cm)		Number of ears plant^{-1}		Weight of ear (g)		Weight of ears plant^{-1} (g)	
	Season		Season		Season		Season	
Treatments	2015	2016	2015	2016	2015	2016	2015	2016
T1:Check treatment (NPK)	16.33	17.37	1.35	1.40	234.82	246.59	432.31	423.72
T2:CS. (10 ton fed^{-1}) + UF. (50 kg fed^{-1})	19.42	18.83	1.93	1.90	269.29	259.85	470.94	490.23
T3: YE. (10 L fed^{-1}) + UF. (50 kg fed^{-1})	15.83	16.53	1.01	1.07	226.53	241.51	418.98	417.02
T4: HA. (6 kg fed^{-1}) + UF. (50 kg fed^{-1})	17.63	17.90	1.43	1.57	229.56	249.31	435.91	432.97
T5:CS. (5 ton fed^{-1}) + YE. (10 L fed^{-1})	17.80	18.07	1.60	1.73	244.89	253.42	449.67	458.40
T6:CS. (5 ton fed^{-1}) + HA. (6 kg fed^{-1})	18.43	18.60	1.85	1.82	261.86	255.06	460.26	478.99
LSD at 0.05	0.84	0.95	0.32	0.26	12.81	5.45	10.38	9.30

***Check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O2 and 50 kg K_2O fed^{-1}) , CS.=(Compost+Sheep) , UF.= Ureaform , YE.= Yeast extract , HA.= humic acid * The present value is the mean of** 3 replicates.

Weight of ears plant^{-1}:

Significant differences in weight of ears plant^{-1} during 2015 and 2016 seasons due to different treatments were observed (Table 5). The maximum weight of ears plant^{-1} (470.94 and 490.23 g) in the 1st and 2nd seasons was recorded by the rate of 10 ton fed^{-1} CS+ 50 Kg fed^{-1} ureaform (T_2). On the other hand, the lowest weight of ears plant^{-1} (418.98 and 417.02 g) was recorded by T_3 in the two seasons. Application of organic materials is important issue for sustainable agricultural production (Molavilli *et al.,* 1994).

Number of grains row^{-1}:

Number of grains row^{-1} is an important parameter contributing the economic yield. Data in Table 6 show that No. of grains row^{-1} was significantly increased due to T_2 (33.97 and 34.29) which gave the maximum No. of grains row^{-1} followed by T_6 (32.90 and 33.60) as compared with T_3 (28.70 and 29.10) in the 1st and 2nd seasons,respectively. The increase in No. of grains row^{-1} may be due to more photosynthetic activities and other nutrients from either organic or inorganic sources for plant development up to ear formation. These findings are in harmony with those obtained by Bakry *et al*.(2009) and Magda *et al*. (2015).

100-grain weight:

It is clear that the outcomes of 100-grain weight resulted from (T_2) 10 ton fed^{-1} CS+ 50 Kg fed^{-1} ureaform proved superiority over the other treatments in both seasons Table 6. While the lowest value of 100-grain weight was obtained by T3 in two seasons .The increase of 100-grain weight depends on the status of soil fertility, water availability, crop management, agronomic practices, environmental factors and plant genetic characteristics. Yield improvement under this treatment might be due to enhanced use of N, water and other associated soil improving benefits of organic sources, which made plants more efficient in photosynthetic activity. The current results are similar with the findings of Shah *et al.* (2009). Achieng *et al.* (2010), Afe *et al*. (2015) and Baloch *et al*. (2015) they found that increase in 100-grain weight was mainly due to the balanced supply of nitrogen in combination with P and K and maximum N use efficiency from both inorganic and organic sources during the grain filling development and growth stages.

Table 6. Effect of different types of fertilizers on number of grains row^{-1}, 100-grain weight, grain yield, and biological yield of maize (*Zea mays* L.) during 2015 and 2016 seasons.

