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Effect of Compost and Nano-Hydroxyapatite on Phosphorus Nutrition and some Properties of Calcareous Soil

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ABSTRACT

Cultivation of calcareous soils faces many difficulties due to its properties, as it lacks organic matter, as well as low availability of nutrients, especially phosphorous. This study, using two cereal crops (wheat and barley) to study the effect of compost as a source of organic matter and nano- hydroxyapatite as a source of phosphorus onsome properties of calcareous soil and P content in plants. The main plots were compost (C) with three doses C_0 (without C), C_1 (12 ton/ha) and C_2 (24 ton/ha), the sub plots were different sources of phosphorous [the traditional P $CaH_6O_8P_2$ (S_0) and nano-hydroxyapatite (nHAP) with two rates of S_1 (1.5 g/L) and S_2 (3 g/L)]. The nano-hydroxyapatite is characterized by X-ray powder diffraction (X-ray), scanning electron microscopy (SEM). Obtained results stated that the biological yield, grain and straw of both wheat and barley were significantly increased with treatments as compared to C_0 and S_0, especially with C_2 and S_2. In addition, there is a positive trend between treatments rate and P contentin straw and grain of both crops, the maximum increase was observed with C_2 and S_2.Also, the application of compost led to a change in soil chemical properties, pH wasdecreased at treatments applied and such decreases were proportional to treatments concentration increase. An opposite trend was observed with organic matter (OM) and available phosphorus. In addition, there is a positive and highly significant correlation between grain yield with P content in plants.

Keywords: Calcareous soil; Compost; Nano-hydroxyapatite**;** Wheat; Barley**.**

INTRODUCTION

In Egypt, the calcareous soilwas estimated at 0.273 million hectares (Abou Hussien et al.,2020). It represents one-third of the worlds and about 25-30% of the total area of Egypt according to the estimation of the Ministry of Agriculture (Taalab et al.,2019). The northwest coastal region (about 1.214 million hectares of calcareous soil) provides great potential for soil reclamation and development to help solve the shortage in food production taking into account the available rainfall in that area (Taalab et al.,2019). It contains from 1% to over 25% $CaCO_3$(w/w), with a pH ranging from 7.6 to 8.4(Abou Hussien et al.,2020).

Calcareous soil is facing many challenges, ashigh infiltration rate,deep percolation, low water holding capacity, low CEC, low clay content and organic matter, poor structure, surface crusting and cracking, loss of nutrients via leaching, high pH, loss of nitrogen (N) fertilizers, low availability of micronutrients, low availability of nutrients particularly phosphorous (P) and imbalance between nutritional such as K, Mg and Ca (FAO, 2016; Aboukila et al.,2018).Calcium carbonate deposits are concentrated in the layers be very solid and non-permeable to water. The cemented condition impedes root development in subsoil layer. Calcium carbonate presence affects directly or indirectly the availability of N, P, Mg, K, Zn, Mn, Cu and Fe(Wahba et al., 2019). The availability of phosphorous is usually restricted in calcareous soils. The phosphate reacts with calcium to form compounds of phosphate with limited solubility (Mortvedt et al.,1999).

The calcareous soil lacksorganic material necessary for plant growth.It is required to improve the nutritional management of cultivation of crops successfully in the soil of calcareousby the addition of organic amendments. The organic amendments improve the physical and chemical properties of soiland increase soil fertility (Getinet, 2016).The application of compost to calcareous soil increases the retained soil water, which improves water holding capacity and available water (Burgin and Groffman, 2012; Vengadaramana and Jashothan, 2012).The Compost provides available nutrients for uptake of plant and enhances microbial activity and carbon dioxide production, which decreasing pH of calcareous soil leads to nutrient availability in soil.Aboukilaet al.,(2018)found that the availableN, P and K increase by using compost in calcareous soil.Compost increased available micronutrients (Zn, Cu, Mn and Fe) in soil(Bhanooduth, 2006).

Phosphorus is one of the most important elements that plants require for growth.Phosphorous plays a vital role in determining the final yield.Phosphorous is part of the genetic material RNA and DNA. It is known as an "activator" because it helps transfer and store energy during photosynthesis (Bieleski and Ferguson, 1983).

Nano-fertilizers can provide a new approach and opportunity To reduce environmental pollution fromthe excessive use of mineral fertilizers (Chhipa 2017)and increase crop production (Doaa and Dalal, 2021).Nano-hydroxyapatite is a promising strategy to raise the use efficiency of phosphorous fertilizers (Mehmet et al., 2018). Nano-hydroxyapatite increases the biomass of plants (Doaa.

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and Khaled 2021), level of vitamin C antioxidant enzymes and chlorophyll (Li and Huang, 2014).

