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THE PREDICTION OF THE COMBINATION EFFECT OF COMPOST, NITROGEN AND PHOSPHORUS FERTILIZERS ON SOME SOIL PROPERTIES AND PRODUCTIVITY OF WHEAT AND MAIZE YIELDS

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ABSTRACT: Two field experiments were conducted on clayey soil during the two successive seasons, i.e. winter season 2018/2019 using wheat plants and summer season 2019 using maize plants at EL-Gemmieza Agriculture Research Station - Agricultural Research Center (ARC) - El Gharbiya Governorate - Egypt (Middle Delta region 30º 43- latitude and 31º 47- longitude). The experiments were designed in a randomized complete block design with three replicates to prediction of the most combination of compost, nitrogen and phosphorus fertilizers and its effects on some soil properties and its productivity of crops. Furthermore, economical evaluation was done by calculating the net revenue to determine the most economical treatment. Thirteen treatments having different compost (C), nitrogen (N) and phosphorus (P) were used to cover all possible combinations of these applications as well as control (without any addition). The results were shown in a triangle diagram using a special computer program.

The obtained results can be summarized as follows:

1. **The individual compost treatment was more effectiveness on reducing Db and increasing E and e than N and P treatments, as well as Hydraulic conductivity and soil moisture content at harvesting were increased with all treatments compared with the control of the two soil depths at the end of the two seasons. The maximum kh value was obtained by using 100% compost or 90% compost + 10% nitrogen. Also, interaction between C, N and C, P were more effective on increasing kh.**
2. **Water consumption (CU) decreased, but water use efficiency (WUE) increased with both individual and combined applications of C, N and P in the two season. The lowest CU values were recorded with the individual compost treatments in the two seasons.**
3. **All treatments of C, N and P and their combinations led to decrease in soil pH and increased soil EC and the soil content of total NPK at the two soil depths in the two seasons compared with control.**
4. **The addition of 100% compost (C) gave the highest O.C content, where C was more effective upon increase O.C than N and P which took the order C > N > P. While, the maximum C/N ratio values were recorded under the treatment consist of 50% C + 50% P in the two seasons.**
5. **Grans yields and growth characters of wheat and maize plants increased with all the additions of C, N and P alone and in combinations compared with the control, where the highest values were recorded with the treatment consists of 50% C +50% N.**
6. **The obtained results in this study show it is more useful to use C, N and P and their combinations to get a markedly improve in soil physical and chemical properties which reflect on highest yield in incorporated with high net revenue. Where, the highest net revenue (7636.84 LE fed^{-1}) was recorded by using the treatment consists of 50% C + 50% N in the two seasons.**

Key words: Compost, Nitrogen, Phosphorus, Soil properties, Wheat and Maize.

INTRODUCTION

Most of organic wastes are rich plant nutrients and through proper management such compost can be used as a soil conditioner, as well as a nutrient source for plants Smith (1992) and Keener et al. (2000) mentioned that compost addition not only increase crop yield, but also improve soil fertility in terms of organic C, N content, permeability, available water and total porosity. Moyin-Jesu (2015) showed that, the use of the various organic fertilizers (poultry manure, wood ash and rice bran) increased soil N, P, K, Ca, Mg, and O.M. compared to control. Adugna (2016) reported that organic manures like compost discharge nutrients very slowly to the plants and these nutrients are not directly absorb by the plants. Therefore, plants are unable access required amount of nutrients in the critical yield-forming period. Hence, an integrated approach, combining application of compost with inorganic fertilizer is a good strategy for increasing crop productivity and this will reduce the cost of inorganic fertilizer and improve soil fertility. Liang et al. (2012) stated that decrease in soil pH could be attributed to the H^+ ion release by roots, and nitrification and acidification processes stimulated by continuous application of inorganic fertilizer. Organic manure also decrease the pH due to the organic acid present in organic manure. Mahmood et al. (2017) showed that growth and yield of maize were substantially improved by chemical fertilizers application alongside organic manures, where soil organic C and total N, P, K contents increased when inorganic fertilizers were applied alone or in combined with organic manures. They noted that soil pH and soil bulk density were decreased due to application of organic fertilizer. Jinwei and Lianren (2011) indicated that, the combined application of organic and inorganic fertilizers were the most beneficial method to increase crop yields and improve soil physical and chemical properties rather than using them individually. Bandyopadhyay et al. (2010) reported that the application of organic manure combine with NPK fertilizers lead to increase soil organic carbon, total porosity and hydraulic conductivity and decreased soil bulk density. Chopra et al. (2016) revealed that, the application of different organic manures (poultry manure, FYM and compost) significantly increased grain, straw and biological yields. Mohammed (2017) found that, the cultivated soil with application of FYM had higher soil porosity, aggregate size, organic matter (OM), total macronutrients. Bharath et al. (2017) reported that N, P and K content were significantly higher with interaction of FYM and urban compost, while pH, EC not significantly influenced. Almaz et al. (2017) reported that integrated application of organic and inorganic fertilizer is the best option to improve soil chemical properties and nutrient uptake of maize and soybean. Gamal (2009) observed increased N, P and K nutrients content in all compost received plots and this increase was higher in plots receiving 10 ton ha^{-1} of compost. Gomaa et al. (2015) concluded that spike length (cm), number of grains/spike, number of spikes/m^2, number of spikelets/spike, 1000- grain weight, straw, grain and biological wheat yields were increased by applying 20 FYM m^3/fed^{-1}+ 70kgNfed^{-1}.El-Sodany et al. (2009) and El-Maddah et al. (2012) stated that natural soil conditioners (FYM, rock phosphate and sulfur) decreased soil reaction (pH), soil bulk density, water consumptive and increased total soil porosity, void ratio, soil hydraulic conductivity, soil moisture content just before harvesting, water use efficiency, Organic carbon (O.C, %) and C/N ratio compared with control. The experiment of Ahmad et al. (2013) shown that, combining organic sources with 50% of recommended NPK fertilizers occurred a significant encreased in grain and biological yields of maize and the net return was also increased. Tayebeh et al. (2010) reported that, combined organic and inorganic fertilizers resulted the highest wheat yield without any negative effect on seed quality. They added that compost could be replaced 30% of the nitrogen requirement by plant. In addition, less use of N fertilization will lead to environmental conversation. Brown and Cotton (2011) observed that, soil bulk density decreased by increasing the compost rates. In addition, the organic fraction is much lighter in weight than the mineral fraction in soil as a result to increase in the organic fraction decrease the total weight and bulk density of the soil. In this context Liu et al. (2007) found that, low bulk density indicates increased pore space and is indicative of improved soil tilth. In this respect, compost increases the portion of micro and macro-pores as a result to improve soil aggregation. Amit et al. (2018) reported that a marked increase occurred in crop yield upon compost application as a result of improving soil physical and chemical properties.

The prediction of the combination effect of compost, nitrogen and phosphorus fertilizers on some soil properties and the productivity of crops is the objective of this experiment. Furthermore, economical evaluation was done by calculating the net revenue to determine the economical treatment.

MATERIALS AND METHODS

Two field experiments were carried out on clayey soils at El-Gemmeiza Agricultural Research Station - Agricultural Research Center (ARC) - El Gharbiya Governorate - Egypt (Middle Delta region 30º 43- latitude and 31º 47- longitude) during two seasons, winter growing season 2018/2019 using wheat plant (*Triticum aestivum., L.*) and summer season 2019 using maize plant (*Zea mays., L.*) as tested plants to prediction of the combination effect of compost, nitrogen and phosphorus fertilizers on some soil properties and the tested crops productivity. At the same time a three – factors computer program was used to predict the best treatment of the studied applications effect on the determined parameters. Furthermore, economical evaluation was done by calculating the net revenue to determine the economical treatment. The initial properties of the experimental soil before planting in the first and second seasons were studied at soil depth of 0-20 and 20-40 cm are presented in Table (1-a) and properties of the used plant compost are shown in Table (1-b).

Computer model represented by Gipsea diagram according to Moussa et al. (1986) and Moussa (1991) was applied on this study. The three studied factors were compost (X1), nitrogen (X2) and phosphate (X3). The level of each factor was represented by one hand of triangle. The amounts of each factor ranged between 100% as its maximum value and decreased gradually when moving from the concerned head towards the opposite side at which the level reaches to zero.

Each hand of triangle is divided into ten sections, where each section represented by 10%, therefore the triangle consists of 66 intersection (combinations) cover all the possible combinations of compost, nitrogen and phosphorus. Thirteen intersection treatments from the triangle were chosen to carry out those experiments, Table (1-c) and Figs. (1 and 2), beside the control (treatment No. 14) where no addition were used.

The maximum rates of compost were 4213.48 and 6741.57 Kg fed^{-1} for wheat and maize plants in the first and second growing seasons, respectively. Also, during the two seasons the basal doses of N, P and K were applied according to the recommendations for each crop. For wheat plant, 75 Kg N fed^{-1} as ammonium nitrate (33.5 % N), 15.5 Kg P_2O_5 fed^{-1} as supper phosphate (15.5 % P_2O_5) and 12 Kg K_2O fed^{-1} as potassium sulphate (48% K_2O) were added. Also, 120 Kg N fed^{-1} in the form of ammonium nitrate, 31 Kg P_2O_5 fed^{-1} in the form of supper phosphate and 24 Kg K_2O fed^{-1} in the form of potassium sulphate were used for maize plant.

Table (1-a): Some soil characters in the first and second seasons.

