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Impact of organic fertilizer on some chemical properties of soil, nutrient availability and yield of the wheat-rice cropping system

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ABSTRACT
Field experiments were conducted at the farm of Agricultural Research Station, Sakha, Kafrelsheikh, Egypt, from the beginning of the 2019 winter season to the end of the 2021 summer season. It aimed to study the performance of some wheat and rice Egyptian cultivars under various organic and inorganic fertilization treatments. The interactions between fertilizer treatment and the wheat and rice cultivars were significant in all studied seasons. Masr 2 cultivar gave the highest grain yield with fertilized by NPK alone or compost +2/3NPK. Concerning the rice crop yield, the highest rice grain yield was found in the combination of Sakha 108 with the application of NPK alone. Application of compost alone or combined with chemical fertilizer reduced the soil pH significantly compared to the control after harvesting rice and wheat. Electrical conductivity showed an increasing trend with the application of NPK fertilizer. The application of rice straw compost increased the organic matter percentage. -Adding organic fertilizer increases the available nitrogen in the soil. The highest values of available soil phosphorus were recorded when 2/3 of NPK fertilizer was applied with compost. Organic materials treatments enhance available potassium in the studied seasons.
Keywords: Compost, electrical conductivity, pH, available nitrogen, phosphorus, potassium, wheat and rice cropping system

INTRODUCTION

Cereals demand is increasing with the increasing population. On the other hand, the available natural resources, such as land and water, are limited. The optimum way to overcome this problem is by using new technologies to increase cereal production per unit area. The most important cereal crops are wheat, rice, and corn. Cereal crops are important for the world population, especially Egyptian humans. Sustainable production of wheat and rice faces many challenges, including competition for resources, soil, water, climate change, labor availability, and the cost of production. The growing human population led to increased agrochemical use in agriculture to increase crop yields. The application of agrochemicals causes environmental pollution and affects human health. Barus (2019) indicated that the advantages of composted rice straw contain some macro and micronutrients such as nitrogen, potassium and phosphorus, which increase the content of chlorophyll and b. The increasing available nutrients from compost, especially potassium, increased the obstinacy of the plant, stimulated the growth of root, tolerant the stress, and enhanced the grain yield.

Elia and Boulos (2019) investigated the effect of compost and chemical fertilizer addition on improving calcareous soil properties. Results showed that the application of compost and combination treatments (compost + recommended chemical fertilizer) significantly decreased affected soil bulk density, hydraulic conductivity, EC and pH compared to the control. The results also showed that the weight of grains kg fed^{-1} increased significantly with soil compost application. Iqbal*et al.* (2019) studied the effect of various combinations of organic and inorganic fertilizers on soil properties, growth, physiology, grain yield and quality of rice. The results showed that the application of 30%poultry manure + 70 % chemical fertilizer increased the net photosynthesis rate, total biomass, grain yield and amylase content compared with the control. They added no significant difference between 30% castle manure +70 % chemical fertilizer and 30% poultry manure +70 % chemical fertilizer was observed.

Ramesh *et al.* (2019) found that the impact of integrated nutrition management (INM) procedures were examined concerning grain production, the quality characteristics of the rice before and after cooking, and hulling, milling, and head rice recovery percentages. Among the INM treatments, applying 75% of the authorized nitrogen dose and 5 t/ha of effective microorganisms (EM) compost considerably increased grain yield and improved rice grain quality. Kumar *et al.* (2019) investigated the impact of various compost rates combined with the recommended fertilizer dosage (RDF) on rice grain yield and yield components. Findings showed that applying urban compost has positive impacts. The plots treated with RDF plus 10 t/ha of urban compost had the highest grain yield, straw yield, total dry matter yield, harvest index, and water productivity. Combining the usage of chemical fertilizers and municipal compost can considerably boost rice yield. Subbaiah (2019) evaluated the impact on soil health of various organic sources like vermicompost, poultry manure, biochar, urban compost, farm yard manure, and biogas digest. According to the findings, organic manure can substitute for 25-30% of the recommended doses of inorganic fertilizers in crop production. Crop yield, quality, and soil health improved due to the integrated use of all nutrients. The cost of inorganic fertilizers was reduced when organic manures were used as a source of nutrients, and the amount of carbon in the soil improved its quality. Sharma and Dhaliwal (2019) found that substitution with 50% N of composted rice straw significantly increased the yield and biochemical properties compared with chemical fertilizers (NPK) alone in rice.

Adding rice straw compost in combination with nitrogen is more crucial for maintaining maximum wheat - rice production. It could be because soil physical properties have been altered, and the availability of plant nutrients has dramatically improved simultaneously. The work is aimed to investigate how grain yield, chemical soil properties, and nutrient availability are affected when organic and mineral fertilizers are combined in the wheat – rice cropping system.