Characters / Treatments	Number of grains row^{-1} Season 2015	2016	100-Grain weight (g) Season 2015	2016	Grain yield (kg fed^{-1}) Season 2015	2016	Biological yield (kg fed^{-1}) Season 2015	2016
T1:Check treatment (NPK)	29.43	30.02	27.60	27.84	3120	3074	8709	8459
T2:CS. (10 ton fed^{-1}) + UF. (50 kg fed^{-1})	33.97	34.29	30.78	32.82	3494	3676	9349	9928
T3: YE. (10 L fed^{-1}) + UF. (50 kg fed^{-1})	28.70	29.10	25.18	25.66	2702	3017	7977	8230
T4: HA. (6 kg fed^{-1}) + UF. (50 kg fed^{-1})	30.63	31.36	27.21	28.06	3089	3043	8302	8123
T5:CS. (5 ton fed^{-1}) + YE. (10 L fed^{-1})	32.50	33.36	27.93	29.17	3160	3134	9037	9099
T6:CS. (5 ton fed^{-1}) + HA. (6 kg fed^{-1})	32.90	33.60	30.70	31.18	3219	3210	9101	9187
LSD at 0.05	0.26	0.51	3.50	4.36	0.28	0.32	0.63	0.52

***Check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O_2 and 50 kg K_2O fed^{-1}) , CS=(Compost+Sheep) , UF.= Ureaform ,YE.= Yeast extract , HA.= humic acid * The present value is the mean of 3 replicates.**

3- Maize yield:

Grain yield (kg fed^{-1}):

The data regarding grain yield of maize as influenced by organic and inorganic sources of fertilizer is given in (Table 6). Combined application of fertilizers had a significant effect on maize grain yield. Maximum grain yield of 3494 and 3676 kg fed^{-1} in seasons 2015 and 2016 respestively was obtained by T_2, followed by (T_6) 3219 and 3210 kg fed^{-1} which include 5 ton fed^{-1} CS +10 L fed^{-1} yeast axtract, in the respestive seasons. The minimum grain yield (2702 and 3017 kg fed^{-1}) in the two seasons was recorded by T_3. The effect of different treatments on maize grain yield could be arranged in descending order of $T_2 > T_6 > T_5 > T_4 > T_1 > T_3$. Grain yield is the end result of many complex morphological and physiological process occurring during the growth and development of crop (Khan *et al.,* 2008 and Fanuel and Gifole, 2013). Results obtained are in agreement with those of Fanuel and Gifole (2013), Afe *et al*. (2015) and Magda *et al.* (2015) they found that the production of grain yield might be due to better growth, development and dry matter accumulation with proper supply of nutrients to plant and increase in the availability of other plant nutrients with the respective source of nitrogen application. Treatment T_2 gave the highest values of yield components (Tables 3 and 4) which were consequently reflected on grain yield fed^{-1}.

Biological yield (kg fed^{-1}):

The results showed that biological yield was significantly affected by the investigated treatments (Table 6). The highest value of biological yield (9.349 and 9.928 kg fed^{-1}) in both seasons was obtained by T_2. While,the minimum biological yield was produced by T_3. Dilshad *et al*. (2010) and Khan *et al*. (2016) found that application of combine use of organic and inorganic sources of nutrients produced the highest maize biological yield.

4- Qualitative characters:

Grain protein content and protein yield as affected by different fertilizers types:

It is obvious from data given in Table 7 that the organic and inorganic treatments differed significantly with regard to protein content % and protein yield in maize grains during each season of experimentation. The applied T_2, T_6 and T_3 treatments caused increases in grains protein content %. The highest was obtained from treatment protein yield 362.0 and 382.7 Kg fed^{-1} (T_2) as compared to the other treatments in both seasons. The increase in grains protein content of maize could be attributed mainly to nitrogen added from either organic or inorganic sources. Similar results were obtained by Mohammed *et al*., (2014), Magda *et al*. (2015) and Abdelzaher et al. (2017)

Table 7. Effect of different types of fertilizers on quality components of maize (*Zea mays* L.) during 2015 and 2016 seasons.