Properties		First season		Second season		Properties	First season		Second season	
Soil depth, cm		0-20	20-40	0-20	20-40	Soil depth, cm	0-20	20-40	0-20	20-40
Soil physical properties										
Particle size distribution, %	Coarse sand	3.32	3.21	3.32	3.21	Bulk density (Db, g cm^{-3})	1.36	1.38	1.32	1.36
	Fine sand	15.26	15.12	15.26	15.12	Total porosity (E, %)	48.68	47.92	50.19	48.68
	Silt	34.23	33.86	34.23	33.86	Void ratio (e)	0.95	0.92	1.01	0.95
	Clay	47.19	47.81	47.19	47.81	Hydraulic conductivity (Kh, cm hr^{-1})	0.47	0.44	0.51	0.49
Texture class		Clayey	Clayey	Clayey	Clayey	Soil moisture content, %	16.17	19.65	15.29	17.98
$CaCO_3$, %		3.35	3.21	3.27	3.18					
Soil chemical properties										
Soil pH, 1:2.5 (suspension)		7.73	7.83	7.72	7.80	Soil EC, dSm^{-1} (soil paste extract)	2.33	2.74	2.36	2.79
Soluble ions, meq l^{-1}	Ca^{++}	8.61	9.89	8.51	10.03	Organic matter (O.M., %)	2.72	2.38	2.71	2.38
	Mg^{++}	7.11	8.76	7.69	9.17	Organic carbon (O.C., %)	1.58	1.38	1.57	1.38
	Na^{+}	7.21	8.43	6.85	8.21	Total nitrogen (T.N., %)	0.146	0.134	0.150	0.138
	K^{+}	0.37	0.33	0.54	0.49	C/N ratio	10.82	10.30	10.47	10.00
	HCO_3^{-}	7.26	8.44	7.21	8.50	Total P (T.P., %)	0.040	0.038	0.043	0.041
	CL^{-}	9.79	11.09	10.18	11.55	Total K (T.K., %)	0.346	0.330	0.355	0.342
	SO_4^{--}	6.25	7.88	6.20	7.85					

Table (1-b): Some characteristics of the used plant compost.

Properties	Value	Properties	Value
pH (1:10 compost: water) susp.	7.39	Available Cu, mgkg^{-1}	31.25
EC, dS m^{-1}(1:10 compost: water) extract.	3.19	Ash, %	66.33
Ca, %	0.84	Organic matter, %	33.67
Mg, %	0.29	Organic carbon, %	19.53
Na, %	0.27	Total N, %	1.78
Available Fe, mgkg^{-1}	1215	C/N ratio	10.97
Available Zn, mgkg^{-1}	83.15	Total P, %	0.95
Available Mn, mgkg^{-1}	72.8	Total K, %	1.6

Table (1-c) : The chosen combinations of application treatments

Treatment No.	Relative fractional as unit			Amount of application treatments					
				First season			Second season		
	X 1	X 2	X 3	Compost, C, Ton fed $^{-1}$	Nitrogen, N, Kg fed $^{-1}$	Phosphorus, P_2O_5, Kg fed $^{-1}$	Compost, C, Ton fed $^{-1}$	Nitrogen, N, Kg fed $^{-1}$	Phosphorus, P_2O_5, Kg fed $^{-1}$
1	100	0	0	4.213	0	0	6.742	0	0
2	0	100	0	0.000	75.00	0	0.000	120.00	0
3	0	0	100	0.000	0	15.50	0.000	0	31.00
4	50	50	0	2.107	37.50	0.00	3.371	60.00	0.00
5	50	0	50	2.107	0.00	7.75	3.371	0.00	15.50
6	0	50	50	0.000	37.50	7.75	0.000	60.00	15.50
7	33.3	33.3	33.3	1.403	24.98	5.16	2.245	39.96	10.32
8	66.6	16.6	16.6	2.806	12.45	2.57	4.490	19.92	5.15
9	16.6	66.6	16.6	0.699	49.95	2.57	1.119	79.92	5.15
10	16.6	16.6	66.6	0.699	12.45	10.32	1.119	19.92	20.65
11	44.4	44.4	11.1	1.871	33.30	1.72	2.993	53.28	3.44
12	44.4	11.1	44.4	1.871	8.33	6.88	2.993	13.32	13.76
13	11.1	44.4	44.4	0.468	33.30	6.88	0.748	53.28	13.76

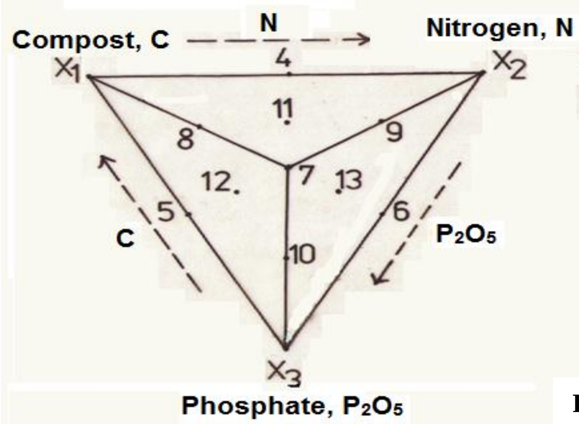

Fig. (1): Location of the thirteen chosen treatments on the triangle diagram

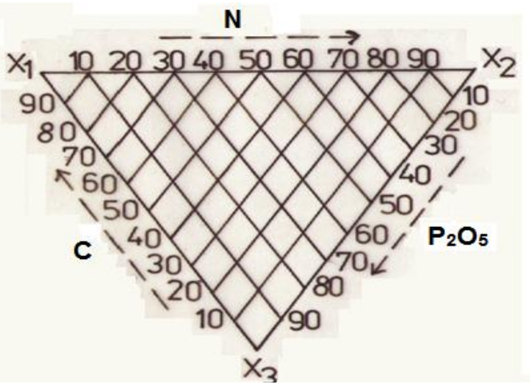

Fig. (2): Guide for C, N and P combination of each point.

The plot area of the experiments was 42 m^2 (6 X 7 m) this study was carried out in a randomized complete block design with three replicates. Compost was added on basis total N (1.78%) and homogenously mixed with the 0–20 cm surface layer before sowing in the first and second seasons. Wheat grains (Giza 168 variety) were planted on 19th November in the first season (2018/2019) at the rate of 60 Kg/fed., while maize grains (*Zea mays*, three-way cross, Giza 329) were planted on 8th June in the second one (2019) at the rate of 15 Kgfed^{-1}. During the two seasons, the normal cultural practices of El-Gemmeiza Research Station were adopted.

At harvesting of each growing season, undisturbed and disturbed soil samples at soil depth of 0-20 and 20-40 cm were collected from each plot. The disturbed soil samples were air-dried, ground and passed through 2 mm sieve and stored for determine some soil chemical properties. Undisturbed soil samples were used to determine some soil physical and hydro physical properties.

Soil bulk density (Db, gcm^{-3}) was determined using the core methods (Vomocil, 1986). Total porosity (E,%) and void ratio (e) were calculated using the following equations:-

$$E,\ \% = \left(1 - \frac{Db}{Dr}\right) \times 100$$

and $$e = \frac{Dr}{Db} - 1$$

Where: Db = the bulk density, gcm^{-3}
Dr = the real density, gcm^{-3}

Hydraulic conductivity ($cmhr^{-1}$) was determined using undisturbed soil cores using a constant water head according to Richards (1954). Soil moisture content (Θw,%) were determined using the method outlined by Stakman (1969). Water consumption (CU) was determined by collecting soil samples from each plot before and after 48 hours of every irrigation and computed according to the equation of Israelsen and Hansen (1962) as follows.

$$Water\ consuption,\ cm = \frac{\theta_2 - \theta_1}{100} \times Db \times D$$

Where:

θ_2 = Soil moisture percentage on weight basis after 48 hours from irrigation.

θ_1 = Soil moisture percentage before irrigation.

Db = Bulk density, g/cm^{-3}

D = Soil depth, cm

Water use efficiency (WUE) was calculated by dividing the grain yield of wheat and maize ($kgfed^{-1}$) by water consumptive use (cm) according to the equation of Jensen (1983):

$$WUE,\ \text{kg fed}^{-1}\text{cm}^{-1} = \frac{Grain\ yield,\ (kg\ fed^{-1})}{Water\ consumption\ (cm)}$$

Soil pH in soil water suspension (1: 2.5) and soil electrical conductivity (EC, dSm^{-1}) in soil paste extract were measured. Organic matter was determined by Walkely and Black method according to Black (1965). The content of total NPK of the soil were determined according to Hesse (1971). Total nitrogen was determined by macro-Kjeldahel method, total phosphorus was measured calorimetrically using ascorbic acid and total potassium was measured by flame photometer method.

Ten random plants of each plot were randomized sampled of each crop to determine the following characters.

Wheat growth characters.

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

Maize growth characters:

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

At harvest stage of both wheat and maize yields for each plot was separately harvested, weighted and related to tons fed^{-1}, also wheat straw (tons fed^{-1}). 1000 wheat seed and 100 corn seed weight were recorded for each treatment.

The collected data were passed through the computer program to receive results represented on the triangle at the same site of the concerned combined treatments. The maximum value will be represented by number 10 and printed in a place form which the combination treatment resulted, other figures will shown values related to the maximum one. Moreover, the computer output

shows the average value, correlation coefficient, fisher criterion, coefficient determination, maximum and minimum value.

