EFFECT OF ORGANIC AND INORGANIC CONDITIONERS ON P-RELEASE FROM ROCK PHOSPHATE AND ITS IMPACT ON WHEAT PLANT

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Abstract

The current work aims to evaluate the effect of organic materials application such as compost (rice straw), Humic acids(HA), Fulvic acids(FA) and agricultural sulfur(S), to rock phosphate (RP) on the availability of P and some macronutrients in the calcareous soil of Al-Galaa location, west Nubaria, cultivated with wheat during winter season 2006/2007.

The obtained results showed the positive effect of applied humic and fulvic acids to RP inoculated with bacteria to P-release from RP and gave the highest values of H_2O-P, $NaHOC_3$-P, NaOH-P, EDTA-P and occluded-P fractions by increasing the incubation time up till 21 days. Also, a gradual increase in the availability index (AI) was obtained. Application of organic materials results in improving the soil characteristics under study as it exhibited a gradual decrease or increase in the values of EC, pH and O.M. Moreover, the application of (HA+RP+B (bacteria)) increased the available N,P and K by 84, 87 and 39% more than the untreated rock phosphate.

Concerning nutrient concentrations in wheat plant, data showed a high response to either the applied individual or combined treatments however, greater values were strictly associated with triple treatments under study. N, P and K% of both shoot and grains were affected by the following treatments and could be arranged as follows: MF> HA+RP+B > FA+RP+B > S+RP+B for nitrogen while for P and K : the arrangements would be HA+RP+B > FA+RP+B > S+RP+B > MF.

Significant increase exists in the values of wheat grain and straw yield (Kg/Fed.) , weight of 1000 grains and the quality parameter i.e crude protein and amino acids as well as N, P and K, due to application all treatments especially the combined treatments. This could be attributed to mineral enrichment, active organic compounds and bio substances which have the ability to chelate nutrients as available strategic storehouse and in turn reflected positively on development of crop yield and its components. This emphases the importance of organic materials to minimize consuming chemical fertilizers and to avoid environmental pollution hazards.

Economical examination was carried out by calculating the benefit to cost ratio B/C parameter.

Key words. Fractionation of phosphorus, rock phosphate, calcareous soil, wheat plant

INTRODUCTION

Phosphorus (P) is an essential nutrient for plant growth. Although plant roots are capable of absorbing P from the soil solution at low P concentrations (Hinsinger, 2001). Some soils cannot supply sufficient amounts of P to the plant. Soil calcium carbonate ($CaCO_3$) has a major impact on soil-phosphorus (P) interactions and can significantly influence levels of plant-available and soluble P in soils. Thus, soil $CaCO_3$ level should be considered in the P- index in calcareous soils, (Schierer et al., 2006).

Complexing and chelation reactions by organic acids, excreted by both higher plants and microbes, bind to the surface of the minerals prior to microbial attachment (Banfield and Hamers, 1997). In the presence of humic substances, complex minerals, which are otherwise considered insoluble, are converted to plant available nutrients through interactions among plant roots, microorganisms, organic substances and clay. The bioavailability of nutrients released from rock minerals by biological activity is enhanced in the presence of humic substances, (Tan, 2003).

Rock phosphate can be solubilized or weathered under the influence of water, acids, complexing agents and oxygen. Biological weathering or biochemical weathering is made by microorganisms which produce organic acids, phenolic compounds, protons and siderophores (Drever and Vance,1994). While Chien (1979) reported significant solubilization of rock phosphate (RP) in a soil organic matter suspension extracted from soil by water. This was attributed to chelation of Ca^{2+} ion by functional groups of soil organic matter that lowered Ca^{2+} ion activity, thus providing the driving force for dissolution of RP in the soil solution. Soil humus improves the soil structure, which has a beneficial effect on P uptake, (Johnston, 2000). On the other hand, organic matter can chelate Ca ions derived from PR phosphate rock dissolution and thus increase P release from PR. It is likely that composting RP with organic matter follows the same mechanism.

The objective of this investigation was to understand the effects of different organic and inorganic conditioners on P-fractions and its impact on nutrient uptake and quality of wheat plants.