This study aimed to evaluate the possibility of using compost to increase soil fertility, phosphorous (P) availability and crop growth in calcareous soil. As well as, studying the efficiency used of nano phosphorus materials (nano-hydroxyapatite) in low amounts can compensate for the plant needed from P during the season compared to the traditional phosphorous source. Thus, preventing the restriction of phosphorous availability in calcareous soils

MATERIALS & METHODS

1. Synthesis of hydroxyapatite nanoparticles

The method used to the synthesis of nano-hydroxyapatite in which, 1M of $CaCO_3$ solved in 50 ml distilled water add to 0.6M of H_2PO_4.The mixture was subjected to ultrasonic irradiation under a specific condition (70% amplitude, 0.5 cycles for 2h) until a white precipitate was obtained (Doaa et al., 2020).

2. Characterization of Nano

X-ray diffraction (XRD): Model D8 discovers manufactured by Bruker Instruments Company. The USA.XRD chart of nano-hydroxyapatite shows the characteristic peaks of Nano-hydroxyapatite Figure (1). Scanning electron microscopy (SEM). Model JSM-IT200 Series. SEM shows the semi-spherical shape ofNano-hydroxyapatite with about 27 nm size Figure (2).

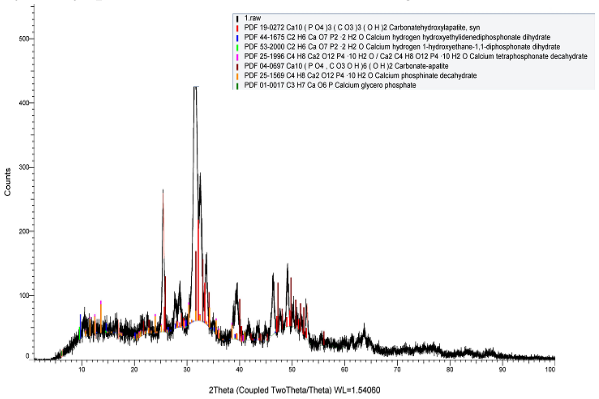

Figure 1. XRD pattern of nano-hydroxyapatite.

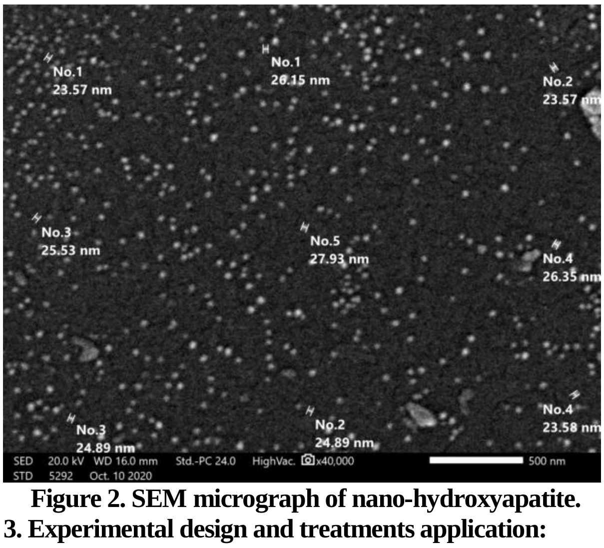

Figure 2. SEM micrograph of nano-hydroxyapatite.

3. Experimental design and treatments application:

Trial experiments were conducted in the winter season (2020) in Agriculture research station, Nubaria, Behaira Governorate, using two cereal crops (wheat and barley) to study the effect of compost as a source of organic matter and nano hydroxyapatite as a source of phosphorus fertilizer onsome properties of calcareous soil and, phosphorus content in plants. The study area located between longitudes 30°20'19'' & 30°26' 50''E and latitudes 30° 31'44'' & 30°36'44''N. Some chemical and physicalcharacteristics of the studied soil were recorded in(Table 1). Analysis of compost used in the experiments was as follows: EC 2.4 dSm^{-1} (1:5, water extract),pH 7.98 (1: 2.5), OM 50.9 %, total N, P and K(1.66, 0.56and 3 %), respectively.

Table 1. Calcareous soil characterization before treatment applications.