Economic evaluation was done to compare between different treatments to state which one is the best. The test was executed according to the price of the grains and straw yields were 4467.00 and 1000 LE ton^{-1}, respectively for wheat in the first season and was 2105 LE ton^{-1} for maize grains in the second season, as well as the cost of different treatments including the price of the addition treatments and the price of labor they added, which was calculated considering conventional method of estimating both fixed and variable costs.

RESULTS AND DISCUSSION

Effect of different treatments on some soil physical properties.

Soil bulk density (Db), total porosity (E) and void ratio (e).

The results in Table (2 and 3) show that, most of soil physical characters were affected by application of compost, nitrogen and phosphorus compared with the control. The lowest Db values were 1.24 and 1.26 g cm^{-3} in the soil depth of 0-20 and 20- 40 cm, respectively in the first season and were 1.08 and 1.13 g cm^{-3} at the same soil depths, respectively in the second season. Whereas, the found values of E and e took the opposite trend, where the highest E values were 53.21 and 52.45% at the two soil depths, respectively in the first season and were 59.25 and 57.36% at the same depths in the second season. Data in Fig. (3) cleared that, the highest E value was 53.21% denoted by number 10 was a achieved by the individual compost treatment (100% compost) at the surface soil layer in the first season. Also the results in Tables (2 and 3) and Fig. (3) it can be concluded that, the individual compost treatment was more effectiveness on reducing Db and increasing E and e than the other treatments at the two soil depths after wheat and maize harvesting. These results may be attribute to the increase in soil organic matter content induced by compost decomposition and concomitant increase in both soil total porosity and void ratio. These results are in agreement with liu et al. (2007) they said that low bulk density indicates increased pores spaces and in this respect, compost increases the portion of macro and micro pores as a result of improve soil aggregation.

Effect of different treatments on some soil hydrophisical properties.

1- Hydraulic conductivity (kh) and soil moisture content at harvesting (θw).

Data in Tables (2 and 3) show that hydraulic conductivity and soil moisture content at harvesting were increased with all the experimental treatments compared with the control at 0-20 and 20-40 cm soil depths at the end of the two growing seasons. The highest kh values were 0.62 and 0.60cm hr^{-1} at the two soil depths, respectively in the first season and were 0.69 and 0.63 cm hr^{-1} at the same depths in the second season. Also the highest θw values were 20.96 and 23.83% at the two soil depths, respectively in the first season and were 18.41 and 21.01% at the same soil depths, respectively in the second season.

Table (2): Effect of different treatments on some soil physical and hydrophysical properties after wheat in the first season (winter 2018/2019)

Treatment No.	First season											
	Bulk density, Db, $gmcm^{-3}$		Total porosity E, %		Void ratio (e)		Hydraulic conductivity (Kh, $cmhr^{-1}$)		Soil moisture content (Θw, %) at harvesting		Water consumption (CU, cm)	Water use efficiency (WUE, Kg $fed^{-1}cm^{-1}$)
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0 -20 cm	20-40 cm		
1	1.24	1.26	53.21	52.45	1.14	1.10	0.62	0.60	20.96	23.83	30.40	136.88
2	1.32	1.34	50.19	49.43	1.01	0.98	0.53	0.51	18.21	21.51	36.72	108.62
3	1.33	1.36	49.81	48.68	0.99	0.95	0.50	0.48	17.41	20.65	37.11	97.21
4	1.26	1.29	52.45	51.32	1.10	1.05	0.60	0.58	20.39	23.25	30.42	143.98
5	1.27	1.30	52.08	50.94	1.09	1.04	0.59	0.57	20.19	23.05	31.02	125.39
6	1.33	1.37	49.81	48.30	0.99	0.93	0.49	0.47	16.66	20.17	37.79	103.07
7	1.29	1.32	51.32	50.19	1.05	1.01	0.57	0.54	19.74	22.71	33.70	115.84
8	1.26	1.29	52.45	51.32	1.10	1.05	0.60	0.58	20.23	23.10	30.42	133.26
9	1.30	1.32	50.94	50.19	1.04	1.01	0.57	0.54	19.60	22.60	33.95	121.03
10	1.30	1.33	50.94	49.81	1.04	0.99	0.56	0.54	19.43	22.52	34.94	107.57
11	1.27	1.30	52.08	50.94	1.09	1.04	0.58	0.56	20.17	23.04	31.82	136.14
12	1.28	1.29	51.70	51.32	1.07	1.05	0.57	0.55	20.17	23.04	32.15	117.54
13	1.31	1.33	50.57	49.81	1.02	0.99	0.56	0.53	19.25	22.35	35.89	107.14
Control	1.35	1.38	49.06	47.92	0.96	0.92	0.48	0.45	16.18	19.86	38.20	72.18

Table (3): Effect of different treatments on some soil physical and hydrophysical properties after maize in the second season (summer 2019)

Treatment No.	Second season											
	Bulk density, Db, $gmcm^{-3}$		Total porosity E, %		Void ratio (e)		Hydraulic conductivity (Kh, $cmhr^{-1}$)		Soil moisture content (Θw, %) at harvesting		Water consumption (CU, cm)	Water use efficiency (WUE, Kg $fed^{-1}cm^{-1}$)
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm		
1	1.08	1.13	59.25	57.36	1.45	1.35	0.69	0.63	18.41	21.01	50.23	60.24
2	1.22	1.26	53.96	52.45	1.17	1.10	0.57	0.55	16.56	19.29	63.82	45.19
3	1.23	1.29	53.58	51.32	1.15	1.05	0.54	0.52	15.92	18.54	64.09	39.83
4	1.12	1.15	57.74	56.60	1.37	1.30	0.69	0.63	18.40	20.85	54.33	57.55
5	1.12	1.15	57.74	56.60	1.37	1.30	0.66	0.62	18.37	20.57	55.08	49.71
6	1.26	1.31	52.45	50.57	1.10	1.02	0.53	0.51	15.57	18.23	64.98	42.63
7	1.17	1.21	55.85	54.34	1.26	1.19	0.62	0.58	15.35	20.15	58.90	47.26
8	1.12	1.15	57.74	56.60	1.37	1.30	0.66	0.63	18.40	20.61	55.08	54.10
9	1.17	1.22	55.85	53.96	1.26	1.17	0.61	0.58	17.24	20.04	59.09	50.89
10	1.20	1.23	54.72	53.58	1.21	1.15	0.61	0.58	17.14	19.98	61.55	42.11
11	1.13	1.17	57.36	55.85	1.35	1.26	0.64	0.60	17.74	20.57	55.09	56.54
12	1.15	1.19	56.60	55.09	1.30	1.23	0.63	0.59	17.60	20.56	56.41	47.63
13	1.20	1.23	54.72	53.58	1.21	1.15	0.61	0.57	17.06	19.85	62.48	43.40
Control	1.31	1.36	50.57	48.68	1.02	0.95	0.52	0.49	15.30	17.99	67.00	37.75

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          DATA

 53.3300  53.0800  53.2100
 50.9400  50.5700  49.0600
 50.1900  49.4300  49.8100
 52.0800  51.7000  53.5800
 52.4500  51.7000  52.0800
 49.4300  50.1900  49.8100
 51.0700  50.8200  52.0800
 52.0800  52.8300  52.4500
 50.5700  50.5700  51.7000
 50.5700  50.0600  52.2000
 52.2000  52.0800  51.9500
 52.0800  51.7000  51.3200
 50.9400  50.1900  50.5700
AVERAGE VALUE     :
 53.2067  50.1900  49.8100  52.4533  52.0767  49.8100  51.3233
 52.4533  50.9467  50.9433  52.0767  51.7000  50.5667
COEFF.DITER.= .8092549
  CORRELATION COEFFICINT= .8995859
CRITERION FISHER F( 12.000 26.000) 9.192296
   SOCT= .6192115
CONTROL 52.07667 - 0 = 52.07667      t= 114.971
CONTROL 51.7 - 0 = 51.7      t= 114.1394
CONTROL 50.56667 - 51.15556 =-.5888939      t= 1.300116

    53.2067     53.1768     53.0865     52.9359     52.7248     52.4533
    52.1215     51.7292     51.2765     50.7635     50.1900
    53.0716     52.9274     52.7362     52.4981     52.2130     51.8810
    51.5021     51.0762     50.6034     50.0836
    52.8911     52.6459     52.3673     52.0552     51.7096     51.3305
    50.9180     50.4719     49.9924
    52.6651     52.3325     51.9798     51.6072     51.2145     50.8018
    50.3691     49.9164
    52.3936     51.9870     51.5738     51.1541     50.7278     50.2950
    49.8556
    52.0767     51.6095     51.1493     50.6960     50.2495     49.8100
    51.7143     51.2001     50.7062     50.2327     49.7796
    51.3064     50.7586     50.2446     49.7644
    50.8531     50.2851     49.7644
    50.3543     49.7796
    49.8100
Ymax= 53.20667           Ymin= 49.7644
     x1   10)  9   9   9   9   9   9   9   9   9  (9   x2
             9   9   9   9   9   9   9   9   9   9
               9   9   9   9   9   9   9   9   9
                 9   9   9   9   9   9   9   9
                   9   9   9   9   9   9   9
                     9   9   9   9   9   9
                       9   9   9   9   9
                         9   9   9   9
                           9   9   9
                             9   9
                               9
                               x3
```

Fig (3): Total porosity (Db%) in the surface soil layer (0-20cm) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

Hydraulic conductivity data for 0-20cm soil depths in the first season are shown in Fig (4). The maximum kh value was 0.62 cmhr^{-1} which obtained by number 10 that consists of 100% compost (4.213 ton fed^{-1}) or 90% compost + 10% nitrogen (3.972 ton fed^{-1} + 7.5kg N fd^{-1}) in the first season. The numbers located on X1 X2 or X1 X3 sides obtain that, the interaction between CN and CP were more effective on increasing kh than NP. The results in Tables (2 and 3) and Fig. (4) cleared that, the compost application to soil led to improve soil hydrophysical properties. It might be due to the higher levels of water stable aggregates and more macro pore fraction leading to greater hydraulic conductivity. These results are in agreement with those of Keener et al. (2000), El-Sodany et al. (2009), Bandyopadhyay et al. (2010) and El-Maddah et al. (2012).