MATERIALS AND METHODS

Materials:

Rise straw compost 5 ton/fed and humic acid, fulvic acid with three rates 10, 20 and 30 l/fed (were extracted from rise straw compost with KOH) and agriculture sulfur with two rates 600 and 850 kg/fed from El-Ahram com., after enriched them with p-dissolved bacteria (Bacillus megatherium bacteria), was provided by the Biofertilizers Unit, Cairo Mircen, Microbiological resource Center. The broth culture was applied on vermiculite based (1:10 V/V) applied to rock phosphate (RP) to studied of p-release from RP and effect on the content of phosphorus in soil and plant.

Incubation studies:

Plastic bags were filled with 200g of the calcareous soil sample collected from Al-Glaa location in West Nubaria. Values of particle size distribution, soil pH, electrical conductivity (EC) of saturated extract, organic matter (O.M) and calcium carbonate contents, of the studied soil (Black, 1965) are presented in Table 1.

Table 1. Some soil physical and chemical properties of the experiment soil.

Particle size distribution, %				Texture class	$CaCO_3$ %	O.M %	pH (1:205)	EC dS/cm	Total P (ppm)	Available nutrient (ppm)		
Coarse sand	Fine sand	Silt	clay							N	P	K
9.68	57.5	15.7	17.1	Sandy loam	21.3	0.51	7.33	9.37	184	21.0	8.63	53.4

The bags were treated with treatments showed in Table 2 :

Table 2. Treatments of used in this investigation.

No	Treatments	Rock phosphate (200 kg/ fed)	Compost (ton/fed)	Humic acid (L/fed)	Fulvic acid (L/fed)	Agriculture sulfur (kg/fed)	Bacteria *
1	RP	+	-	-	-	-	-
2	C+RP	+	5	-	-	-	-
3	HA1+RP+B	+	-	10	-	-	+
4	HA2+RP+B	+	-	20	-	-	+
5	HA3+RP+B	+	-	30	-	-	+
6	FA1+RP+B	+	-	-	10	-	+
7	FA2+RP+B	+	-	-	20	-	+
8	FA3+RP+B	+	-	-	30	-	+
9	S1+RP	+	-	-	-	600	+
10	S2 + RP	+	-	-	-	850	+

* (Bacillus megatherium bacteria)

The analysis of applied materials was carried out according to standard methods described by Black (1965), as shown in Table 2.

Table 2. Characteristics of humic and fulvic acid and rock phosphate used in the study.

Determination	Humic acid	Fulvic acid	Rock phosphate	Rice straw compost *
EC dS/cm (1:10)	9.83	6.45	-	5.67
pH (1:10)	7.05	3.12	-	7.08
O.M %	-	-	-	56.6
C/N ratio	-	-	-	17.6
Total macronutrient %				Available nutrients (ppm)
N	0.87	0.23	-	-
P	0.52	0.15	6.5	5033
K	1.29	0.37	-	6319
Available micronutrients $ug.g^{-1}$				
Fe	92.3	66.8	10.4	217
Mn	11.0	10.6	3.12	107
Zn	2.65	1.9	1.48	98
Cu	0.06	0.06	4.01	16.6

* Rice straw compost enriched with chicken manure as nitrogen source, rock phosphate as phosphorus source and feldspar as potassium source.

The treatments were replicated three times with a total of 30bags. Saturated soil samples were incubated for 0,7, 14, 21, 28,35,42, 49 and 56 days under laboratory conditions, afterwards, 1g of each soil was taken and prepared for phosphorus fractions determination.

Sequential Phosphorus Fractionation

Fractions of inorganic and organic P was performed on soil by a modified P fractionation i.e. water soluble (H_2O-P), exchangeable ($NaHCO_3$-P, NaOH-P, HCl-P and EDTA-P),occluded (Occ-P), and residual (Res-P) scheme of Sui et al.,(1999).

Availability Index (AI) is expressed by the following equation:

AI= [(Readily available forms (RAF) + Moderately available forms (MAF)) / Hardily available forms (HAF)] X 100

Where: AI : Available Index

RAF: WS-P+ $NaHCO_3$-P

MAF: NaOH-P + HCl-P + EDTA-P

HAF: Res-P+Occluded-P

Field experimental work

A field experiment was conducted during winter season of (2006/2007) in a farm at Al-Galaa location, West of Nubaria to evaluate the release of phosphorus from rock phosphate as affected by organic and inorganic conditioners and its impact on wheat plant (Triticum *aestivum*, Sakha 69). The previous ten treatments applied in case of the soil incubation experiment were used this study plus control.