Soil property	Value	Soil property	Value
Particle size distribution (%)		Anion and cation meq L^{-1}	
Sandy	66.7	HCO_3^-	7.04
Clay	17.1		
Silt	16.2	Cl^-	8.10
Texture class	Sandy loam		
pH (1:2.5 soil: water suspension)	8.20	SO_4^{--}	10.90
EC in soil past (dSm^{-1})	2.31	Ca^{++}	8.64
O.M %	1.34	Mg^{++}	8.02
$CaCO_3$ %	22.9	Na^+	8.80
Available P (mg/kg)	3.2	K^+	0.55

The experiment treatments were arranged in a split plot design with three replicates. The main plots were organic amendment as compost (C) with three doses C_0 (without C), C_1 (12 ton/ha) and C_2 (24 ton/ha). The sub plots were fertilized with the traditional phosphorous source $CaH_6O_8P_2$ (calcium superphosphate) 480 kg/ha (S_0) according to the recommendations of the Egyptian Ministry of Agriculture and, nano- hydroxyapatite (nHAP) with two rates S_1 (1.5 g/L) and S_2 (3 g/L) as a foliar application.

The area of the experimental plot was 1.2 m× 3.5 m(4.2 m^2) where each plot was surrounded by a wide border (1 meter). The Compost was thoroughly mixed with 0 - 20 cm of the surface soil layer before sowing. Wheat (*Triticum aestivum*)cultivar (Giza 171) and barley (*Hordeum vulgare*) cultivar (Giza 123) were sown in the winter season on15 November 2020. The traditional phosphorous sourcewas thoroughly mixed with the surface soil layer before sowing. While nano-hydroxyapatite was sprayed three timeson the plants after 30, 65, and 85 days after wheat and barleygrow. Applied fertilizers at a rate of 120 kg K_2O/ha (potassium sulfate 48% K_2O) were added before the flowering stage as well as addition recommended dose of nitrogen (240 kg N/ha in wheat and 145kg N/ha in barley) in two equal doses, 4 and 10 weeks after complete germination. At maturity, plants were harvested, production recorded and prepared for analysis. After harvesting, soil samples (0 - 20 cm and 20 - 40 cm) were taken to determine some chemical properties of the soil such as (pH, EC, OM, $CaCO_3$,and available P).

4. Soil analysis:

After plant harvesting, surface (0-20 cm) and subsurface (20-40 cm) soil samples were collected separately from each experimental unit, air-dried, ground sieved through 2 mm sieve and analysis. Soil pH was measured potentiometrically with glass electrode in a mixture of soil: water at ratio of 1:2.5.EC in soil past (dSm^{-1}) was determined by using EC meter,$CaCO_3$ (%) was measured using calcimeter and diliuted HCl according to the methods described by Cottenie et al. (1982) andPage et al (1982). Available P was measured spectrophotometrically after its extraction from the soil with a $NaHCO_3$ 0.5 M solution at pH 8.5 (Olsen and Sommers, 1982), and soil organic C (SOC) was determined by the humid oxidation method and Walkley and Black (1974) titration.Organic matter (OM) was calculated(OM

= SOC * 1.724) based on the assumption that organic matter contains 58% organic carbon.

5. Plant sample preparation and analysis:

Plant in each plot was harvested to determine the yield components (biological yield, grain and straw yield), and the yield was calculated and expressed on a dry matter basis. The plant sample was oven-drying at 70 °C 48 h to record the dry weight. The oven-dried samples (grain and straw) of wheat and barley plants were finely grinded and digested with H_2SO_4–H_2O_2 according to the method described by Chapman and Pratt (1961)to determine the P content in the digesting solution using a spectrophotometer.

6. Statistical analysis:

The obtained data of both soil and plant were statistically analyzed according to Snedecor and Cochran (1980). The significant differences among means were tested using the least significant differences (L.S.D.) at 5 % level of significant error. Simple person correlations were done among all traits using excel.

RESULTS AND DISCUSSION

Results:

1. Impact of treatments application as a soilconditioner on chemical properties of calcareous soil.

The obtained data in Tables (2&3)indicated that compost treatments had a significant effect on the chemical properties of calcareous soil. The contrast of these different sources of phosphorous and interaction between compost and different sources of phosphorous had nosignificance on the chemical properties of calcareous soilwith wheat and barley plant in both soil depths.

Soil reaction (pH)

About the effect of compost as a soil conditioner on pH values of soil cultivated with the wheat plant after harvest, data in Tables (2&3) clear that all mean values were generally slightly decreased as compared to control. The addition of compost at the rate of (24 ton/ha) gave a higher reduction in soil pH followed by compost at the rate of (12 ton/ha) whereas the maximum reduction in surface soil reached 8.15 and 8.10 in the case of C_2 treatment followed by 8.17 and 8.12 with C_1 as compared to 8.21 and 8.15 in the control treatment (C_0) of both soil depths, respectivelywith the wheat plant. The same trend was observed in soil cultivated with barley plantsTables (3). The maximum reduction in surface soil reach 8.15 and 8.13 in the case of (C_2) treatment followed by 8.19 and 8.14 with C_1 as compared to 8.20 and 8.18 in the control treatment (C_0) of both soil depths, respectively.