MATERIALS AND METHODS

An experiment was conducted under a controlled system (concrete plots) at the Greenhouse of Rice Research and Training Center (31.098E, 30.945N attitude), Sakha region, Kafr El-Sheikh governorate to examine the impact of organic and nonorganic fertilizer on soil properties, growth, and yield traits of wheat - rice cropping system. The experiment was performed in the wheat-rice crop system from the wheat season in 2019/2020 up to the rice season in 2021. Soil samples were collected from 0 to 15 cm in different spots for physical and chemical analyses. The physical and chemical characteristics of the experimental soil are presented in Table (1).

Table 1. Some chemical properties of the experimental soil before planting.

Characteristics	**Value**
Texture	Clay
Organic matter (%)	1.61
Total N (ppm)	460
Available P (ppm)	13.80
Available K (ppm)	324.56
EC (dSm^{-1})	1.20
pH	8.1
Soluble Cations, $meq.L^{-1}$	
Ca^{++}	5.30
Mg^{++}	2.00
K^{+}	0.50
Na^{+}	14.80
Soluble anion, $meq.L^{-1}$	
CO_3^{--}	--
$HCO3^{-}$	3.80
Cl^{-}	15.00
So_4^{--}	1.20
Some available micro-nutrients (ppm)	
Fe^{++}	6.10
Zn^{++}	1.13
Mn^{++}	3.35

The experiment was laid out in a split-plot design in four replications, where main plots were assigned to fertilizer treatments, and sub-plots were allocated to wheat/rice varieties.

The fertilizer's treatments were

1-Compost (without any mineral fertilizer application),

2-Full recommended dose of NPK Fertilizer.

3-Compost+2/3 of NPK recommended dose of NPK Fertilizer.

4- Compost+1/3 of NPK recommended dose of NPK Fertilizer.

The studied wheat varieties were Giza 171, Masr2, Sids 14, Masr 3 and Sakha 95. meanwhile, the studied rice varieties were Sakha 101, Sakha 105, Sakha 106, Sakha 107 and Sakha 108.

NPK recommended doses are 163 kg N/ha, 36 kg P_2O_5/ha, and 50 kg K_2O/ha, respectively. The recommended doses of the organic materials are 5000 kg compost/ ha. All cultural practices were done according to each crop's agronomic package of recommendations. The plants had reached full maturity when 80% of the panicles turned yellow.

Studied characteristics were grain yield (t/ ha), N, P and K content in whole wheat /milled rice grains and soil analysis after harvesting of each crop each season. The Micro-kjeldahl apparatus extracted available nitrogen with 2.0 mg potassium chloride following Page et al. (1982). According to Cottenie et al., ammonium acetate-EDTA was used to extract potassium. Flammable photometers were used to measure potassium. The ascorbic acid method was used to measure phosphorus using a spectrophotometer (Page et al., 1982). According to Black et al. (1965), the soil's organic matter percentage (O.M. %) was measured. The chemical analysis of the finished compost is presented in Table (2).

Table 2. Some chemical analyses of the compost in the 2019-2020 and 2020-2021 growing seasons.

Season	C %	N%	C:N Ratio	P%	K%	Fe ppm	Mn ppm	Zn ppm
2019	33	1.72	19.18	0.43	0.64	489	212	40
2020	31	1.78	17.42	0.55	0.80	524	268	63

Statistical analysis:

The data were analyzed using an analysis of variance (ANOVA), and Duncan's Multiple Range Test (P 0.05) and multiple F. tests were used to compare the means of the different treatments (Duncan, 1955). CoHort Software and Costat Statistical Software were utilized for all statistical analyses.

RESULTS

Grain yield (t/ha):

Table 3 shows how fertilizer treatment affects the grain yield of Egyptian wheat and rice cultivars during wheat-rice and wheat two growing seasons. In four rice and wheat growing seasons, the findings demonstrated that applying various fertilizer treatments significantly impacted grain yield. In both seasons, wheat grain yield was highest when recommended full doses of NPK were applied alone, and there were no significant differences between this and compost +2/3NPK. In addition, rice grain yields were highest when NPK has applied alone and wheat yielded the most in both seasons.

Table 3. Grain yields t/ha of different wheat and rice cultivars as affected by fertilizer treatments

Wheat		
	2019-2020	**2020-2021**
Treatment		
Compost	6.15	6.30
NPK	6.98	7.79
Compost +2/3NPK	6.78	7.33
Compost +1/3NPK	6.47	6.64
L.S.D.0.05	0.45	0.48
Cultivar		
Giza 171	5.26	5.73
Masr2	8.11	8.75
Sids 14	6.68	6.97
Masr 3	5.81	6.22
Sakha 95	7.13	7.42
L.S.D.0.05	0.57	0.52
Interaction	*	**
Rice		
Treatment	**2019-2020**	**2020-2021**
Compost	5.65	5.13
NPK	9.13	8.62
Compost +2/3NPK	7.63	6.38
Compost +1/3NPK	6.87	5.75
L.S.D.0.05	0.55	0.57
Cultivar		
Sakha 101	8.15	7.35
Sakha 105	7.50	7.13
Sakha 106	7.23	6.45
Sakha 107	5.80	5.06
Sakha 108	8.41	8.02
L.S.D.0.05	0.56	0.57
Interaction	*	**

In both seasons, grain yield (t/ha) varied significantly among the tested cultivars. The highest grain yield were obtained from Masr 2 wheat cultivar while, Giza 171 wheat cultivar produced the lowest grain yield. Regarding rice crops, the highest rice grain yields were obtained by Sakha 108 in both seasons, respectively. While Sakha 107 rice cultivar produced the lowest grain yield values in both seasons.