```
              DATA
    0.6100    0.6300    0.6200
    0.5500    0.5400    0.5000
    0.5000    0.5200    0.4800
    0.5800    0.5900    0.6300
    0.5900    0.5800    0.6000
    0.4800    0.4900    0.5000
    0.5600    0.5900    0.5600
    0.5900    0.5800    0.6300
    0.5900    0.5800    0.5400
    0.5800    0.5700    0.5300
    0.5700    0.6000    0.5700
    0.6000    0.5600    0.5500
    0.5500    0.5700    0.5600
 AVERAGE  VALUE       :
    0.6200    0.5300    0.5000    0.6000    0.5900    0.4900    0.5700
    0.6000    0.5700    0.5600    0.5800    0.5700    0.5600
COEFF.DITER.= .8243689
  CORRELATION COEFFICINT= .9079476
CRITERION FISHER F( 12.000 26.000) 10.1698
   SOCT= 2.075483E-02
CONTROL .58 - 0 = .58         t= 38.2026
CONTROL .57 - 0 = .57         t= 37.54393
CONTROL .56 - .5744445 =-1.444447E-02      t= .9514074
       0.6200      0.6200      0.6180      0.6140      0.6080      0.6000
       0.5900      0.5780      0.5640      0.5480      0.5300
       0.6188      0.6170      0.6129      0.6064      0.5976      0.5864
       0.5728      0.5569      0.5386      0.5180
       0.6152      0.6113      0.6047      0.5954      0.5834      0.5686
       0.5511      0.5309      0.5080
       0.6092      0.6028      0.5934      0.5809      0.5653      0.5466
       0.5248      0.5000
       0.6008      0.5916      0.5790      0.5629      0.5434      0.5204
       0.4940
       0.5900      0.5776      0.5614      0.5414      0.5176      0.4900
       0.5768      0.5608      0.5407      0.5164      0.4880
       0.5612      0.5413      0.5169      0.4880
       0.5432      0.5190      0.4900
       0.5228      0.4940
       0.5000
Ymax= .62              Ymin= .488
```

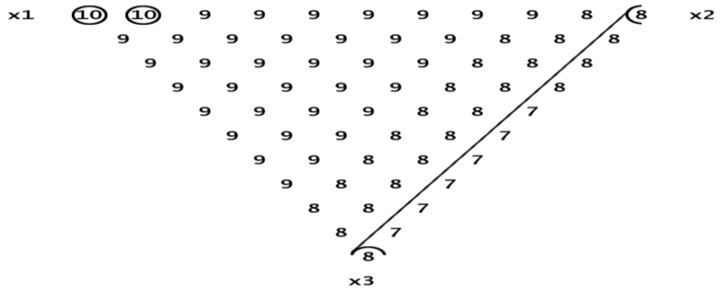

Fig (4): Hydraulic conductivity (kh, cmhr^{-1}) in the surface soil layer (0-20cm) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

2- Water consumption (CU) and water use efficiency (WUE).

The obtained results in Tables (2 and 3) indicated that, The lowest CU values were 30.40 and 50.23 cm decreased by 20.42 and 25.03% compared with the control in the first and second seasons, respectively. The lowest CU values were recorded with the single compost treatments (100% compost) in the two seasons. On the other hand, the highest WUE value was 143.98 kg fed^{-1} cm^{-1} and increased by 99.47% over the control in the first season, it was resulted by the treatment which consists of 50% C and 50% N. Whereas, in the second season, the highest WUE value was 60.24 kgfed^{-1}cm^{-1} which increased by 59.58% over the control, it was recorded with the single compost treatment (100% compost).

The results in Figs. (5 and 6) showed the single effects of C, N and P on WUE, where these treatments gave 90,70 and 60% of the maximum WUE values equal to 136.88, 108.62 and 97.21kg fed^{-1} cm^{-1}. The highest WUE was 146.24kg fed^{-1}cm^{-1} which obtained by number 10 which consists of 70% compost (2.949 ton fed^{-1}) and 30% N (22.50kg N fed^{-1}) in the first season (Fig, 5). While, in the second

season the single effects of C, N and P on WUE gave 90,70 and 60% of the maximum WUE values equal to 60.24, 45.19 and 39.84 kg fed^{-1} cm^{-1}, respectively. Whereas, the results in Fig. (6) obtain that, the highest WUE was 60.47 kg fed^{-1} cm^{-1} which denoted by number 10 which consists of 90% C (6.068 ton fed^{-1}) + 10% N (12 kg fed^{-1}). Also, the numbers located on X1 X2, X1 X3 sides and inside triangle refer to positive interactions more than X2 X3 on water use efficiency (WUE) in the tow seasons (Figs, 5 and 6). From the results in Tables (2 and 3) and Figs. (5 and 6) noted that, the addition of C or C+N to soil caused an increase in water use efficiency. These results may be due to the improve of soil physical and hydrophysical properties. Similar results were obtained by Bandyopadhyay et al. (2010) and Brown and Cotton (2011).

```
          DATA
 145.0300 144.9500 120.6500
 119.7300 110.4600  95.6700
  95.2800  94.1700 102.1900
 148.7500 136.8700 146.3300
 131.7400 123.2300 121.2100
 108.7600 103.0400  97.4300
 125.4900 113.6900 108.3200
 130.0700 132.4100 137.2900
 125.9600 116.4800 120.6600
 107.4300 108.5100 106.7900
 136.7100 135.2000 136.5200
 116.3100 117.8200 118.4700
 116.2800 104.8900 100.2600

 AVERAGE VALUE     :

 136.8767 108.6200  97.2133 143.9833 125.3933 103.0767 115.8333
 133.2567 121.0333 107.5767 136.1433 117.5333 107.1433

COEFF.DITER.= .8571614
  CORRELATION COEFFICINT= .9258301

CRITERION FISHER F( 12.000 26.000) 13.00197
   SOCT= 7.072794
CONTROL 136.1433 - 0 = 136.1433      t= 26.31415
CONTROL 117.5333 - 0 = 117.5333      t= 22.71716
CONTROL 107.1433 - 114.2174 =-7.074059      t= 1.367293

    136.8767    141.6956    144.8157    146.2371    145.9596    143.9833
    140.3083    134.9344    127.8617    119.0903    108.6200

    135.9157    137.0473    137.1076    136.0968    134.0147    130.8615
    126.6372    121.3416    114.9749    107.5369

    134.2869    132.3587    129.9868    127.1715    123.9125    120.2100
    116.0639    111.4743    106.4411

    131.9903    127.6298    123.4535    119.4611    115.6529    112.0286
    108.5885    105.3324

    129.0257    122.8607    117.5074    112.9658    109.2358    106.3175
    104.2109

    125.3933    118.0514    112.1488    107.6855    104.6614    103.0767

    121.0931    113.2018    107.3775    103.6201    101.9296

    116.1249    108.3120    103.1936    100.7697

    110.4889    103.3819     99.5971

    104.1851     98.4116

     97.2133

Ymax= 146.2371               Ymin= 97.21334
```

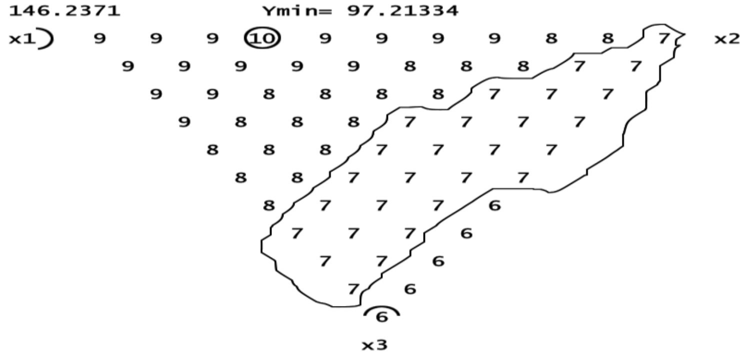

Fig (5): Water use efficiency (WUE, kg fed^{-1} cm^{-1}) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

```
            DATA

 57.6500  56.1100  66.9600
 44.0800  44.7000  46.7900
 38.4900  38.0600  42.9600
 60.7600  61.1700  50.7100
 49.8700  49.7900  49.4900
 42.0800  41.9400  43.8600
 47.7900  45.6000  48.4000
 52.4900  52.1800  57.6200
 47.5400  46.9000  58.2400
 40.1900  41.6400  44.5000
 55.0000  54.9500  59.6800
 48.0800  46.3200  48.5000
 44.1700  42.1600  43.8800

 AVERAGE VALUE     :

 60.2400  45.1900  39.8367  57.5467  49.7167  42.6267  47.2633
 54.0967  50.8933  42.1100  56.5433  47.6333  43.4033