The applied materials were thoroughly mixed with the surface soil layer (0-15cm) of plots, a randomized complete block design with three replications, was followed whereas, the plot area was 10.5 m^2. Plots received chemical fertilizers as follows: ammonium sulfate (20 % N)' superphosphate (15 % P_2O_5) and potassium sulfate (48 % K_2O) a level of 100, 30 and 48 kg/fed of N, P_2O_5 and K_2O, respectively. Phosphorus and potassium fertilizers were added before planting, while ammonium sulfate was added in two equal doses. Soil samples (0-15 cm) for each treatments were collected after harvesting wheat. Where: EC, pH, O.M, and available N, P and K were determined according to Black (1965). Wheat plants were harvested and the yield components ,grain, straw and weight of 1000 grain, of each plot was recorded. Plant samples were dried at 70 C^0, ground and prepared for digestion and analysis. The digested were materials subjected to determine of N, P, and K using procedures described by Chapman and Pratt (1961). While protein percent in the grain was calculated by multiplying N% by 6.25 according to A.O.A.C. (1980). Free amino acids were extracted using 70 % ethanol as reported by Lee and Takahashi, (1966). Benefit- cost analysis were carried out according to Gittinger (1973).

Obtained results were subjected to statistical analyses according to Snedecor and Cochran (1980)

RESULTS AND DISCUSSION

Effect of incubation period on P-release from rock phosphate as affected by organic and inorganic conditioners applied to calcareous soil.

Data in Fig.(1) represented P fractions values as a result of applying compost, humic acid, fulvic acid and sulfur to rock phosphate in case of the studied calcareous soil for 56 days.

Generally, the H_2O-P fraction extracted from soil samples ranged between 3.09, 3.21, 5.37, 4.05 and 3.43 % of total P (184 ppm), respectively during the incubation period, regardless the level of conditioners application. The highest value was observed in case of humic acids treatment, followed by fulvic acid and sulfur, while the application of compost gave lower values as compared to other conditioners. In contrast, RP applied alone gave the lowest values which equal approximately the control treatment. These values were increased by increasing the level of humic acid, fulvic acid and sulfur application.

Values of H_2O-P fraction gradually increased by increasing the time of soil incubation till 21 days followed by a decreasing order till the end. This trend was observed in all the applied treatments.

As a general result, the application of humic substances enriched with RP in calcareous soil and inoculated with bacteria gave the highest H_2O-P compared with other treatments, especially in case of applying 30 L / fed of humic acid.

Generally, it is evident that this fraction, ($NaHOC_3$-P) extracted from different treatments was higher than (RP) treatment by increasing time of soil incubation .

Data in Fig. (1) showed the effect of RP with organic and inorganic materials used at different levels on soil amended with P on extracted by $NaHCO_3$-P. An increase in $NaHOC_3$-P values was observed as it reached 81.4, 177.2, 147.8 and 113.8% over (RP) in case of C+RP, HA+RP+B, FA+RP+B and S+RP+B treatments, respectively. Also, it was noticed that regardless the time of soil incubation, the highest extractable P value was obtained from HA+RP+B followed by FA+RP+B, S+RP+B and then C+RP treatments whereas the RP applied individually gave the lowest values. In case of this fraction, through the entire incubation time, results of released P from abovementioned treatments showed a gradual, increase in P% by increasing the incubation time until 21 days however, a gradual decrease exists by the end of the incubation. Appling the organic materials and sulfur to rock phosphate as an amended materials works on decreasing pH of the system beside it works as a slow release fertilizer, this trend was specially observed at end of incubation period, (Wahdan, 2006).

In case of NaOH-P pool, data (Fig.1) indicated that the highest P extracted by NaOH from treatments exist in case of HA3+RP+B, FA3+RP+B and S2+RP+B, while C+RP gave the lowest values compared to RP only.