The results in Tables 4 and 5 indicate that the interactions between fertilizer treatment and each of the rice and wheat cultivars were significant in all studied seasons. The main objective of the present study deals with the interaction between wheat/rice cultivars and fertilizer treatment. The highest wheat grain yield was found when Masr 2 cultivar was fertilized by either NPK alone or compost +2/3NPK in the 2019-2020 and 2020-2021 seasons. The lowest wheat grain yield was found in the interaction between Giza 171 and compost in both seasons. Concerning the rice crop yield, the highest rice grain yield was found in the combination of Sakha 108 with the application of NPK alone in both seasons while, the lowest rice grain yield was found in the combination of Sakha 107 and compost application alone in 2020 and 2021.

Table 4.. Grain yield t/ha as affected by the interaction between wheat cultivar and fertilizer treatment.

Factor	Wheat cultivar				
	Giza 171	Masr 2	Sids 14	Masr3	Sakha 95
2019-2020 seasons					
Compost	4.92	7.60	6.27	5.49	6.50
NPK	5.57	8.51	7.05	6.13	7.64
Compost +2/3NPK	5.33	8.49	6.81	5.91	7.38
Compost +1/3NPK	5.19	7.84	6.59	5.71	7.01
LSD 0.05	**0.71**				
2020-2021 seasons					
Compost	5.22	7.73	6.38	5.62	6.57
NPK	6.34	9.61	7.63	7.05	8.32
Compost +2/3NPK	5.89	9.65	7.09	6.43	7.60
Compost +1/3NPK	5.45	8.01	6.75	5.80	7.17
LSD 0.05	**0.79**				

Table 5. Grain yield t/ha as affected by the interaction between rice cultivars and fertilizer treatments.

Factor	Rice cultivar				
	Sakha 101	Sakha 105	Sakha 106	Sakha 107	Sakha 108
2020 season					
Compost	6.18	5.70	5.15	4.75	6.49
NPK	9.95	9.34	9.11	7.01	10.24
Compost +2/3NPK	8.08	7.84	7.74	6.08	8.39
Compost +1/3NPK	7.39	7.13	6.93	5.37	7.52
LSD 0.05	0.59				
2021 season					
Compost	5.54	5.35	4.86	4.28	5.61
NPK	9.07	9.04	8.75	6.32	9.91
Compost +2/3NPK	6.64	6.49	6.41	5.10	7.28
Compost +1/3NPK	6.17	5.95	5.77	4.55	6.29
LSD 0.05	**0.64**				

Chemical analysis of grains:

Nitrogen content in grain (%):

Data in Tables 6 and 7 show that the nitrogen content in whole wheat grains was increased by applying NPK alone, followed by compost +2/3NPK, without any significant differences between both treatments. The lowest value was recorded when wheat plants were fertilized with only compost in the two seasons.

Table 6. NPK concentrations in whole wheat grains of different wheat cultivars as affected by fertilizer treatments

	N%		P%		K%	
	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021
Treatment						
Compost	1.0435	1.1243	0.2740	0.2744	0.3177	0.3185
NPK	1.9126	1.9846	0.4810	0.4981	0.3485	0.3907
Compost +2/3NPK	1.8506	1.9225	0.4619	0.4795	0.3405	0.3610
Compost +1/3NPK	1.4426	1.5228	0.3796	0.4007	0.3285	0.3326
L.S.D.0.05	0.0479	0.0799	0.0127	0.0194	0.0431	0.0524
Cultivar						
Giza 171	1.3394	1.4019	0.3517	0.3689	0.2707	0.2915
Masr2	1.5075	1.5992	0.4016	0.4248	0.4105	0.4314
Sids 14	1.8852	1.9944	0.4320	0.4307	0.3360	0.3479
Masr3	1.6864	1.7820	0.4437	0.4689	0.2915	0.3119
Sakha 95	1.3933	1.4151	0.3667	0.3723	0.3603	0.3708
L.S.D.0.05	0.0315	0.0395	0.0788	0.0102	0.0362	0.0602
Interaction	**	**	**	**	**	*

Table 7. NPK concentrations in milled rice grains of different rice cultivars as affected by fertilizer treatments