Characters / Treatments	Grain protein Season 2015	2016	Protein yield (kg fed^{-1}) Season 2015	2016	Grain oil Season 2015	2016	Oil yield (kg fed^{-1}) Season 2015	2016
T1:Check treatment (NPK)	8.97	8.91	279.9	273.9	8.17	8.28	254.9	254.5
T2:CS. (10 ton fed^{-1}) + UF. (50 kg fed^{-1})	10.36	10.41	362.0	382.7	5.05	5.11	176.4	187.8
T3: YE. (10 L fed^{-1}) + UF. (50 kg fed^{-1})	9.49	9.55	256.4	288.1	6.06	6.13	163.7	184.9
T4: HA. (6 kg fed^{-1}) + UF. (50 kg fed^{-1})	8.91	8.80	275.2	267.8	6.81	6.92	210.4	210.6
T5:CS. (5 ton fed^{-1}) + YE. (10 L fed^{-1})	8.63	8.51	272.7	266.7	7.96	8.01	251.5	251.0
T6:CS. (5 ton fed^{-1}) + HA. (6 kg fed^{-1})	10.29	10.18	331.2	326.8	5.35	5.40	172.2	173.3
LSD at 0.05	0.06	0.12	1.78	2.28	0.06	0.10	1.91	1.79

***Check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O2 and 50 kg K_2O fed^{-1}) , CS.=(Compost+Sheep) , UF.= Ureaform , YE.= Yeast extract , HA.= humic acid * The present value is the mean of** 3 replicates.

Grains oil content and oil yield as affected by different fertilizers types:

It is clear from data given in Table 7 that the effect of different treatments on grain oil content of maize was significant in both seasons. The highest grain oil content % was noticed from T_1 (8.17 and 8.28 %) compared to T_2 (5.05 and 5.11 %) in the 2015 and 2016 seasons, respectively. Different combinations of fertilizer caused an decrease in grain oil yield. T_1 recorded the maximum value of oil yield (254.9 Kg fed^{-1}) in 2015 season and (254.5 Kg fed^{-1}) in 2016 season, followed by T_5 251.5 and 251.0 Kg fed^{-1} and T_4 (210.4 and 210.6 Kg fed^{-1}) in the first and second seasons, respectively. All different treatments decreased the oil of maize grain as compared to check treatment. The reduction in oil content might be due better supply of nitrogen from the higher levels of fertilizers source. The results are in conformity with findings of Mohammed *et al*. (2014) and Fadlalla et al. (2016).

4- Effect of organic and inorganic treatments on nutrient contents of maize grain.

Data in Table 8 refers to the nutrient contents (N, P and K) in maize plant as affected by different organic and inorganic N treatments.

Nitrogen %:

The given data indicate that the N-content in maize grains was significantly affected by adding slow release nitrogen fertilizer (Ureaform) followed by organic materials in both seasons. The highest values of nitrogen content were generally attained by adding CS. (10 ton fed^{-1}) +UF. (50 Kg fed^{-1}) = (T_2) in 2015 and 2016, respectively, followed by the addition of 5 ton fed^{-1} CS+ 6 kg fed^{-1} HA=(T_6) in both seasons. However, the lowest values of nitrogen content in grain of maize were obtained in CS. (5 ton fed^{-1}) +YE.(10 L fed^{-1})=T_5 compared to the other treatments.

Phosphorus %:

Data in Table 8 shows that the effect of organic and inorganic sources of N on P-content in maize grains. It was observed that the check treatment recorded the highest values of P-content in grains. It is obvious that the highest values of P-content were observed under (T_2) values obtained were 0.33 and 0.38 % in both seasons. These results may be due to the positive effect of organic materials on soil reaction that might increase available phosphorus. The obtained results are similar to those obtained by Baloch *et al.* (2015). On the other hand, the lowest values of P-content in grain were 0.19 and 0.21 % in both seasons and recorded in treatment YE.(10 L fed^{-1})+UF.(50 kg fed^{-1})= (T_3).

Table 8. Effect of different types of fertilizers on nutrient content, in maize grains (*Zea mays* L.) and some soil properties after planting during 2015 and 2016 seasons.