Electrical conductivity (EC)

Data presented in Tables (2&3) showed the effect of different treatments on the concentration of salt in the soil (EC).Concerningthe individualapplication of compost as an organic soil conditioner obtained results reveal that all mean values of EC were increasedwith compost at the rate of addition (C_1& C_2) as compared to the control treatment (C_0). The maximum increase in EC reach 2.63 and 2.61 for C_2 compared to 2.39 and 2.56 for C_0 in soil cultivated with the wheat plant while reach to 2.65 and 2.63 for C_2 compared to 2.37and 2.50 for C0 in soil cultivated with barley plant in both soil depths respectively.On the other hand, individualapplication of phosphorous with different concentrationswas hadn't significant effect on EC in soil cultivated with wheat or barley plant.

Table 2. Effect of different application rates on chemical properties of calcareous soil with two depths after wheat harvested.

Treatments		Wheat									
		0-20 cm					20-40 cm				
		pH	EC dS/m	OM %	P available mg/kg	$CaCO_3$%	pH	EC dS/m	OM %	P available mg/kg	$CaCO_3$%
Compost means	C_0	8.21	2.39	1.51	3.6	22.2	8.15	2.56	1.64	2.3	22.9
	C_1	8.17	2.57	1.68	4.7	21.9	8.12	2.58	1.79	2.3	22.1
	C_2	8.15	2.63	1.81	5.6	21.4	8.10	2.61	1.80	3.1	22.1
phosphorous mean	S_0	8.18	2.54	1.67	5.0	21.8	8.10	2.59	1.74	2.6	22.0
	S_1	8.18	2.52	1.67	4.5	21.9	8.14	2.59	1.72	2.6	22.3
	S_2	8.17	2.54	1.66	4.4	21.7	8.12	2.57	1.77	2.4	22.8
		LSD at 0.05									
Compost (A)		0.05	Ns	0.24	0.73	Ns	Ns	NS	0.14	NS	NS
phosphorous (B)							NS				
A*B							NS				

***Ns: Not significant**

Table 3. Effect of different application rates on chemical properties of calcareous soil with two depths after barley harvested.

Treatments		Barley									
		0-20 cm					20-40 cm				
		pH	EC dS/m	OM %	P available mg/kg	$CaCO_3$%	pH	EC dS/m	OM %	P available mg/kg	$CaCO_3$%
Compost means	C_0	8.20	2.37	1.62	3.5	22.4	8.18	2.50	1.66	2.5	22.9
	C_1	8.19	2.53	1.79	4.8	21.9	8.14	2.54	1.72	2.8	22.7
	C_2	8.15	2.65	1.90	5.7	21.6	8.13	2.63	1.78	2.9	22.3
phosphorous mean	S_0	8.17	2.51	1.78	4.9	22.1	8.15	2.59	1.70	2.9	22.4
	S_1	8.18	2.53	1.76	4.6	22.0	8.16	2.56	1.71	2.7	22.9
	S_2	8.18	2.50	1.77	4.5	22.3	8.15	2.53	1.74	2.5	22.7
		LSD at 0.05									
Compost (A)		0.04	NS	0.11	1.21	NS	Ns	NS	0.11	NS	NS
phosphorous (B)							Ns				
A*B							Ns				

***Ns: Not significant**

Also, the maximum increase was observed in the case of C_2 with both soil depth from (0-20 cm) to (20-40 cm), as well as, the soluble salt was increased in all treatments applied regardless of growing plant type.

Organic matter (OM)

Data presented in Tables (2&3)indicated that using compost as organic amendments with different rates were generally increased soil organic matter compared to the control treatments. The increased mean values of OM in calcareous soil were noticed markedly when compost (C_2) was applied. The mean values of OM ranged from 1.51%(C_0) to 1.81%(C_2) with depth (0-20 cm)and 1.64%(C_0) to 1.80%(C_2)with depth (20-40cm) in soil cultivated with the wheat plant, the same trend was observed with barely plant whereas the mean values of OM increment from 1.62%(C_0) to 1.90%(C_2) and from 1.66%(C_0) to 1.78%(C_2) in In both soil depths,respectively.

Available phosphorus

Concerning the availability of P in soil is presented in Tables (2&3). Obtained results reflect the positive relation between treatments applied and the amount of nutrients able to be used by the plant. The mean values of available P in soil were significantly increased under compost applied as compared to control.