	N %		P %		K%	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Treatment						
Compost	1.1822	1.1196	0.1390	0.1366	0.2833	0.2798
NPK	1.2349	1.1784	0.1955	0.1943	0.3166	0.3146
Compost +2/3NPK	1.2298	1.1699	0.1946	0.1927	0.3156	0.3129
Compost +1/3NPK	1.2054	1.1474	0.1881	0.1865	0.3038	0.3016
L.S.D.0.05	0.0692	0.0529	0.0363	0.0209	0.0418	0.0246
Cultivar						
Sakha 101	1.1527	1.0959	0.2083	0.2049	0.3229	0.3185
Sakha 105	1.2253	1.1658	0.1658	0.1643	0.2673	0.2653
Sakha 106	1.2041	1.1443	0.1582	0.1559	0.2599	0.2568
Sakha 107	1.2059	1.1470	0.1555	0.1553	0.3504	0.3507
Sakha 108	1.2773	1.2159	0.2083	0.2062	0.3232	0.3197
L.S.D.0.05	0.0770	0.0614	0.0216	0.0116	0.0221	0.0121
Interaction	**	**	**	*	**	*

Nitrogen content in rice grains was affected by fertilizers treatments in the first and second seasons. Data also indicated that nitrogen content (%) in milled rice grains was higher when NPK has applied alone, which was at par with compost +2/3NPK in both seasons respectively. The lowest value was recorded with the solo application of compost. Data in the same tables (6 and 7) indicated that the Sids 14 wheat cultivar gave the highest nitrogen content in the 2019-2020 and 2020-2021seasons, while Giza 171 wheat cultivar recorded the lowest one in the two seasons. Meanwhile, the tested rice cultivars differed significantly in nitrogen content in milled grains in the two seasons. Sakha 108 gave the highest nitrogen content in both seasons, , while Sakha 101 rice cultivar recorded the lowest in the two seasons .

Data in Tables 8 and 9 show the effect of the interaction between wheat/rice cultivar and fertilizer treatment on nitrogen content in both seasons. For wheat, the interaction between Sids 14+ NPK gave the highest nitrogen content, while Sakha95+ compost gave the lower nitrogen content in the two seasons. As for rice, the highest values of nitrogen content were found in the interaction between Sakha 108 + NPK followed by Sakha 108 + compost +2/3NPK in the 2019 and 2020 seasons. On the other hand, the plants of Sakha 101 that received only organic materials recorded the lowest content of nitrogen in milled rice grains in both seasons.

Table 8. N% in whole wheat grains as affected by the interaction between wheat cultivar and fertilizer treatment.

Factor	**Wheat cultivar**				
	Giza 171	**Masr 2**	**Sids 14**	**Masr3**	**Sakha 95**
2019-2020					
Compost	0.9105	0.8910	1.3565	1.2210	0.8385
NPK	1.6305	1.8889	2.2609	2.0079	1.7749
Compost +2/3NPK	1.5701	1.8784	2.1668	1.9367	1.7010
Compost +1/3NPK	1.2464	1.3718	1.7562	1.5797	1.2589
LSD 0.05	**0.3257**				
2020-2021					
Compost	0.9600	1.0125	1.4665	1.3185	0.8640
NPK	1.7062	1.9431	2.3671	2.1078	1.7985
Compost +2/3NPK	1.6412	1.9344	2.2819	2.0320	1.7230
Compost +1/3NPK	1.3003	1.5067	1.8623	1.6697	1.2748
LSD 0.05	**0.4191**				

Table 9. N% in milled rice grains as affected by the interaction between rice cultivar and fertilizer treatment.

Factor	Rice cultivar				
	Sakha 101	Sakha 105	Sakha 106	Sakha 107	Sakha 108
2020					
Compost	1.1227	1.1957	1.1694	1.1788	1.2440
NPK	1.1738	1.2446	1.2280	1.2248	1.3033
Compost +2/3NPK	1.1701	1.2404	1.2238	1.2181	1.2966
Compost +1/3NPK	1.1441	1.2204	1.1953	1.2017	1.2652
LSD 0.05	**0.0151**				
2021					
Compost	1.0523	1.1417	1.1169	1.1200	1.1668
NPK	1.1243	1.1824	1.1699	1.1674	1.2481
Compost +2/3NPK	1.1157	1.1796	1.1571	1.1592	1.2377
Compost +1/3NPK	1.0916	1.1594	1.1334	1.1415	1.2113
LSD 0.05	**0.0117**				

Phosphorus content in grain (%):

Data in Tables 6 and 7 show that fertilizer application to Egyptian wheat and rice cultivars significantly increased phosphorus content. In wheat, the application of NPK alone gave the highest phosphorus content in whole wheat grains in the two seasons respectively. The application of compost alone gave the lowest phosphorus content in whole wheat grains in both seasons. Moreover, applying a total dose of NPK fertilizer without compost recorded the highest percentage of phosphorus in milled rice grains in 2020 and 2021. Moreover, the lowest phosphorus content was observed with the application of compost without any application of NPK in 2020 and 2021, respectively. Phosphorus content in Egyptian wheat and rice cultivars during the 2019-2020 and 2020-2021 seasons are presented in Tables (6 and 7). Data indicated that wheat cultivar Masr3 gave the highest phosphorus content in whole wheat grains, while the Giza171 wheat cultivar recorded the lowest in the two seasons. The tested rice cultivars have differed significantly in phosphorus content in milled rice grains in the two seasons. Sakha 108 gave the highest phosphorus content, followed by Sakha 101 in the two seasons. While Sakha 107 rice cultivar recorded the lowest range in both seasons.