COEFF.DITER.= .8386598
  CORRELATION COEFFICINT= .9157837

CRITERION FISHER F( 12.000 26.000) 11.26251
   SOCT= 3.361791
CONTROL 56.54334 - 0 = 56.54334       t= 22.99295
CONTROL 47.63333 - 0 = 47.63333       t= 19.36976
CONTROL 43.40334 - 46.49926 =-3.095925      t= 1.258936

     60.2400     60.4744     60.3223     59.7836     58.8584     57.5467
     55.8484     53.7636     51.2923     48.4344     45.1900

     58.0839     57.4482     56.5996     55.5380     54.2634     52.7758
     51.0752     49.1616     47.0350     44.6955

     55.9535     54.6214     53.2498     51.8388     50.3883     48.8984
     47.3690     45.8002     44.1919

     53.8488     51.9938     50.2728     48.6859     47.2331     45.9144
     44.7297     43.6792

     51.7699     49.5654     47.6686     46.0794     44.7978     43.8238
     43.1575

     49.7167     47.3363     45.4372     44.0192     43.0823     42.6267

     47.6892     45.3066     43.5786     42.5054     42.0868

     45.6875     43.4760     42.0928     41.5379

     43.7115     41.8448     40.9799

     41.7612     40.4128

     39.8367

Ymax= 60.47441            Ymin= 39.83667
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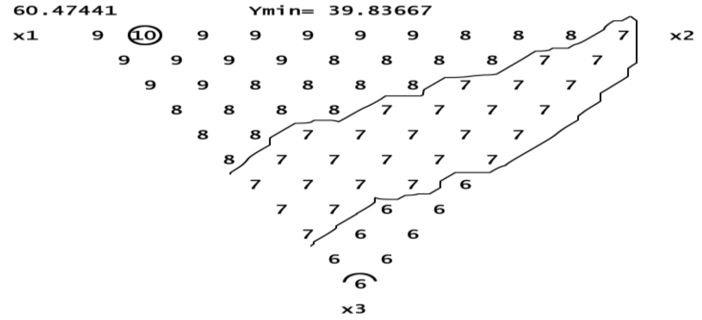

Fig (6): Water use efficiency (WUE,kg fed^{-1} cm^{-1}) as affected by all possible combinations of compost, nitrogen and phosphours in the second season.

Effect of different treatments on some soil chemical properties.

1- Soil reaction (pH) and electrical conductivity (EC)

The results in Tables (4 and 5) indicated that, all treatments led to decrease in soil pH and increased soil EC at soil depths 0- 20 and 20- 40 cm in the two seasons compared with the control. The lowest pH values were 7.34 and 7.32 which decreased by 5.17 and 6.63% compared to the control at the two soil depths, respectively in the first season (Table, 4) and were 7.29 and 7.33, where its decreased by 5.45 and 6.03% compared to the control at the tow soil depths, respectively in the second season (Table, 5). These results also show that, the plots were tested by the addition of 100% C gave the lowest pH values at the two soil depths in the two seasons. It might be due to organic acids resulting from compost decomposition. Similar results are in agreement with Liang et al. (2012) and Bharath et al. (2017).

Table (4): Effect of different treatments on some soil chemical properties after wheat in the first season (winter 2018/2019)

Treatment No.	pH, 1:2.5 (soil: water susp.)		EC, dSm^{-1} (Soil paste extract)		Total macronutrients, %						Organic carbon, %		C / N ratio	
					N		P		K					
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0- 20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
1	7.34	7.32	3.03	3.56	0.160	0.135	0.045	0.041	0.386	0.371	1.814	1.579	11.34	11.70
2	7.53	7.60	2.44	2.88	0.164	0.149	0.042	0.039	0.357	0.340	1.638	1.423	9.99	9.55
3	7.54	7.61	2.41	2.86	0.148	0.136	0.059	0.054	0.354	0.336	1.622	1.409	10.96	10.36
4	7.38	7.44	2.77	3.22	0.160	0.146	0.044	0.040	0.376	0.360	1.778	1.535	11.11	10.51
5	7.39	7.49	2.75	3.20	0.150	0.138	0.053	0.050	0.375	0.358	1.748	1.516	11.65	10.99
6	7.58	7.66	2.38	2.78	0.151	0.139	0.053	0.049	0.351	0.332	1.605	1.394	10.63	10.03
7	7.47	7.53	2.57	3.03	0.154	0.143	0.049	0.045	0.364	0.348	1.692	1.474	10.99	10.31
8	7.39	7.45	2.76	3.21	0.157	0.144	0.048	0.044	0.375	0.359	1.758	1.523	11.20	10.58
9	7.48	7.55	2.56	2.96	0.158	0.145	0.047	0.043	0.363	0.345	1.678	1.463	10.62	10.09
10	7.50	7.58	2.52	2.91	0.149	0.137	0.054	0.050	0.361	0.344	1.666	1.450	11.18	10.58
11	7.43	7.49	2.66	3.19	0.159	0.145	0.046	0.042	0.371	0.356	1.736	1.512	10.92	10.43
12	7.45	7.50	2.62	3.07	0.152	0.140	0.052	0.049	0.369	0.354	1.720	1.500	11.32	10.71
13	7.51	7.59	2.47	2.89	0.153	0.141	0.051	0.047	0.358	0.343	1.652	1.436	10.80	10.18
Control	7.74	7.84	2.34	2.75	0.137	0.134	0.041	0.038	0.348	0.331	1.412	1.379	10.31	10.29

Table (5): Effect of different treatments on some soil chemical properties after maize in the second season (summer 2019).

Treatment No.	pH, 1:2.5 (soil: water susp.)		EC, dSm^{-1} (Soil paste extract)		Total macronutrients, %						Organic carbon, %		C / N ratio	
					N		P		K					
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 Cm	20-40 cm
1	7.29	7.33	3.12	3.65	0.163	0.149	0.049	0.045	0.396	0.388	1.798	1.585	11.03	10.64
2	7.48	7.54	2.51	2.96	0.168	0.154	0.046	0.043	0.368	0.351	1.622	1.427	9.65	9.27
3	7.49	7.55	2.44	2.95	0.152	0.139	0.069	0.059	0.365	0.348	1.607	1.410	10.57	10.14
4	7.34	7.39	2.86	3.34	0.164	0.150	0.047	0.044	0.386	0.369	1.753	1.537	10.69	10.25
5	7.35	7.40	2.85	3.33	0.154	0.141	0.057	0.054	0.384	0.368	1.733	1.563	11.25	11.09
6	7.52	7.60	2.39	2.82	0.155	0.142	0.057	0.054	0.361	0.345	1.593	1.396	10.28	9.83
7	7.42	7.48	2.62	3.12	0.158	0.145	0.053	0.050	0.381	0.358	1.678	1.476	10.62	10.18
8	7.35	7.40	2.85	3.33	0.161	0.147	0.052	0.049	0.385	0.368	1.741	1.524	10.81	10.37
9	7.43	7.49	2.61	3.05	0.162	0.148	0.051	0.047	0.376	0.356	1.667	1.465	10.29	9.90
10	7.45	7.52	2.59	2.98	0.153	0.140	0.058	0.055	0.374	0.355	1.652	1.450	10.80	10.36
11	7.38	7.43	2.71	3.30	0.163	0.148	0.050	0.046	0.383	0.365	1.720	1.510	10.55	10.20
12	7.40	7.45	2.91	3.18	0.159	0.143	0.057	0.053	0.381	0.363	1.707	1.498	10.74	10.48
13	7.46	7.53	2.54	2.97	0.157	0.144	0.055	0.052	0.371	0.353	1.640	1.438	10.45	9.99
Control	7.71	7.80	2.37	2.79	0.151	0.138	0.044	0.042	0.357	0.342	1.580	1.384	10.46	10.03

Concerning soil electrical conductivity (EC). The lowest EC values in the first growing season were 2.38 and 2.78 ds m^{-1} increased by 1.71 and 1.09% over the control at the soil depths of 0-20 and 20-40 cm, respectively and were 2.39 and 2.82 ds m^{-1} increased by 0.84 and 1.08% over the control at the same depths in the second season. These increases in soil EC values may be attribute to high content of soluble cations and anions as shown in Tables (1-a and 1-b). Similar results were obtained by Liang et al. (2012) and Mahmood et al. (2017).