Concerning the effect of incubation time, results indicated that increasing of incubation time up to 7 and 21 days, led to an increase in P extracted by NaOH in all treatments, however, increasing incubation time over 21 days decreased the extractable P till it reaches its minimum value after 56 days. The application of humic substances was more effective on fraction NaOH-P as compared to other treatments, especially when 30 L/fed is applied. For example, after 21days, the application of humic acid (10, 20 and 30 L/fed) to RP treated soil, led to an increase in the extractable P by 97.5, 119 and 179% over RP treatment, respectively.

The soil HCl-P of different treatments applied indicated that again HA+RP+B was the highest treatment compared with (RP), FA+RP+B and S+RP+B. The application of humic acid to RP treated soil increased the HCl extracted P by 86.3, 148 and 170 % over RP, for the levels of 10, 20 and 30 l/fed respectively. The variations of extractable P through the entire incubation time take the same trend of H_2O-P, $NaHCO_3$-P and NaOH-P fractions, and continued in all incubation times.

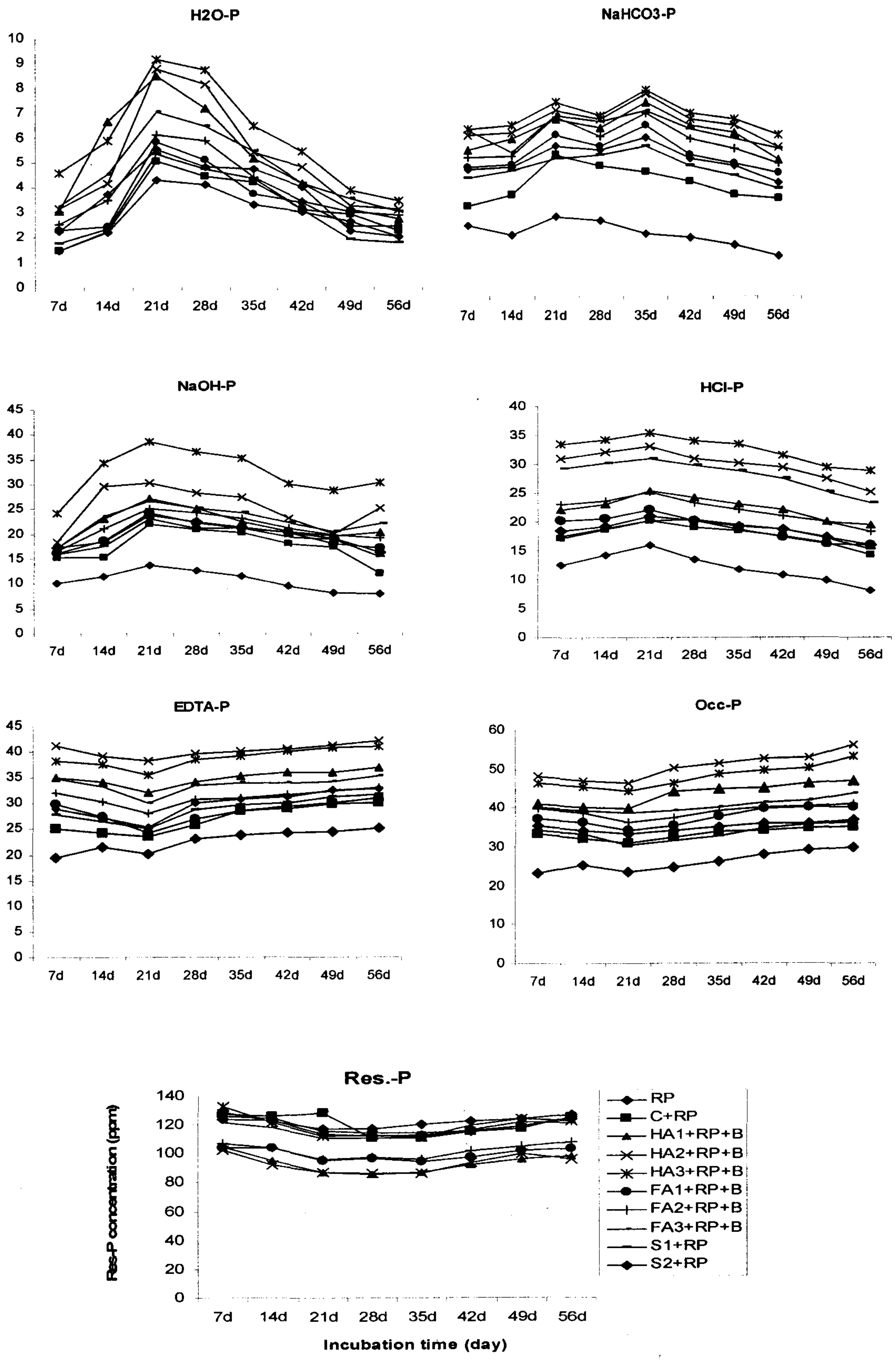

Fig1. Effect of organic and inorganic conditioners on fractionations of P

The value of extractable P as affected by organic and inorganic conditioners and time of incubation are presented in (Fig.1). Generally data showed that no significant difference was observed between different treatments applied, however, all treatments gave higher HCl-P compared with RP.

Data depicted in Fig. (1) represents the effect of application of organic and inorganic conditioners applied to rock phosphate on EDTA-P concentration at different incubation period. The obtained results showed that the lowest value was observed in control treatment reached 17.44 ppm. Application of compost, humic acid, fulvic acid, and sulfur to RP treated calcareous soil at different rates, led to an increase in the extractable EDTA-P by 18.9, 67.4, 36.8 and 29.4 % over RP treatment only, respectively, regardless level of application and incubation time. The comparison between the humic and fulvic acids applied in relation to P extracted by EDTA, data indicated that there is a wide variation between these types of acids where the application of humic acid at level of 20 L/fed to RP treated soil was more effective than other levels, while , the application of fulvic acid ata level of 30 L/fed was superior of increase of EDTA-P fraction values, and the same trend was continued in other incubation periods studied. Generally, the application of humic substances was the best treatments as it gave higher P values extracted compared with other treatments throughout the different incubation period.