Data in Tables 10 and 11 show that adding a full dose of NPK fertilizer significantly increased phosphorus contents in both whole wheat and milled rice grains. The combination of wheat cultivar Masr3 with NPK gave the highest phosphorus content in whole wheat grains, followed by Masr3+compost+2/3NPK. In contrast, the interaction between Sakha 95+compost gave the lower phosphorus content in the two seasons. The highest values of phosphorus contents in milled rice grains were found in the interaction between Sakha 108+NPK followed by Sakha 108+ Compost +2/3NPK in the two seasons. While the plots that did not receive any NPK (compost only) recorded the lowest phosphorus content. Thus, the interaction between Sakha 106 + compost recorded the lowest values of phosphorus content in milled rice grains in 2020 and 2021.

Table 10. P % in whole wheat grains as affected by the interaction between wheat cultivars and fertilizer treatment.

Factor	Wheat cultivar				
	Giza 171	Masr 2	Sids 14	Masr3	Sakha 95
2019-2020					
Compost	0.2367	0.2345	0.3569	0.3213	0.2206
NPK	0.4291	0.5164	0.4641	0.5284	0.4671
Compost +2/3NPK	0.4132	0.4943	0.4448	0.5096	0.4476
Compost +1/3NPK	0.3280	0.3610	0.4622	0.4157	0.3313
LSD 0.05	**0.0818**				
2020-2021					
Compost	0.2526	0.2665	0.2784	0.3469	0.2274
NPK	0.4490	0.5274	0.4858	0.5546	0.4733
Compost +2/3NPK	0.4319	0.5090	0.4683	0.5347	0.4534
Compost +1/3NPK	0.3420	0.3965	0.4900	0.4394	0.3355
LSD 0.05	**0.1082**				

Table 11. P % in milled rice grains as affected by the interaction between rice cultivars and fertilizer treatment.

Factor	Rice cultivar				
	Sakha 101	**Sakha 105**	**Sakha 106**	**Sakha 107**	**Sakha 108**
			2020		
Compost	0.1674	0.1265	0.1166	0.1172	0.1674
NPK	0.2254	0.1808	0.1751	0.1704	0.2261
Compost +2/3NPK	0.2251	0.1803	0.1745	0.1688	0.2246
Compost +1/3NPK	0.2172	0.1758	0.1664	0.1657	0.2152
LSD 0.05			**0.0225**		
			2021		
Compost	0.1610	0.1260	0.1159	0.1179	0.1619
NPK	0.2229	0.1787	0.1731	0.1714	0.2252
Compost +2/3NPK	0.2215	0.1785	0.1708	0.1695	0.2229
Compost +1/3NPK	0.2141	0.1738	0.1637	0.1662	0.2145
LSD 0.05			**0.0122**		

Potassium content in grain (%):

The effect of fertilizer treatment on potassium content in whole wheat grains and milled rice grains of different cultivars is presented in Tables 6 and 7. Application of NPK treatment gave the highest potassium content in whole wheat grains in the two seasons, while compost application alone gave the lowest values in the two seasons. For rice, the application of either NPK alone or combined with organic materials resulted in a significant increase in potassium content in milled rice grains compared with the application of organic material alone. Applying a full dose of NPK was superior to other treatments regarding potassium content in milled rice grains. Moreover, the lowest potassium content in milled rice grains was observed with organic material alone in both seasons.

Data in Tables 6 and 7 indicate that Masr3 gave the highest potassium content in whole wheat grains, while the Giza171 wheat cultivar recorded the lowest in the two seasons, respectively. Meanwhile, the tested rice cultivars differed significantly in potassium content in milled rice grains in the two seasons. Sakha 107 rice cultivar recorded the highest potassium content, while Sakha 106 rice cultivar recorded the lowest in the two seasons.

The interaction effect between wheat/rice cultivar and fertilizer treatment rates in regard to the potassium content in both seasons is listed in Tables 12 and 13.

Table 12. K% in whole wheat grains as affected by the interaction between wheat cultivars and fertilizer treatments.