According to the individual effect of compost,the mean values of P availability in soil have significantly increased as compared to control; this trend was true for soil cultivated with wheat and barley plants in both soil depths. The superior rate of compost applied (24ton/ha) was increased the mean value of available P from3.6 (C_0) to 5.6 (C_2)in soil cultivated with the wheat plant while increased from 3.5(C_0) to 5.7(C_2)in soil cultivated with barley plant. On the other hand, by increasing the depth of soil the amount of available P in calcareous soil was decreased.

On the other hand, separately applications of P were increased the mean value of available P from 4.4 (S_2) to 5.0 (S_0) in soil cultivated with the wheat plant while increased from 4.5 (S2) to 4.9 (S0) in soil cultivated with barley plant.

Calcium carbonate ($CaCO_3$):

The main problem in calcareous soil is the presence of $CaCO_3$ and to solve it should be used organic soil conditioner to produce some acids which can dissolve the $CaCO_3$ by converting it to Ca^{++} ions and carbonic acids. To confirm this theory data presented in Tables (2&3)showed the application of compost as an organic amendment led to decrease mean values of $CaCO_3$ with all applied rates, such decreases ranged from 22.2 %(C_0) to 21.4 % (C_2) with depth (0-20 cm) and ranged from 22.9% (C_0) to 22.1% (C_2 and C_1) with depth (20-40 cm) in soil cultivated with the wheat plant as well as ranged from 22.4%(C_0)to 21.6%(C_2) with depth (0-20 cm) while decreased from 22.9%(C_0)to 22.3 %(C_2)with depth (20-40 cm) in soil cultivated with barley plant.

Concerning the individual effect of phosphorous on soil $CaCO_3$ data presented in Tables (2&3) clearly that the different sources of phosphorous with different rates on plant didn't have any significant effect on soil $CaCO_3$ in both soil depths.

2. Assessment on the response of grain yield and yield components to treatments:

Data regarding growth criteria of wheat and barley plantsare shown in Table (4) as affected by different compost and nano-hydroxyapatite application rates. Generally, means values of yield, grain and straw of both wheat and barley plant were increased with all rates of applied treatments as compared to the control treatment especially ($C_2$with S_2) followed by(C_2 with S_1) and (C_1 with S_2). As well as, the meansvalue of compost addition was increased biologicalyield criteria especially the application of C_2 by 15.64 and 32.47 %, grain by 9.96 and 14.87%, straw by 17.68 and 39.41 % as well as 1000 grain by 11.8 and 14.3 % for wheat and barley plant respectively at C_2 as compared to C_0. Moreover, application of different rates of nano-hydroxyapatite as a source of phosphorus fertilizer (S_1&S_2) compared to the traditional phosphorous source (S_0) were increased growth criteria especially the application of S_2 by 10.43 and 16.41 % for biological yield, by 6.13 and 12.29 % for grain, by 11.82 and 17.88 % for straw and by 7.1 and 8.6 % for 1000 grain of wheat and barley plant respectively.

Table 4. Effect of different application on growth criteria of wheat and barley plant cultivated in calcareous soil.

Compost	phosphorous	Wheat (kg plot^{-1})			1000- grain	Barely (kg plot^{-1})			1000- grain
		Biological Yield	Grain	Straw	Weight (g)	Biological Yield	Grain	Straw	Weight (g)
C0	S0	10.53	2.64	7.89	52.8	3.77	1.09	2.68	38.0
	S1	10.52	2.66	7.86	53.6	4.30	1.20	3.10	38.5
	S2	11.17	2.83	8.34	56.2	4.77	1.34	3.43	41.2
C1	S0	11.66	2.79	8.87	59.0	4.81	1.22	3.58	41.7
	S1	11.63	2.82	8.81	60.8	4.84	1.31	3.53	43.1
	S2	12.80	2.93	9.87	62.1	5.47	1.35	4.12	43.4
C2	S0	11.74	2.88	8.86	57.4	5.31	1.34	3.97	42.8
	S1	12.03	2.98	9.05	61.7	5.75	1.38	4.37	43.4
	S2	13.50	3.07	10.43	62.7	5.94	1.44	4.50	48.3
Compost means	C0	10.74	2.71	8.03	54.2	4.28	1.21	3.07	39.2
	C1	12.03	2.85	9.19	60.6	5.04	1.29	3.75	42.7
	C2	12.42	2.98	9.45	60.6	5.67	1.39	4.28	44.8
phosphorous mean	S0	11.31	2.77	8.54	56.4	4.63	1.22	3.41	40.8
	S1	11.39	2.82	8.57	58.7	4.96	1.29	3.67	41.7
	S2	12.49	2.94	9.55	60.4	5.39	1.37	4.02	44.3
					LSD at 0.05				
Compost (A)		1.54	0.16	1.38	6.26	0.54	0.13	0.48	4.58
phosphorous (B)		0.65	0.13	0.68	2.44	0.55	0.11	0.60	3.39
A*B		1.13	0.23	1.19	4.22	0.95	0.33	1.05	6.74

3. Phosphorus content:

Concerning data in Table (5) revealed that the translocate of P ions from soil toward straw and grains expressed as P content was increased by compost addition separately or with spaying nHAP as compared to control treatment (C_0 with S_0). In addition, there is a positive trend between treatments rate and P content in straw and grain of both wheat and barley plants i.e. by increasing application rate the P contentwas increased, the maximum increase was observed with (C_2 with S_2)followed by(C_1 with S_2)followed by (C_2 with S_1).