Data represented in Fig.(1) showed that the increasing order of treatments applied on RP treated soil takes the order: HA+RP+B> FA+RP+B > S+RP+B >C+RP > RP. Moreover, in all treatments, increasing the incubation time up to 21 days, led to a decrease of the Occ-P. Addition of humic acid, fulvic acid and sulfur to RP treated soil led to increase P in this fraction, moreover, increasing of application level, led to increase P concentration in Occ-P form. The application of humic acid using different levels gave higher P-values compared with fulvic acid regardless the time of soil incubation. Occluded P is considered the fraction released by the action of reluctant after removing most of P adsorbed to Fe oxides and Fe-rich phosphate particles in previous extraction step (Wahdan, 2006).

The residual-P fraction contains naturally occurring minerals which may hold macronutrients within their crystalline matrix. Residual P occurred in this study consistently represented the highest fraction of soil P, without any exceptions (Wahdan, 2006). Generally, the application of humic substances markedly decreased Res-P any at level as compared to RP-treatment, while, the application of sulfur to RP treated soil slowly decreased Res-P as compared with the RP followed by the compost treatment. It is clear that the first period of incubation (7-21 days) is characterized by a decrease in Res-P, followed by an increasing order in all incubation times studied, which is not irregular for all treatments.

Availability Index (AI) of different treatments applied to RP treated calcareous soil as affected by times of soil incubation

In this study availability index (AI) was used to determine the effectiveness of different treatments applied in increasing P availability in calcareous soil. The increasing order of the (AI) value referred to the effectiveness of applied organic and inorganic conditioners in maximizing P availability in treated calcareous soil. Data in Table (4) showed the AI values of different treatments through the entire incubation time. Generally, results indicated that compost, humic acid, fulvic acid and sulfur application to RP, led to an increase in (AI) values through the incubation period (56days) as compared to RP. The results indicated that application of humic substances to RP were the best materials applied compared with other treatments, especially when of humic acid was applied 20 L/fed. The numerical value of this treatment after 7 and 21 days was 74.5 and 99.0, respectively. Data in Table (4) showed that a gradual increase in (AI) exists in both RP and treated soils from 7 to 21 days, followed by a decrease in this parameter by increasing incubation times, however, the compost and sulfur treatments increased (AI) until 28 days followed by a decrease until the end of incubation period.

Table 4. P-availability index (AI) as affected by incubation time and different treatments applied.