Factor	Wheat cultivar				
	Giza 171	**Masr 2**	**Sids 14**	**Masr 3**	**Sakha 95**
			2019-2020		
Compost	0.2627	0.3846	0.3205	0.2783	0.3363
NPK	0.2785	0.4229	0.3525	0.3064	0.3820
Compost +2/3NPK	0.2681	0.4292	0.3407	0.2955	0.3692
Compost +1/3NPK	0.2676	0.4053	0.3303	0.2856	0.3537
LSD 0.05			**0.0899**		
			2020-2021		
Compost	0.2723	0.3953	0.3175	0.2786	0.3286
NPK	0.3185	0.4446	0.3818	0.3526	0.4160
Compost +2/3NPK	0.2989	0.4852	0.3547	0.3265	0.3799
Compost +1/3NPK	0.2766	0.4005	0.3376	0.2898	0.3585
LSD 0.05			**0.1159**		

Table 13.K% in milled rice grains as affected by the interaction between rice cultivars and fertilizer treatment.

Factor	Rice cultivar				
	Sakha 101	**Sakha 105**	**Sakha 106**	**Sakha 107**	**Sakha 108**
2020					
Compost	0.3001	0.2466	0.2370	0.3315	0.3009
NPK	0.3352	0.2777	0.2724	0.3601	0.3369
Compost +2/3NPK	0.3348	0.2772	0.2718	0.3586	0.3353
Compost +1/3NPK	0.3216	0.2676	0.2585	0.3513	0.3199
LSD 0.05	**0.0233**				
2021					
Compost	0.2935	0.2462	0.2358	0.3319	0.2913
NPK	0.3321	0.2749	0.2694	0.3606	0.3356
Compost +2/3NPK	0.3306	0.2748	0.2671	0.3587	0.3329
Compost +1/3NPK	0.3177	0.2651	0.2549	0.3514	0.3190
LSD 0.05	**0.0128**				

Soil pH :

Applying compost alone and in combination with chemical fertilizer reduced the soil pH significantly compared to control and chemical fertilizer after harvesting rice and wheat (Fig 1). Effects on pH were similar with compost alone or combined with fertilizer at the same application level. Numerical values were a bit lower after wheat in the same treatments indicating a consistently positive impact of compost on this soil parameter.

Electrical conductivity EC:

Electrical conductivity showed an increasing trend with the application of NPK fertilizer to the soil. Differences among treatments were significant. The highest EC was found with the application of NPK alone, followed by 2/3 of NPK + compost. The increase in EC was more pronounced after wheat as compared to rice. Electrical conductivity is a soil parameter that indirectly indicates the total concentration of soluble salts and is a direct measurement of salinity. A general increase in EC of normal soil was observed after rice and wheat crops by application of sole NPK or in combination with organic fertilizer. Although the EC of the soil increased in different treatments, the actual values did not cross the critical limit of 2.0 dS m-1. Such similar results have been reported in the literature.

Organic matter % (OM):

Organic matter after harvest was found to be significantly affected by the application of fertilizers treatments. Generally, applications of composted rice straw increased organic matter percentage