By comparing, means of compost application rates treatment the highest increased percent of P content reach 33.75 and 23.27 % for straw and grain of wheat while reach to 53.04 and 42.55% for straw and grain of barley plant respectively at C_2 as compared to C_0. On the other hand, regarding P concentration applied to plants the P content was increased by 59.18 and 27.11 % for straw and grain of wheat as well as, increased by 36.5 and 25.49 % for straw and grain of barley plant respectively at S_2 as compared to S_0.

4. Correlation matrix between grains yield and soil properties

Linear, quadratic, square root, and mitscherlich models were fitted to find out the relationship between wheat grain yield and some soil chemical properties. Positive and highly positive significant correlation (Table 6) of grain yield with P content (r = 0 .920**) and significant with OM (r=0.419*)and available P (r = 0.328*).

Table 5. Effect of different application rates on phosphorus content of wheat and barley plant cultivated in calcareous soil.

Compost	phosphorous	P content g plot^{-1} Straw	P content g plot^{-1} Grain	P content g plot^{-1} Straw	P content g plot^{-1} Grain
C_0	S_0	11.2	10.00	9.3	8.3
	S_1	15.9	11.7	11.7	8.6
	S_2	19.9	13.2	13.6	11.3
C_1	S_0	16.5	12.4	13.0	9.8
	S_1	20.0	12.7	13.0	11.4
	S_2	24.3	15.5	17.5	12.4
C_2	S_0	16.5	13.0	15.3	12.4
	S_1	20.4	13.7	17.0	13.1
	S_2	26.0	16.3	20.4	14.7
Compost means	C_0	15.7	11.6	11.5	9.4
	C_1	20.3	13.5	14.5	11.2
	C_2	21.0	14.3	17.6	13.4
phosphorous mean	S_0	14.7	11.8	12.6	10.2
	S_1	18.8	12.7	13.9	11.0
	S_2	23.4	15.0	17.2	12.8
		LSD at 0.05			
Compost (A)		5.22	1.53	2.32	3.16
Phosphorous(B)		4.63	0.95	3.16	2.09
A*B		8.01	1.65	5.46	5.17

Moreover, the same trend was observed with barley plant in Table (7) where grain yield had a highly significant correlation matrix with P content (r = 0.933**) and had significant with OM (r = 0.477*) and available P (r = 0.398*), such correlation indicated that the application of compost in combination with different sources of phosphorous was highly efficient on P translocation through plant parts.Thereis significant correlation between OM with available P (r =0.449*) and P content (r = 0.546**).

Table 6. Correlation matrix between wheat yield, phosphorus content and some soil chemical properties.

		Grain yield	P content	OM	Available P
Grain yield	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	27			
P content	Pearson Correlation	.920**	1		
	Sig. (2-tailed)	.000			
	N	27	27		
OM	Pearson Correlation	.419*	.317	1	
	Sig. (2-tailed)	.030	.107		
	N	27	27	27	
Available P	Pearson Correlation	.328*	.200	.339	1
	Sig. (2-tailed)	.050	.316	.084	
	N	27	27	27	27

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**

Table 7. Correlation matrix between barley yield, phosphorus content and some soil chemical properties.

		Grain yield	P content	OM	Available P
Grain yield	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	27			
P content	Pearson Correlation	.933**	1		
	Sig. (2-tailed)	.000			
	N	27	27		
OM	Pearson Correlation	.477*	.546**	1	
	Sig. (2-tailed)	.012	.003		
	N	27	27	27	
Available P	Pearson Correlation	.398*	.456*	.449*	1
	Sig. (2-tailed)	.040	.017	.019	
	N	27	27	27	27

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**

Discussion

The organic amendments improve the physical and chemicals properties of calcareous soil, help increase the availability of nutrients, and provide a good environment for plants (Hager et al.,2018).It increases yield and growth (Doaa and Mohamed, 2019).

Compost is one of the factors that contribute to increasing soil fertility and crop productivity where it improves soil properties (physical, biological and chemical) and increases availability and organic matter in the soil (Getinet, 2016;Yumin and Pengcheng, 2016). Compost contains macronutrients (N, P, K, S, Mg and Ca) and micronutrients as well as organic matter (Agegnehu et al., 2014).