Characters	In maize grain						Soil after maize harvesting					
Treatments	N%		P%		K%		pH Susp. (1: 2.5)		E.C (dSm^{-1}) (1:2.5)		OM (%)	
	Season		Season		Season		Season		Season		Season	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T1:Check treatment (NPK)	1.56	1.55	0.42	0.47	2.49	2.57	8.21	8.11	0.631	0.694	1.47	1.48
T2:CS.(10 ton fed^{-1})+UF.(50kg fed^{-1})	1.80	1.81	0.33	0.38	2.81	2.86	7.31	7.09	0.843	0.881	1.59	1.61
T3:YE.(10Lfed^{-1})+UF.(50kg fed^{-1})	1.65	1.66	0.19	0.21	2.09	2.13	8.08	8.06	0.659	0.701	1.47	1.48
T4:HA.(6kg fed^{-1})+UF.(50kg fed^{-1})	1.55	1.53	0.25	0.27	2.79	2.83	7.84	7.71	0.681	0.735	1.49	1.51
T5:CS.(5ton fed^{-1})+YE.(10L fed^{-1})	1.50	1.48	0.26	0.30	2.18	2.23	7.73	7.60	0.722	0.771	1.51	1.53
T6:CS. (5 ton fed^{-1})+ HA.(6 kg fed^{-1})	1.79	1.77	0.29	0.32	2.98	3.07	7.60	7.46	0.757	0.796	1.54	1.58
LSD at 0.05	0.03	0.01	0.01	0.02	0.03	0.02	0.08	0.07	0.10	0.08	0.03	0.01

***check treatment=recommended dose of NPK (100 kg N , 50 kg P_2O_2 and 50 kg K_2O fed^{-1}) , CS.= (Compost+Sheep) , UF.= Ureaform , YE.= Yeast extract , HA.= humic acid * The presented value is the mean of 3 replicates.**

Potassium %:

Data in Table 8 illustrate the effect of organic and inorganic sources of N on K % in maize grains. The results pointed out that there were significant increase in K% in maize grain due to the addition of organic or inorganic materials as compared to the check treatment. The obtained data revealed that the maximum values of K-content (2.98 and 3.07 %) were found in case of (T_6), in both seasons. This increase may be due to the effect of humic acid since it leads to an increase in the absorption of potassium and help the movement of K within the plant.

Finally, the application of organic materials to the soil enhanced the NPK uptake by maize plants in different responses. This could be attributed to the effect of the addition of organic materials which enhanced the metabolic activity within plants and promoted the migration of the metabolites through root and stems toward leaves, thereby it may increase the percentage of nutrients in leaves and stems (Sikander, 2001).

5- Effect of organic and inorganic sources of N on some soil properties:

Determination of some chemical properties of soil is of great concern when evaluating organic and inorganic materials that croporate into soil. Some chemical properties of the studied soil such as soil pH, EC and OM is presented in Table 8.

Soil Reaction (pH)

Data presented in Table 8 show that, application of different organic materials decreased soil pH after harvesting maize plants as compared to the control. The soil pH dropped from 8.21 in the control treatment to 7.31, 7.60 and 7.73 in T_2, T_6 and T_5 respectively. While in the case of adding inorganic materials, the soil pH was slightly decreased as compared to the control in both seasons. The reduction in soil pH can be explained by the decomposition of added organic materials, such processes tends to increase the concentration of organic acid in soil that could nutrailzed the high pH. The obtained results are in accordance with those reported by Rifaat and Negm (2004), Ewulo (2005) and Youssef (2006).

Electrical Conductivity (EC):-

Data in Table 8 show the soil salinity (EC) as affected by addition of organic materials and inorganic fertilizer after harvesting maize plant. Data indicated that addition of organic materials as well as inorganic fertilizer increased significantly soil salinity. The highest increase in soil salinity was recored in T_2 in both seasons as compared to the control. Such increase did not reach the hazardous effect and might be due to the high salt content of sheep manure and compost in comparison to the other organic materials. Abu-Zahra & Tahboub (2008) stated that application of organic manure caused an increase in soil salinity especially sheep manure. On the other hand, the data in Table 8 show that soil salinity was not affected by the added materials in T_3 and T_4. Chang *et al*. (2007) showed that electrical conductivity in soil treated by compost was generally higher than those received chemical fertilizer treatment**.**

Organic Matter (OM)

Several studies have reported that the balanced fertilization using both organic and chemical fertilizers is important for maintenance soil organic matter (OM) content and sustainable productivity in the tropics where soil OM content is low. Baloch *et al*. (2015) found that farm manure in combination with small inorganic fertilizer applications improved the soil as opposed to heavy fertilizer doses alone or mere application of crop residues. Hellal *et al*. (2015) and Magda *et al*. (2015) also obtained significant increase in crop yields when a combination of organic and mineral fertilizers was applied compared with sole application of organic or mineral fertilizer. The data showed that soil OM content was increased by the application of organic materials (Table 8). The treatment (T_2) recorded the highest value in the soil organic matter1.59 and 1.61 in both season respectively.