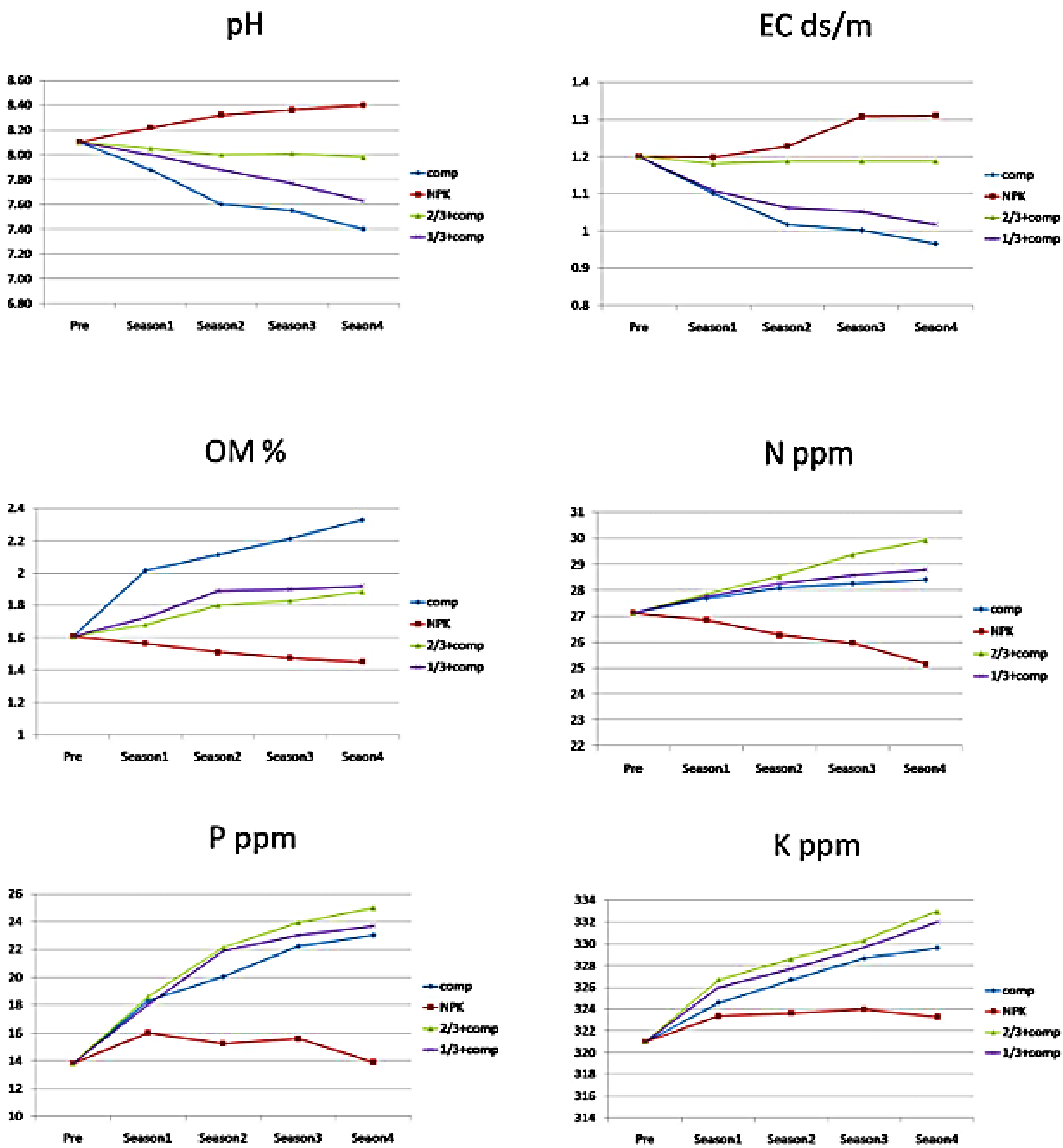

Fig 1. Soil characteristics pattern during the studied growing seasons.

Available nitrogen N %:

Available nitrogen in the soil increased with applying organic fertilizer (compost). There was a higher concentration of available nitrogen in plots that received compost application in addition to receiving 2/3 of the NPK fertilizer (the full dose of NPK). The conversion of organic forms of nitrogen into inorganic nitrogen as ammonium N (NH4) results in the release of nitrogen from compost, also known as mineralization. Throughout the seasons being examined, the total amount of nitrogen available in the soil decreased when NPK mineral fertilizers were applied in place of organic fertilizers. NPK uptake may have increased with plant age, resulting in increased nitrogen concentration in the soil, which could explain this phenomenon.

Available phosphorus P %:

Available phosphorus was affected significantly by the application of different fertilizers treatments**.** It is worth mentioning that the highest values of available soil phosphorus were recorded when 2/3 of NPK fertilizer was applied with compost. While the lowest values of soil phosphorus availability were observed in plots that received NPK alone without compost application. Phosphorus is minimally available to plants because it is usually fixed in the insoluble structure of calcium–phosphorus.

Available potassium K %:

In the seasons that were investigated, it was discovered that organic material treatments had a significant impact on the available potassium. Utilizing 1/3 NPK and compost resulted in the highest mean values. In contrast, the lowest mean values were obtained without using organic materials (NPK alone).

DISCUSSION

Under an intensive cropping system, high use of fertilizer can cause a deficiency of macro and micronutrients. Presently farmers are using only NPK, that too in an imbalance ratio and there is no attention paid to secondary and micronutrients. Long-term fertility experiments, however, are a good indicator for monitoring soil quality and crop productivity and are of vital importance in nutrient management as well as soil health.

NPK application's beneficial impact on yield may be attributable to its actions to enhance growth as well as yield component traits and, ultimately, the grain yield of wheat and rice. A similar trend was found by Metwally*et al.* (2015) who found that NPK application resulted in increasing photosynthetic efficiency as well as translocation assimilates, which reflected the increase in most grain yield components. Significant interactions existed between fertilizer treatment and rice and wheat cultivars in all studied seasons. It could be attributed to the combination of compost with chemical fertilizer enhanced the biomass and grain yield of rice and wheat (Sudhakar, 2018), who found the beneficial effects of integrated use of organic and mineral fertilizers on rice grain yield.

Nitrogen content in Egyptian wheat and rice grains was increased by applying NPK and compost +2/3NPK without any significant differences between both treatments. It could be attributed to N fertilizer increasing the dry matter production of grain, straw, and roots significantly. Nitrogen uptake also increased linearly in response to an increase in the rate of N. The application of nitrogen fertilizer in the soil, whether added individually or combined with compost recovery of soil N due to the application of fertilizer N, is relatively common and is believed to be due to microbial-induced isotopic exchange between the applied N and the native soil organic N (Naeem 2006), Zadeh (2014), Krishna *et al.* (2018). Also, there was a great variation among the rice cultivars in nitrogen content in milled grains. It might be due to the genetic diversity of rice varieties in the mineral contents of rice grains (Singh and Singh, 2019).