Treatments	Incubation period (days)								
	0	7	14	21	28	35	42	49	56
RP*	43.4	34.0	38.2	45.1	43.5	39.2	36.1	33.2	30.4
C+RP	45.0	43.3	45.6	54.6	59.6	59.6	54.3	51.3	43.5
HA1+RP+B	67.8	64.9	77.9	90.0	84.8	82.3	74.3	68.6	65.7
HA2+RP+B	80.8	74.5	88.8	99.0	93.4	92.1	81.2	73.4	74.2
HA3+RP+B	72.6	67.1	78.6	90.1	87.2	86.4	75.8	70.9	69.6
FA1+RP+B	50.0	59.2	60.2	73.6	69.6	69.6	63.1	57.9	56.4
FA2+RP+B	55.2	61.8	66.6	80.0	76.2	75.2	67.6	63.6	59.7
FA3+RP+B	60.2	64.1	68.8	77.4	76.8	75.4	68.0	62.1	61.3
S1+RP	48.2	47.8	50.6	61.5	63.0	62.7	57.3	53.9	47.5
S2+RP	51.8	51.3	53.1	63.3	64.6	64.1	59.6	56.0	50.0

*RP. Rock phosphate C. compost HA. Humic acid FA. Fulvic acid S sulfur B. phosphate dissolved bacteria.

Generally, application of humic acid inoculated with P dissolving bacteria *Bacillus megatherium* bacteria) to RP treated soil was more effective in improving P-availability index followed by sulfur and compost as compared to RP. This effect was increase by increasing the level of humic application (30 L/Fed). Thus, those molecules containing several functional groups (e.g., OH^-, COOH), which are capable of forming stable complexes with metals (Earl *et al.* (1979). The increase of P availability due to the addition of organic compounds could be related to the replacement or competition between humate and phosphate ions for sites on adsorbing surfaces, the formation of fulvic acids- metal phosphate and the decreased soil pH (Shehata *et al.* (1984).

Effect of organic and inorganic conditioners and rock phosphate on soil properties after harvesting wheat.

Results obtained (Table 5) revealed that, the beneficial influences of the combined treatments were more effective, however, the highest level of the combined treatments of (HA+RP+B), (FA+RP+B) and (S+RP+B) gave the highest decrease percentage (-15.02 , -18.31 and -21.38%) for EC and (-7.9 , -7.9 and -6.24%) for pH over the untreated soil, respectively. That is true, since the obtained results outlined by Wahdan *et al.,* (2006), pointed out that favorable conditions of the combined treatments are commonly achieved by lowering soil pH. Similar results were obtained by Mohamed *et al.,*(2008).

Concerning soil organic matter (O.M) the data in Table 5 reveled a positive effect in increasing the percentage to reach 73.04, 59.8 and 41.91% for treatments (HA+RP+B), (FA+RP+B) and (S+RP+B) over the control respectively.

The magnitude of available nutrients in calcareous soil as affected by the treatments is shown in Table 5. The obtained results showed obvious increases in the availability of N,P and K by increasing the applied levels in the treated soil compared with the control. The highest soil content of available nutrients was achieved upon treating the soil with the maximum level of the studied organic amendments, with superiority to (HA+RP+B). Accordingly, the positive effect of the applied treatments on the available nutrients content could be arranged, in general, into the descending order (HA+RP+B) > (FA+RP+B) > (S+RP+B). Moreover, following application of (HA+RP+B) to soil increased available N, P and K concentrations by 84 , 103 and 45% more than the control and 84 , 87 , and 39 % more than untreated rock phosphate treatments respectively. Similar results were obtained by Elgala and El bordiny (2004).