CONCLUSION

Applied organic materials in adequate quantity realized higher yield. Also, the combined use of organic and inorganic fertilizers reduce the chemical fertilizer cost as well as mitigate the environmental hazardous effect. It is noticed that the best practice is using sheep manure + compost (10 ton fed^{-1}) + (50 kg fed^{-1}) Ureaform (T_2) since this treatment achieved the highest growth, yield and yield components and quality of maize crop (*var*., Hi-Tech 1100) as well as soil properties under Assiut condition.

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تأثير التكامل بين الأسمدة العضوية والغير عضوية على نمو وإنتاجية محصول الذرة وخواص التربة تحت ظروف مصر العليا

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أجريت تجربتان حقليتان خلال موسمى ٢٠١٥، ٢٠١٦ بالمزرعة البحثية لكلية الزراعة جامعة الأزهر بمحافظة أسيوط على نباتات الذرة الشامية صنف (هجين ثلاثى هاى تك ١١٠٠) لدراسة تأثير الأسمدة الغير عضوية (NPK) وبعض أنواع الأسمدة العضوية (اليوريا فورم ، سماد الكمبوست ، سماد الأغنام ، حمض الهيوميك ، مستخلص الخميرة) على إنتاجية وجودة الذرة الشامية وكذلك بعض خصائص التربة.أشتملت التجربة على ٦ معاملات كانت كالتالى : (م١) الموصى بـ NPK الكنترول ، (م٢) ١٠ طن/ف كمبوست مع سماد أغنام + ٥٠ كجم/ف سماد اليوريا فورم ، (م٣) ١٠ لتر/ف مستخلص الخميرة + ٥٠ كجم/ف اليوريا فورم ، (م٤) ٦ كجم/ف حمض الهيوميك + ٥٠ كجم/ف اليوريا فورم ، (م٥) ٥ طن/ف كمبوست مع سماد أغنام + ١٠ لتر/ف مستخلص الخميرة ، (م٦) ٥ طن/ف كمبوست مع سماد أغنام + ٦ كجم/ف حمض الهيوميك . تم توزيع المعاملات فى تصميم القطاعات كاملة العشوائية فى ثلاث مكررات .أوضحت النتائج أن : المعاملة الثانية (م٢) بإستخدام ١٠ طن/ف كمبوست مع سماد أغنام + ٥٠ كجم/ف يوريا فورم حققت أعلى قراءات لجميع الصفات تحت الدراسة وصفات الجودة (نسبة البروتين والزيت بالحبوب ومحصول الفدان لكل منهما) وبعض خواص التربة خلال موسمى الدراسة بالمقارنة بالمعاملات الأخرى ، كما أعطت نفس المعاملة أعلى محصول من الحبوب (٣٤٩٤ و ٣٦٧٦ كجم/ف) بزيادة قدرها (٢٩,٣١ و ٢١,٨٤ %) عن المعاملة رقم ٣ (٢٧٠٢ و ٣٠١٧ كجم/ف) خلال موسمى الدراسة على الترتيب . ضافة سماد الكمبوست وسماد الأغنام أدى لتحسين خواص التربة وزيادة مكونات المادة العضوية ونقص تفاعلات التربة (درجة الحموضة). بصفة عامة كان لإستخدام التكامل بين الأسمدة العضوية والغير عضوية أفضل المعاملات فى جميع صفات المحصول ومكوناته وصفات الجودة وخصائص التربة مقارنة بالمعاملات الأخرى أو إستخدام أى منهما منفرداً تحت ظروف منطقة الدراسة.