In this study, the application of compost decreased soil pH. The decrease in soil pH depends on an increase in processes of decomposition of organic matter, organic compounds oxidation and nitrification processes (Kabirinejad et al.,2014), and an increase in biological and chemical activities, which led to the presence of acidic compounds. The application of compost reduces pH and the addition rate of compost increase the pH decrease. This reduction in the pH may be due to an increase of phenol, carboxyl groups and fatty acids in calcareous soilas a result of the decomposition of compost and decrease bicarbonate in calcareous soil. Compost enhances microbial activity and carbon dioxide production, which decreases pH of calcareous soil (Soheil et al., 2012; Franco-Otero et al., 2012; Aboukila et al.,2018).

In this study, the application of compost to the soil increases the EC, this may be due to its high content of calcium, magnesium and chlorine similar results were obtained by (Lakhdar et al. 2009; Hager et al.,2018).Saudi et al. (2020) reported that organic matter significantly increases soil salinity as compared to the control, where biochar, humic acid and compost increase soil salinity by 6.11, 28.13 and 33.81%, respectively. Incorporation of organic matter in the soil increased EC of the soil when using high doses of organic matter, due to the high salinity of the organic matter (Youssef and Issa 2017).

In the current study, the addition of compost leads to increases in the organic matter of calcareous soil.Shabeg et al., (2011) mentioned that compost increased organic matter, N levels and microbial biomass. Many previous studies have confirmed that the use of compost raises the organic matter and organic carbon in the soil(Daniel and Bruno, 2012; Saoussan et al., 2020)because of the high level of stable carbon. Saudi et al. (2020) found that the addition of the tested organic matter significantly increased the OM compared to the control, where biochar, humic acid and compost increased the OM by 13.9, 75.0 and 58.3%, respectively, compared to the control.

In this study, the application of compost reduced calcium carbonate. Abou Hussienet al. (2017) showed a decrease in calcium carbonate in the calcareous soil treated by compost.The compost changes the chemical properties of calcareous soil. It led to an increase in EC with a slight decrease in calcium carbonate and pH (Hager et al.,2018).

In the current study, applying compost increased available phosphorus in calcareous soil.Yu et al., (2013) reported that the application of organic matter leads to an increase of organic matter and available P in the soil as a result of the reduction in pH.It increases the efficiency of phosphorus fertilizer added and provides extra resources of nutrients (Al-Rohily et al., 2013). Compost increased available phosphorus in calcareous soil.The reduction of pH resulting from the compost application contributed mainly to phosphorus the conversion and release of in soil of calcareous (Zhengjuan et al., 2018). Wahbe et al., (2018)recently investigated the phosphorus availability in the soil of calcareous. The results of the experiments showed that adding 5 to 10% of the compost enhances the availability of P in the soil.Brown and Cotton, (2011) conclude that adding compost increases available micronutrients and macronutrients compared to control. Aboukilaet al.,(2018) conclude that adding compost to calcareous soils is more effective in increasing available N, P and K. It shows positive effects on uptake of macronutrients. It makes changes in the properties of soil and increases yield and growth (Afroja et al., 2019) where provides balanced nutrients.

Obtained results stated that the biological yield, grain and straw of both wheat and barley were increased with treatments. Compost had positive effects on soil properties as the growth and yield of barley was more than that of traditional organic fertilization (Abdel-Ati and Eisa 2015). Labeeb et al. (2016) pointed out that, the addition of biochar, compost and chicken manure increased the barley grain yield by 16.59, 28.43 and 31.17%. compared to the control, while the same adjustment in the same order increased the wheat grain yield by 6.36, 14.92 and 21.21 %. Plant height, wet weight and dry weight of barley plants were significantly increased by the organic matter. The high use of biochar, humic acid and compost increased fresh weight by 3.2, 9.7 and 9.7%, respectively as compared to the control (Saudi et al. 2020). Compost affected the growth rate of wheat and barley. Yield gains were associated with improved crop health as indicated by the chlorophyll content in the leaves (Newton and Guy 2020).

Nano fertilizers are useful in preventing the loss of nutrients in the soil thus reducing pollution of soil and water with excessive mineral fertilizers. Also, these nano fertilizers can avoid the interaction of nutrients with soil, water and air (Laila et al., 2018).Nano fertilizers increase the productivity of cropsby increasing the efficiency of nutrient use (Shang et al., 2019) and improve biomass, protein content, chlorophyll and phosphorous-mobilizing enzyme (Raliya and Tarafdar 2013). The uptake of nano fertilizers by plant cells depends on their diameter where can easily enter through the cell and reach the plasma membrane when its diameter is less than the diameter of the cell wall pores (Solanki et al.2015).