Table 5. Effect of organic and inorganic conditioners and rock phosphate on soil properties after harvesting wheat

Treatments	EC dS/cm	pH (1:2.5)	O.M %	Available nutrient (ppm)		
				N	P	K
Mineral fertilizer (NPK)	9.12	7.85	0.68	312	91.0	560
RP *	8.45	7.45	0.81	313	98.7	575
C+RP	8.98	7.18	1.05	410	130	645
HA1+RP+B	8.05	7.46	1.12	498	141	712
HA2+RP+B	7.98	7.46	1.16	510	156	757
HA3+RP+B	7.75	7.23	1.25	575	185	802
FA1+RP+B	8.0	7.42	1.03	412	136	632
FA2+RP+B	7.46	7.42	1.09	456	145	698
FA3+RP+B	7.45	7.23	1.14	498	166	740
S1+RP+B	7.46	7.33	0.91	346	102	687
S2+RP+B	7.17	7.36	1.02	384	112	714
L.S.D. 0.05	0.04	0.01	0.01	11.02	2.15	698

*RP. Rock phosphate C. compost HA. Humic acid FA. Fulvic acid S sulfur B. phosphate dissolved bacteria.

Wheat grain and straw yield

Data in Table (6) indicated that the application of the studied amendments to the soil create a beneficial effect on wheat plant yield. Almost all the combined treatments yielded a substantial increase in yield of wheat compared either to untreated soil or to RP only. The highest yield is associated with (HA+RP+B) and (FA+RP+B) treatments.

The grain yield reached 3530 and 2812 kg/Fed., while the straw yield were 5509 and 5067kg/Fed., for the highest level of the above mentioned treatments respectively. The obtained crop yield reaches 2 and 1.6 times than the control for grains and 2.15 and 1.98 times for straw, respectively. These increases were statistically confirmed (L.S.D at 0.05), however, the data showed a more pronounced beneficial effect of the combined treatment in increasing the wheat grain and straw yield and weigh of 1000 grain. The effect of triple combined treatments showed a considerable effect on weigh of 1000 grains which reached 4.16 and 2.2 % over the control.

It seems that the beneficial effect of organic materials is mainly attributed to improving soil water retention and the drought resistance of grown plants as well as increasing the ability of leaves for photosynthetic process. Also, these materials improve not only NPK availability that also the overall soil fertility. Moreover, it lowers pH values and forming organo-metallic compounds. This results in increasing grain filling intensity and the grain weight. These findings are in harmony with those of Badawy (2008) and Mohamed *et al.* (2008).

Table 6. Responses of wheat yield to applied rock phosphate enriched with organic and inorganic conditioners.

Treatments	Grain		Straw		Weight of 1000	
	yield kg/fed	R.P %	yield kg/fed	R.P %	Grain g	R.P %
Mineral fertilizer (NPK)	1736	100	2564	-	360	
RP *	1690	97.3	3259	127	326	90.6
C+RP	2144	123	4462	174	328	91.1
HA1+RP+B	2887	166	2662	104	345	95.8
HA2+RP+B	3057	176	4437	173	366	101
HA3+RP+B	3530	203	5509	215	375	104
FA1+RP+B	2503	144	3287	128	320	88.9
FA2+RP+B	2706	156	5043	197	345	95.8
FA3+RP+B	2812	162	5067	198	368	102
S1+RP+B	2354	136	4123	161	340	94.4
S2+RP+B	2490	143	3653	143	357	99.2
L.S.D. 0.05	21.5	-	0.05	-	1.12	-

*RP. Rock phosphate C. compost HA. Humic acid FA. Fulvic acid S. sulfur B. phosphate dissolved bacteria.

Wheat yield.

Straw and grain contents of some nutrients:

Wheat straw and grain contents of N ,P and K are presented in Table (7). Regarding nitrogen concentration in wheat (shoot and grain), it is obvious that their N content significantly increased in case of untreated soil, in contrast to combined treatments which exhibited relatively lower values. Stevenson (1994) reported that much of the organic N stabilized in soil humic fractions resists attack by soil microorganisms and thus is not readily available for plant uptake. As a consequence of mineralization-immobilization reactions, up to one third of the N-fertilizer applied to the soil might be stabilized into humic substances and only a small fraction (<15%) will be available for the next growing season Kelley and Stevenson (1996). In general, behavior of nitrogen on wheat yield (straw and grain), followed the trend of those obtained at vegetative stage, obtained values were significantly higher when nitrogen fertilizer was applied Wafaa *et al.* (2006).

While phosphorous and potassium content in wheat (shoot and grain) showed an opposite trends. In general, they increased when organic materials were added to the calcareous soil, such beneficial effect may be attributed to enhancing releasing P and K by the applied materials and make it to be more available for plants (Omran *et al.*, 1979).