Applying a full dose of NPK fertilizer significantly recorded the highest content of P in both whole wheat and milled rice grains. The addition of NPK fertilizers enhanced plant uptake of phosphorus. There is evidence that NPK promotes phosphorus uptake by the plant: (1) increasing top and root growth, (2) altering plant metabolism (3) increasing solubility and availability of phosphorus. Zadeh (2014) reported that adding NPK fertilizer enhanced plant phosphorus uptake. There is evidence that nitrogen promotes phosphorus uptake by plants increasing top and root growth, altering plant metabolism, and increasing solubility and availability of phosphorus, Hashem (2010) confirmed these results.

K content in wheat and milled rice grains increased with NPK alone or integrated with compost. It might be because mixing compost with chemical fertilizers increases the potassium available in the soil and, consequently, increases the K contents of milled rice grain (Howida B. El-Habet, 2014).

Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. Soil pH is the single soil characteristic which elucidates an overall picture of the medium for plant growth, including nutrient supply trend, the fate of added nutrients, salinity/sodicity status and soil aeration, soil mineralogy, and ultimate weather conditions of the region. Soil pH is significantly reduced with compost alone or integrated with chemical fertilizer. A similar trend was found by Sarwar *et al.* (2008) also observed a decrease in soil pH after using organic materials. The production of organic acids (amino acid, glycine, cystein and humic acid) during mineralization (amminization and ammonification) of organic materials by heterotrophs and nitrification by autotrophs would have caused this decrease in soil pH.

There are indications of declining productivity due to depletion in soil organic matter, over-mining of nutrient reserves, and loss of nutrients, as evolved through long-term fertilizer experiments conducted in different parts of the country. Presently, the major concern in agriculture is to arrest any further decline in productivity and soil quality. The organic matter percentage increased with the addition of composted rice straw. These results are in harmony with Naeem (2006), who reported that organic matter was increased with the application of composted rice straw than with no compost. Gajalakshmi and Abbasi (2008), Metwally (2015) , Singh *et al.* (2017) and Subbaiah (2019)reported that the applications of compost enhance the organic matter of the soil. Organic material application leads to enhanced enrichment of organic nitrogen in the soil (Gajalaskshmi and Abbasi, 2008) who reported that rice straw incorporation or organic manure application significantly increased NH_4 concentration in rice soil.

The addition of compost in addition to artificial fertilizer was found to have a considerable impact on the amount of available phosphorus and potassium. The increased soil phosphorus concentration observed after compost insertion points to an appropriate release of phosphorus to satisfy plant demand . According to Naeem (2006), the higher increase in soil solution Fe^{3+} and Mn^{2+} due to compost's release of K^+ from exchange complexes may also contribute to the higher availability of K. Gajalaksjmi and Abbasi (2008) reported that compost addition can affect soil fertility by altering the physical, chemical, and biological properties of the soil. The chemical changes include the enhancement of the nutrients content of the soil.

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تأثير الأسمدة العضوية على بعض خواص التربة الكيمائية ومدى تيسير المغذيات والإنتاجية في نظام زراعة القمح والأرز

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أجريت هذه الدراسه فى المزرعه البحثيه التابعه لمركز البحوث والتدريب فى الارز ، معهد المحاصيل الحقليه، جمهوريه مصر العربيه، من بداية الموسم الشتوي 2019-2020 وحتى نهاية الموسم الصيفي بهدف دراسه أداء بعض أصناف القمح والارز المصريه تحت معاملات مختلفه من التسميد العضوى وغير العضوى . التفاعل بين معاملات التسميد كلا من أصناف القمح والارز كانت معنويه فى كل مواسم الدراسه وكان أعلى محصول حبوب وجد مع صنف مصر 2 عند التسميد بى NPK أو التسميد بالكمبوست + NPK 3/2 وفيما يتعلق بمحصول الارز كان أعلى محصول حبوب وجد مع صنف سخا 108 عند التسميد بى NPK منفردا. أظهرت النتائج أيضا أن إضافه الكمبوست منفردا أو مع الاسمده المعدنيه أدى إلى تقليل قيم PH فى التربه معنويا بعد الحصاد مقارنه بالكنترول فى الارز والقمح. أيضا أوضحت النتائج أن قيم التوصيل الكهربائى فى التربه أرتفعت عند إضافه الأسمده المعدنيه NPK . كما أوضحت النتائج أن إضافه كمبوست قش الأرز قد أدى لزياده قيمه الماده العضويه فى التربه وأيضا قيم النتروجين الميسر. وجد أن أعلى قيم للفسفور الميسر فى التربه قد سجلت عند إضافه NPK 3/2 + الكمبوست. أيضا زاد البوتاسيوم الميسر فى التربه عند إضافه الأسمده العضويه خلال مواسم الدراسه .

الكلمات المفتاحية: الكومبوست ، التوصيل الكهربائي ، درجة الحموضة ، النيتروجين المتاح ، والفوسفور المتاح، والبوتاسيوم المتاح، نظام زراعة الأرز والقمح