In this study, spraying nano-hydroxyapatite increased phosphorus content in both grain and straw of wheat and barley. Nano-hydroxyapatite is an alternative source of phosphorous where it is more effective than ordinary phosphorous source (H_3PO_4) on growing and phosphorous concentration of plants (Mehmet et al., 2018).Nano-hydroxyapatite leads to more efficient use of phosphorus through mechanisms as low molecule diameter, slow or controlled release and targeted delivery (Mehmet et al., 2018).Liu and Lal (2014) conclude that the nano-hydroxyapatite increases seed yield and growth of soybean compared to those of soybean treated by ordinary phosphorous (H_3PO_4).Amira et al., (2016)showed that the plant of Baobab sprayed by nano-hydroxyapatite significant increased in total carbohydrates percentage, total chlorophyll, vitamin C, carotenoids concentration, total phenols content, crude protein, macronutrients (N, P and K) and plant growth characters (number of leaves per plant, plant height, root length, leaf area, total fresh, stem diameter and dry weights). Application nano-hydroxyapatite led to the improvement of the fresh weight, boosted the ryegrass growth, motivated ryegrass to secrete tartaric acid (Ling et al., 2017) andprovides nutrient phosphate (Xing et al., 2016). Nano-hydroxyapatite has bio-compatibility and excellent bio-activity(Venkatasubbu et al., 2013).

CONCLUSION

In this study,the application of compost in combination with nHAPhas enhanced the productivity of wheat and barley yield, as well as P content in plants,was increased, the maximum values were obtained with C_2 and S_2 as compared to C_0 and S_0. The application of compost led to a change in soil chemical properties, pH was decreased at compost treatments applied and such decreases were proportional to treatments increasewith wheat and barley plant. An opposite trend was observed with OM and available phosphorus. In addition, there is a positive and highly significant correlation between grain yield and P contentwith wheat and barley plant.

We can conclude that the application of nano phosphorus materials in low amounts can compensate the plant needed from P during the season compared to ordinary phosphorus sources. Also,compost improves the properties of calcareous soil.

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تأثيرالسماد العضوي والنانوهيدروكسي اباتيت على تغذية الفسفور وبعض خواص التربة الجيرية

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الملخص

تواجه زراعة التربة الجيرية العديد من الصعوبات بسبب خصائصها ، حيث تفتقر إلى المواد العضوية ، فضلاً عن قلة توافر العناصر الغذائية ، وخاصة الفوسفور. استخدمت هذه الدراسة محصولين من الحبوب (القمح والشعير) لدراسة تأثير الكمبوست كمصدر للمواد العضوية والنانو هيدروكسي اباتيت كمصدر للفوسفور على بعض خواص التربة الجيرية ومحتوى الفوسفور في النباتات. كانت القطع الرئيسية الكمبوست بثلاث معدلات (بدون كمبوست – بمعدل 12 طن/هكتار – بمعدل 24 طن/هكتار) و القطع الثانوية مصادر مختلفة من الفوسفور (الفوسفور التقليدي (سوبر فوسفات) - النانو هيدروكسي اباتيت بمعدلين 1,5 جم/ لتر و 3 جم/ لتر). وتم توصيف والنانو هيدروكسي اباتيت بواسطة حيود مسحوق الأشعة السينية و المجهر الإلكتروني الماسح. اظهرت النتائج المتحصل عليها أن المحصول البيولوجي والحبوب والقش لكل من القمح والشعير قد زاد معنوياً مع المعاملات وخاصة مع معاملة (24 طن /هكتار كمبوست و3 جم/ لتر نانو هيدروكسي اباتيت) مقارنة بمعاملة (بدون الكمبوست و الفوسفور التقليدي). بالإضافة إلى ذلك ، هناك اتجاه إيجابي بين معدل المعاملات ومحتوى الفوسفور في القش والحبوب لكلا المحصولين ، وقد لوحظت الزيادة القصوى في معاملة (24 طن /هكتار كمبوست و3 جم/ لتر نانو هيدروكسي اباتيت). كما أدى استخدام الكومبوست إلى تغير في الخواص الكيميائية للتربة ، وانخفض الرقم الهيدروجيني عند المعاملات المطبقة وكانت هذه الانخفاضات متناسبة مع زيادة معدل المعاملات. لوحظ اتجاه معاكس مع المادة العضوية والفوسفور المتاح. بالإضافة إلى ذلك ، توجد علاقة ارتباط موجبة وعالية المعنوية بين محصول الحبوب ومحتوى الفسفور في النباتات.