Data in Fig (7) clarified that, the individual applications of C, N and P gave 100, 80 and 70% of the maximum EC values which equal to 3.03, 2.44 and 2.41 dSm^{-1}, respectively. Meanwhile, the highest EC values was 3.03 dSm^{-1} which denoted by number 10 consists of 100% C, it was also observed that, the numbers located on X1 X2 and X1 X3 sides and inside triangle refer to the positive interactions of the studied treatments on increasing EC values more than X2 X3. These results mean that, the addition of C increased soil salinity more than N or P. It might be due to the high amount of dissolved salts in compost (Table, 1-b). Similar results were confirmed by Jinwei and Lianren (2011) and Almaz et al. (2017).

```
           DATA

  3.0000    2.9900    3.1000
  2.4200    2.4700    2.4300
  2.4300    2.4700    2.3300
  2.7500    2.7800    2.7800
  2.7700    2.7400    2.7400
  2.4100    2.4000    2.3300
  2.5900    2.6000    2.5200
  2.7700    2.7500    2.7600
  2.5500    2.5400    2.5900
  2.5300    2.5400    2.4900
  2.6700    2.6500    2.6600
  2.6400    2.6300    2.5900
  2.4900    2.4800    2.4400

 AVERAGE  VALUE     :

  3.0300    2.4400    2.4100    2.7700    2.7500    2.3800    2.5700
  2.7600    2.5600    2.5200    2.6600    2.6200    2.4700

COEFF.DITER.= .9724552
  CORRELATION COEFFICINT= .9861315

CRITERION FISHER F( 12.000 26.000) 76.49325
   SOCT= 3.616909E-02
CONTROL 2.66 - 0 = 2.66        t= 100.5375
CONTROL 2.62 - 0 = 2.62        t= 99.02566
CONTROL 2.47 - 2.553333 =-8.333326E-02      t= 3.149668

      3.0300      2.9836      2.9344      2.8824      2.8276      2.7700
      2.7096      2.6464      2.5804      2.5116      2.4400

      2.9788      2.9138      2.8496      2.7861      2.7234      2.6614
      2.6001      2.5396      2.4798      2.4208

      2.9252      2.8452      2.7695      2.6981      2.6310      2.5681
      2.5095      2.4552      2.4052

      2.8692      2.7777      2.6941      2.6183      2.5503      2.4901
      2.4377      2.3932

      2.8108      2.7114      2.6234      2.5467      2.4814      2.4274
      2.3848

      2.7500      2.6462      2.5573      2.4833      2.4242      2.3800

      2.6868      2.5821      2.4959      2.4281      2.3788

      2.6212      2.5192      2.4392      2.3812

      2.5532      2.4574      2.3872

      2.4828      2.3968

      2.4100

Ymax= 3.03            Ymin= 2.3788
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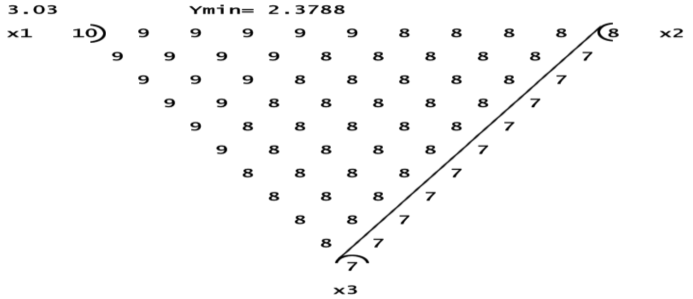

Fig (7): Electrical conductivity (EC, dsm^{-1}) in the surface soil layer (0-20cm) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

2- Soil content of total macronutrients (NPK).

The results in Tables (4 and 5) cleared that, all treated plots individually by C, N and P and in combinations increased the soil content of total NPK at 0-20 and 20-40 cm soil depths in the first and second seasons compared with control. The highest content of total N were 0.164 and 0.149% at the two soil depths, respectively in the first season and were 0.168 and 0.154% at the same depths in the second season. Whereas, the highest content of total P were 0.059 and 0.054% at the two soil depths, respectively in the first season and were 0.069 and 0.059% at the same depths in the second season. The highest content of total K were 0.386 and 0.371% at the two soil depths, respectively in the first season and were 0.396 and 0.388% at the same depths in the second season. From the previous results may be noticed that, the highest content of total N, P and K were recorded with the individual treatments (100% N, 100% P and 100% C) respectively at the two soil depths in the two seasons. These results could be attributed to the ability of additional treatments to supply nutrients and improvement the physical and chemical properties of the soil and the ability of compost to release nutrients gradually throughout the growing season. These results are supported by the work of Adugna (2016), Bharath et al. (2017) and Mahmood et al. (2017).

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

The obtained results in Tables (4 and 5) showed that, the highest O.C content were 1.814 and 1.579% recorded increase percent by 41.06 and 14.5% over the control at 0-20 and 20-40cm soil depths, respectively in the first season (Table, 4) and were 1.798 and 1.585% which increased by 13.80 and 14.52% over the control at the two soil depths, respectively (Table, 5) in the second season. It can be noted that, the individual compost treatment (100% compost) gave the highest O.C content. This result might be due to compost contents higher content of organic matter and the retention of dissolved organic mater leading to change in O.C% in soil. These results are in line with those reported by Keener et al. (2000), Moyin-Jesu (2015) and Mahmood et al. (2017).

Data in Fig (8) show that, the effects of individual treatments of C, N and P gave 90, 90 and 80% of the maximum O.C content which equal to 1,184, 1.638 and 1.622%, respectively. These results mean that C was effective upon O.C increase more than N and P which took the order C > N > P. While, the highest O.C content was 1.815% which denoted by number 10 which consists of 90% C (3.792 ton fed^{-1} + 10% N (7.50kg N fed^{-1}) in the first season.

Concerning, C/N ratio, the results in Tables (4 and 5) cleared that, the maximum C/N ratio values were 11.65 and 10.99 at the 0-20 and 20-40 cm soil depths, respectively in the first season and were 11.25 and 11.09 at the same depths in the second season. It recorded under the treatment consist of 50% C + 50% P in the two seasons. Data presented in Fig (9) denoted that, the effects of the three individual treatments of C, N and P gave 90, 80 and 90% of the maximum C/N ratio values which equal to 11.34, 9.99 and 10.96, respectively. On the other hand the highest C/N ratio was 11.67 obtained by number 10 which consists of 60% C + 40% P in the first season. This might be due to higher accumulation of C in soil in comparison to N. Similar conclusion were obtained by El-Sodany et al. (2009), Bandyopadhyay et al. (2010), El-Maddah et al. (2012), Almaz et al. (2017) and Mahmood et al. (2017) .

Effect of different treatments on yield and yield components.

The results in Tables (6 and 7) indicated that, growth characters and yield of wheat and maize plants increased with all the individually additions of C, N and P and in combinations compared with the control, where the highest grain yield of wheat was 4.380 ton fed^{-1} with relative increase yield (R.I.Y) of 58.85% over the control, also the highest straw yield of wheat was 4.471 ton fed^{-1} with (R. I. Y) of 41.98% over the control, (Table, 6). While, the highest maize grain yield was 3.127 ton fed^{-1} by (R.I.G.Y) of 23.62% over the control, (Table ,7). From the results in Tables (6 and 7) may be noted that, the highest growth characters and grain yield of wheat and maize were recorded with the treatment consists of 50% C +50% N. The recorded results in Figs. (10 and 11) showed that, the effect of the individual treatments of C, N and P gave 90.90 and 80% of the maximum grain yield for wheat and maize, respectively. Whereas, the highest grain yields were 4.385 and 3.134 ton fed^{-1} for wheat and maize, respectively obtained by number 10 which consists of 60% C + 40% N. Increasing in grain and straw yields from the combined application of compost and nitrogen could be attributed to better crop growth, due to the readily available nutrients from the inorganic fertilizers sources and controlled release of nutrients from compost. Also, the positive effect of compost in preventing lose of nutrients from mineral fertilizers. These results are in agreement with these cleared by Jinwei and Lianren (2011), Ahmad et al. (2013), Gomaa et al. (2015) and Chopra et al. (2016).

```
             DATA

    1.8170    1.8190    1.8060
    1.6350    1.6310    1.6480
    1.6240    1.6290    1.6140
    1.7730    1.7730    1.7880
    1.7420    1.7420    1.7600
    1.6060    1.6040    1.6050
    1.7000    1.6950    1.6810
    1.7590    1.7570    1.7570
    1.6750    1.6780    1.6800
    1.6690    1.6700    1.6590
    1.7330    1.7370    1.7380
    1.7210    1.7190    1.7200
    1.6580    1.6550    1.6430
 AVERAGE  VALUE      :

    1.8140    1.6380    1.6223    1.7780    1.7480    1.6050    1.6920
    1.7577    1.6777    1.6660    1.7360    1.7200    1.6520
COEFF.DITER.= .9921451
  CORRELATION COEFFICINT= .9960648
CRITERION FISHER F( 12.000 26.000) 273.6704
   SOCT= 6.712758E-03
CONTROL 1.736 - 0 = 1.736      t= 353.5353
CONTROL 1.72 - 0 = 1.72      t= 350.2769
CONTROL 1.652 - 1.678259 =-2.625942E-02      t= 5.347715

       1.8140      1.8151      1.8121      1.8049      1.7935      1.7780
       1.7583      1.7345      1.7065      1.6743      1.6380
       1.8056      1.7971      1.7858      1.7716      1.7547      1.7349
       1.7122      1.6868      1.6585      1.6274
       1.7948      1.7780      1.7598      1.7400      1.7188      1.6960
       1.6718      1.6460      1.6188
       1.7816      1.7579      1.7340      1.7100      1.6858      1.6614
       1.6369      1.6122
       1.7660      1.7367      1.7085      1.6816      1.6557      1.6311
       1.6076
       1.7480      1.7144      1.6833      1.6547      1.6286      1.6050
       1.7276      1.6911      1.6584      1.6295      1.6044
       1.7049      1.6667      1.6337      1.6059
       1.6798      1.6413      1.6094
       1.6522      1.6148
       1.6223
Ymax= 1.81512          Ymin= 1.60444
       x1    9) (10)  9   9   9   9   9   9   9   9  (9   x2
                 9   9   9   9   9   9   9   9   9   8
                   9   9   9   9   9   9   9   9   8
                     9   9   9   9   9   9   9   8
                       9   9   9   9   9   8   8
                         9   9   9   9   9   8   8
                           9   9   9   8   8
                             9   9   9   8
                               9   9   8
                                 9   8
                                  (8)
                                  x3
```

Fig (8): Organic carbon (O.C%) in the surface soil layer (0-20cm) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

```
            DATA
  11.4000   10.9900   11.6300
   9.8500   10.1900    9.9200
  11.1200   11.3100   10.4500
  11.3600   11.2500   10.7200
  11.6900   11.5200   11.7500
  10.8500   10.7200   10.3200
  10.9700   10.7700   11.2200
  11.6500   11.4800   10.4600
  10.7400   11.0400   10.0800
  11.3600   11.3100   10.8800
  11.0400   10.8100   10.9100
  11.4000   11.2400   11.3200
  10.8100   10.6800   10.9100
 AVERAGE VALUE      :
  11.3400    9.9867   10.9600   11.1100   11.6533   10.6300   10.9867
  11.1967   10.6200   11.1833   10.9200   11.3200   10.8000
COEFF.DITER.= .6966031
  CORRELATION COEFFICINT= .8346275
CRITERION FISHER F( 12.000 26.000) 4.974693
   SOCT= .3232053
CONTROL 10.92 - 0 = 10.92        t= 46.1879
CONTROL 11.32 - 0 = 11.32        t= 47.87976
CONTROL 10.8 - 11.01148 =-.2114811       t= .8944932

      11.3400     11.3655     11.3552     11.3092     11.2275     11.1100
      10.9568     10.7679     10.5432     10.2828      9.9867
      11.4832     11.4192     11.3339     11.2272     11.0993     10.9501
      10.7796     10.5879     10.3748     10.1404
      11.5861     11.4471     11.3011     11.1483     10.9887     10.8222
      10.6489     10.4687     10.2816
      11.6488     11.4491     11.2570     11.0725     10.8955     10.7262
      10.5644     10.4103
      11.6712     11.4253     11.2015     10.9997     10.8199     10.6621
      10.5264
      11.6533     11.3757     11.1346     10.9299     10.7617     10.6300
      11.5952     11.3003     11.0563     10.8632     10.7211
      11.4968     11.1991     10.9667     10.7996
      11.3581     11.0720     10.8656
      11.1792     10.9191
      10.9600
Ymax= 11.6712          Ymin= 9.986667
     x1   9)  9   9   9   9   9   9   9   9   8  (8   x2
            9   9   9   9   9   9   9   9   8   8
              9   9   9   9   9   9   9   8   8
                9   9   9   9   9   9   9   8
                 (10)  9   9   9   9   9   9
                    9   9   9   9   9   9
                      9   9   9   9   9
                        9   9   9   9
                          9   9   9
                            9   9
                             (9)
                             x3
```

Fig (9): C/N ratio in the surface soil layer (0-20cm) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

Table (6): Effect of different treatments on wheat yield and some growth characters in the first season (winter 2018/2019)

Treatment No.	Biological yield Ton fed^{-1}	Grain yield Ton fed^{-1}	Straw yield Ton fed^{-1}	Plant height, cm	Spike length cm	1000 Seed weight, g	Dry matter g/10 plants after 90 days	* R.I.Y., %		Harvest Index,%
								Grain	Straw	
1	8.4770	4.1611	4.3159	102.67	12.59	77.53	27.98	50.91	37.04	49.09
2	8.2880	3.9885	4.2995	100.86	12.16	75.41	24.89	44.65	36.52	48.12
3	7.5636	3.6075	3.9561	94.03	11.27	60.89	20.28	30.83	25.61	47.70
4	8.8514	4.3800	4.4714	104.29	12.69	80.71	38.83	58.85	41.98	49.48
5	7.9700	3.8897	4.0803	99.05	11.97	70.24	23.30	41.07	29.56	48.80
6	8.0406	3.8952	4.1454	99.81	12.08	72.63	23.79	41.27	31.63	48.44
7	8.1692	3.9037	4.2655	100.17	12.10	74.43	24.19	41.58	35.44	47.79
8	8.3225	4.0537	4.2688	101.47	12.23	75.66	25.32	47.02	35.54	48.71
9	8.3816	4.1091	4.2725	101.99	12.41	76.77	26.33	49.03	35.66	49.02
10	7.7657	3.7586	4.0071	95.80	11.66	63.01	21.52	36.31	27.23	48.40
11	8.7863	4.3321	4.4542	103.03	12.63	78.50	30.30	57.11	41.43	49.31
12	7.8441	3.7788	4.0653	96.88	11.84	65.01	22.37	37.05	29.08	48.17
13	7.8997	3.8454	4.0543	97.45	11.91	68.71	22.95	39.46	28.73	48.68
Contro	5.9067	2.7573	3.1494	92.69	10.85	60.21	20.12	0.00	0.00	46.68

*** relative increasing yield**

Table (7): Effect of different treatments on maize yield and some growth characters in the second season (summer 2019)

Treatment No.	Plant height, cm	Ear length, cm	Ear diameter, cm	No. of rows per ear	No. of kernels per row	100 seed weight, g	Dry matter, g/plant after 80 days	Grain yield Ton fed^{-1}	**R.I.G.Y.
1	228.25	20.25	7.77	14.18	42.80	40.53	196.35	3.0257	19.63
2	223.11	19.78	7.61	13.67	41.63	38.69	176.80	2.8840	14.03
3	198.66	18.17	6.91	12.83	36.73	33.74	150.47	2.5530	0.94
4	232.50	21.17	7.86	14.76	45.07	41.79	226.77	3.1265	23.62
5	218.47	19.30	7.42	13.43	40.59	37.16	163.58	2.7383	8.27
6	219.75	19.48	7.51	13.55	40.86	37.73	168.51	2.7700	9.52
7	220.44	19.65	7.53	13.63	41.08	38.27	171.58	2.7839	10.07
8	223.94	19.99	7.66	13.91	42.08	39.29	186.83	2.9796	17.81
9	225.10	20.11	7.71	14.08	42.24	39.49	194.33	3.0072	18.90
10	204.43	18.60	7.14	13.01	37.98	35.66	154.40	2.5920	2.48
11	229.04	20.50	7.83	14.33	43.95	40.79	209.82	3.1148	23.15
12	214.12	18.98	7.23	13.07	38.99	36.07	158.44	2.6870	6.24
13	218.03	19.21	7.35	13.38	39.67	36.45	160.39	2.7119	7.22
Control	165.56	14.83	5.85	10.14	28.28	30.05	126.96	2.5292	0.00

**** relative increasing grain yield**

```
             DATA
    4.2538    4.1877    4.0418
    4.1083    3.9115    3.9458
    3.6897    3.4068    3.7260
    4.4744    4.2770    4.3886
    4.0607    3.7849    3.8235
    4.0623    3.7950    3.8283
    4.0682    3.7985    3.8444
    4.1594    4.0415    3.9602
    4.2475    4.0435    4.0363
    3.8202    3.7152    3.7403
    4.3372    4.2066    4.4525
    3.8292    3.7367    3.7705
    4.0072    3.7582    3.7708
  AVERAGE  VALUE     :
    4.1611    3.9885    3.6075    4.3800    3.8897    3.8952    3.9037
    4.0537    4.1091    3.7586    4.3321    3.7788    3.8454
COEFF.DITER.=  .8257779
  CORRELATION  COEFFICINT=  .9087232
CRITERION  FISHER  F( 12.000 26.000) 10.26957
   SOCT=  .1214967
CONTROL 4.3321 - 0 = 4.3321          t= 48.74364
CONTROL 3.7788 - 0 = 3.7788          t= 42.51806
CONTROL 3.8454 - 3.901049 =-5.564857E-02          t= .626143

        4.1611        4.2537        4.3219        4.3657        4.3850        4.3800
        4.3505        4.2967        4.2184        4.1157        3.9885
        4.1077        4.1493        4.1771        4.1911        4.1913        4.1778
        4.1504        4.1092        4.0542        3.9854
        4.0538        4.0551        4.0531        4.0480        4.0397        4.0282
        4.0135        3.9956        3.9745
        3.9996        3.9710        3.9499        3.9362        3.9300        3.9312
        3.9398        3.9559
        3.9448        3.8972        3.8675        3.8559        3.8624        3.8869
        3.9294
        3.8897        3.8335        3.8059        3.8070        3.8368        3.8952
        3.8341        3.7800        3.7651        3.7895        3.8532
        3.7781        3.7367        3.7451        3.8034
        3.7217        3.7035        3.7459
        3.6648        3.6806
        3.6075
Ymax=   4.38505              Ymin=  3.6075
        x1     9)  9   9   9  (10)  9   9   9   9   9  (9    x2
                 9   9   9   9   9   9   9   9   9   9
                   9   9   9   9   9   9   9   9   9
                     9   9   9   8   8   8   8   9
                       8   8   8   8   8   8   8
                         8   8   8   8   8   8
                           8   8   8   8   8
                             8   8   8   8
                               8   8   8
                                 8   8
                                  (8)
                                  x3
```

Fig (10): Wheat grain yield (ton fed^{-1}) as affected by all possible combinations of compost, nitrogen and phosphours in the first season.

```
            DATA
   2.9511    2.8440    3.2820
   2.8277    2.7389    3.0854
   2.4385    2.4570    2.7636
   3.3779    3.3321    2.6695
   2.7423    2.6655    2.8071
   2.7529    2.6737    2.8835
   2.7606    2.6788    2.9124
   2.8696    2.8164    3.2528
   2.9317    2.8273    3.2626
   2.4773    2.5053    2.7935
   3.0849    2.9741    3.2855
   2.6595    2.5988    2.8028
   2.7020    2.6277    2.8060
 AVERAGE VALUE     :
   3.0257    2.8840    2.5530    3.1265    2.7383    2.7700    2.7839
   2.9796    3.0072    2.5920    3.1148    2.6870    2.7119
COEFF.DITER.= .5766216
  CORRELATION COEFFICINT= .759356
CRITERION FISHER F( 12.000 26.000) 2.950899
  SOCT= .193788
CONTROL 3.114833 - 0 = 3.114833       t= 21.97313
CONTROL 2.687034 - 0 = 2.687034       t= 18.95528
CONTROL 2.7119 - 2.774348 =-6.244803E-02       t= .4405304

      3.0257      3.0733      3.1072      3.1274      3.1338      3.1265
      3.1055      3.0707      3.0222      2.9600      2.8840
      2.9600      2.9804      2.9931      2.9983      2.9958      2.9858
      2.9681      2.9428      2.9099      2.8694
      2.8985      2.8977      2.8954      2.8917      2.8865      2.8797
      2.8716      2.8619      2.8508
      2.8410      2.8252      2.8140      2.8075      2.8057      2.8085
      2.8159      2.8280
      2.7876      2.7629      2.7490      2.7458      2.7535      2.7719
      2.8011
      2.7383      2.7108      2.7003      2.7066      2.7299      2.7700
      2.6931      2.6690      2.6679      2.6899      2.7349
      2.6519      2.6373      2.6519      2.6956
      2.6149      2.6159      2.6522
      2.5819      2.6047
      2.5530
Ymax= 3.133804          Ymin= 2.553034
      x1    9  9  9  9  10  9  9  9  9  9  9    x2
              9  9  9  9  9  9  9  9  9  9
                9  9  9  9  9  9  9  9  9
                  9  9  8  8  8  8  8  9
                    8  8  8  8  8  8  8
                      8  8  8  8  8  8
                        8  8  8  8  8
                          8  8  8  8
                            8  8  8
                              8  8
                                8
                                x3
```

Fig (11): Maize grain yield (ton fed^{-1}) as affected by all possible combinations of compost, nitrogen and phosphours in the second season.

Economical analysis.

Data in Tables (8 and 9) show the total inputs costs, outputs and net revenue for the actual thirteen treatments besides the control. It can be noticed from Table (9) that, the highest net revenue (7636.84 LE fed^{-1}) was recorded by using the treatment consists of 50% C + 50% N in the two seasons at the rates of 2.107 C ton fed^{-1} +37.50 kg N fed^{-1} for wheat plants and 3.371 ton C fed^{-1} + 60 kg N fed^{-1} for maize plants. This result may be due to this treatment gave the highest values of wheat and maize grain yields. Similar results were obtained by Tayebeh et al. (2010), Ahmad et al. (2013) and Adugna (2016).

Table (8): Input production items and output of the experiments through the two growing seasons under study (winter 2018/2019 and summer 2019).

Items	Treatment				Unit	Unit price (LE)
Input	First season	Second season				
Compost	4.213	6.742	ton/fed	and all possible combination of these parameter in both seasons	Ton	230.00
Nitrogen fertilizer	75.00	120.00	Kg fed $^{-1}$		Kg N	9.55
Phosphorus fertilizer	15.50	31.00	Kg fed $^{-1}$		Kg P_2O_5	10.97
Potassium fertilizer	Recommended dose in both seasons				Kg K_2O	25.00
Seeds of wheat	60	kg fed $^{-1}$			Kg	7.67
Seeds of maize	15	kg fed $^{-1}$			Kg	23.00
Land preparation					per fed	1000
labor					per fed	1100
pesticides					per fed	1000
Other costs					per fed	600
Output						
Wheat grain					Ton	4467.00
Wheat straw					Ton	1000.00
Maize grain					Ton	2105.00

Table (9): The net revenue * (LE/fed.) due to different treatments through the two growing seasons under study.

Treatment No.	Increasing yield ton fed $^{-1}$			Total yield price, LE/fed.			Total cost of soil addition	Net revenue LE/fed.
	Wheat grain	Wheat straw	Maize grain	Wheat grain	Wheat straw	Maize grain		
1	1.4038	1.1665	0.4965	6270.77	1166.50	1045.13	2519.65	5962.75
2	1.2312	1.1501	0.3548	5499.77	1150.10	746.85	1862.25	5534.47
3	0.8502	0.8067	0.0238	3797.84	806.70	50.10	510.11	4144.53
4	1.6227	1.3220	0.5973	7248.60	1322.00	1257.32	2191.07	7636.84
5	1.1324	0.9309	0.2091	5058.43	930.90	440.16	1514.99	4914.49
6	1.1379	0.9960	0.2408	5083.00	996.00	506.88	1186.18	5399.70
7	1.1464	1.1160	0.2547	5120.97	1116.10	536.14	1629.04	5144.17
8	1.2964	1.1194	0.4504	5791.02	1119.40	948.09	2071.90	5786.61
9	1.3518	1.1231	0.4780	6038.49	1123.10	1006.19	1743.09	6424.69
10	1.0013	0.8577	0.0628	4472.81	857.70	132.19	1067.01	4395.69
11	1.5748	1.3047	0.5856	7034.63	1304.80	1232.69	2002.17	7569.94
12	1.0215	0.9159	0.1578	4563.04	915.90	332.17	1551.90	4259.21
13	1.0881	0.9048	0.1827	4860.54	904.90	384.58	1332.94	4817.08
Control	0.0000	0.0000	0.0000	0000.00	000.00	000.00	0000.00	0000.00

*** = (Yield of treatment - control) - the cost of the treatment**

The price of yield and the costs of different treatments were calculated as subsidized price of 2018 and 2019.

Conclusions

It is more useful to use compost (C), Nitrogen (N) and phosphorus (P) fertilizers and their combinations to get a markedly improve in soil physical and chemical properties which reflect on highest yield in incorporated with high net revenue.

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التنبؤ بالتأثير المتداخل من الكمبوست وأسمدة النتروجين والفوسفور على بعض خصائص التربة وإنتاجية محصولى القمح والذرة.

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الملخص العربي

أجريت تجربتين حقليتين على أرض طينية خلال موسمين متعاقبين، الموسم الشتوي 2018/ 2019 باستخدام نباتات القمح والموسم الصيفي 2019 باستخدام نباتات الذرة في محطة البحوث الزراعية بالجميزة، محافظة الغربية. وكان تصميم التجربة قطاعات كاملة العشوائية في ثلاث مكررات للتنبؤ بأفضل الإضافات من الكمبوست والسماد النتروجيني والفوسفوري وتأثيراتهم علي بعض خصائص التربة وإنتاجية المحاصيل، بالإضافة إلى إجراء التقييم الاقتصادي وحساب العائد الصافي بهدف تحديد أفضل معاملة اقتصاديا.

واشتملت التجربة على ثلاثة عشر معاملة لتغطية كل التوافقات المحتملة من الكمبوست والنتروجين والفوسفور بالإضافة إلى معاملة المقارنة (بدون أي إضافات). والنتائج موضحة في شكل مثلث باستخدام برنامج كمبيوتر ثلاثي العوامل.

ويمكن تلخيص النتائج المتحصل عليها كالآتي:

1- معاملة الكمبوست الفردية كانت أكثر تأثيرا على انخفاض قيم الكثافة الظاهرية وزيادة قيم كل من المسامية الكلية ونسبة المسام عن باقي المعاملات وكذلك زيادة قيم التوصيل الهيدروليكي والمحتوى الرطوبي للتربة عند الحصاد في كل المعاملات في عمقي التربة في نهاية موسمي النمو بالمقارنة بالكنترول. وقد سجلت أقصي قيمة للتوصيل الهيدروليكي عند استخدام 100% كمبوست أو 90% كمبوست + 10% نتروجين. أيضا فإن التداخلات بين (الكمبوست، النتروجين) و (الكمبوست، الفوسفور) كانت أكثر تأثيرا علي زيادة قيم التوصيل الهيدروليكي للتربة.

2- تناقصت قيم الاستهلاك المائي لكن كفاءة استخدام المياه زادت في كل المعاملات في موسمي النمو بالمقارنة بالكنترول. وقد سجلت اقل قيم الاستهلاك المائي مع معاملة الكمبوست الفردية في الموسمين.

3- أدت كل المعاملات إلي انخفاض رقم حموضة التربة وزيادة قيم كل من ملوحة التربة ومحتوى التربة من النتروجين والفوسفور والبوتاسيوم الكلى فى العمقين خلال موسمى النمو مقارنة بمعاملة الكنترول.

4- إضافة 100% من الكمبوست أعطت اعلي قيم من الكربون العضوي، حيث أن الكمبوست كان أكثر تأثيرا في زيادة الكربون العضوي عن سماد النتروجين والفوسفور حيث يأخذ الترتيب التالي: الكمبوست > النتروجين > الفوسفور. بينما اعلي قيم من نسبة الكربون إلى النتروجين سجلت في المعاملة 50% كمبوست + 50% فوسفور في الموسمين.

5- محصول حبوب القمح والذرة وخصائص النمو زادت مع كل الإضافات من الكمبوست والنتروجين والفوسفور وتداخلاتهما مقارنة بالكنترول، وقد سجلت اعلي قيم للمعاملة التي تتكون من 50% كمبوست + 50% نتروجين

6- أوضحت نتائج الدراسة أنه من المفيد استخدام الكمبوست والنتروجين والفوسفور وتداخلاتهم للحصول على تحسن واضح في الخواص الطبيعية والكيميائية في الأراضي الطينية وقد سجلت المعاملة المكونة من 50% كمبوست + 50% سماد نتروجين أعلى محصول وأعلي صافي دخل مزرعي (7636,84 جنيه / فدان) في الموسمين.

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