Data presented also showed a high response in plant P and K % to the combined treatments, with considerably greater values strictly associated with the applied triple treatments (HA+RP+B), since it surpassed the untreated soil by 128.57and 41.86 % for shoot, 152.17and 52.38 % for grains for P and K, respectively. The superiority of the abovementioned treatment could be explained as direct and indirect role of organic materials. The direct effect includes the continuous release of organic P into soluble form, while the indirect effect is due to the role of organic acids compounds of solubilizing more P from insoluble P-bearing compounds, El-Ghozoli (1994) beside the role of humus in improving the physical, chemical and biological properties of the soil, Elgala *et al.*,(1975). Accordingly, the positive effect of the treatments under study on N,P and K concentrations of both shoot and grains could be arranged in the following ascending order : M.F> (HA+RP+B) >(FA+RP+B) >(S+RP+B) for N while for P and K: (HA+RP+B) >(FA+RP+B) >(S+RP+B) >(MF).

Table 7. Total content of N,P and K both straw and grain of wheat plants growing in calcareous soil treated with organic and inorganic conditioners.

Treatments	Macronutrients concentration %					
	Shoot			Grain		
	N	P	K	N	P	K
Mineral fertilizer (NPK)	0.90	0.21	0.43	2.46	0.23	0.21
RP *	0.35	0.23	0.43	1.04	0.31	0.27
C+RP	0.41	0.28	0.44	1.46	0.38	0.30
HA1+RP+B	0.64	0.41	0.43	1.62	0.42	0.27
HA2+RP+B	0.68	0.42	0.49	2.01	0.51	0.27
HA3+RP+B	0.80	0.48	0.61	2.10	0.58	0.32
FA1+RP+B	0.53	0.32	0.40	1.66	0.31	0.22
FA2+RP+B	0.66	0.35	0.42	1.66	0.41	0.24
FA3+RP+B	0.68	0.39	0.44	1.82	0.43	0.27
S1+RP+B	0.51	0.29	0.37	1.24	0.78	0.32
S2+RP+B	0.57	0.33	0.43	1.32	0.37	0.37
L.S.D. 0.05	0.02	0.01	0.03	0.02	0.01	0.02

*RPRock phosphate C. compost HA. Humic acid FA. Fulvic acid S sulfur

B. phosphate dissolved bacteria.

wheat grain quality:

The obtained results in Table 8 indicate that the prevailing favorable conditions of vegetative growth positively affected wheat grain yield and its quality. The effect of NPK treatment and the triple combined treatment of (HA+RP+B) or (FA+RP+B) showed a considerable increase in protein content which reached 14.15, 12.08 and 10.47%, respectively. These increases were statistically confirmed (L.S.D. at 0.05), however, the NPK treatment was significantly superior over the other studied ones. Concerning amino acid content, all the applied treatments caused considerable changes in free and total amino acids content of wheat grains. Table 8 indicated that the treatment of (S1+RP+B) caused the highest accumulation of total amino acids content which ranged from 18.78 to 26.18 % in wheat grains. Data cleared that total amino acids followed the order: S+RP+B > C+RP > HA+RP+B > FA+RP+B > RP > MF.

Table 8. Protein and amino acids content in the grain of wheat plants.

Treatments	Protein content %	Amino acids %	
		Free	Total
Mineral fertilizer (NPK)	14.15	6.43	19.60
RP *	5.98	5.44	20.16
C+RP	8.40	5.93	21.70
HA1+RP+B	9.32	6.18	19.20
HA2+RP+B	11.56	6.43	20.97
HA3+RP+B	12.08	6.60	21.39
FA1+RP+B	9.55	6.05	20.34
FA2+RP+B	9.55	6.18	20.66
FA3+RP+B	10.47	6.47	18.78
S1+RP+B	7.13	5.51	26.18
S2+RP+B	7.59	6.30	19.51
L.S.D. 0.05	0.28	0.75	1.15

*RP. Rock phosphate C. compost HA. Humic acid FA. Fulvic acid S sulfur B. phosphate dissolved bacteria.

Economic evaluation:

The economic evaluation is carried out based on the benefit cost and ratio for each material type. This ratio was calculated from the obtained data of the maximum yield for each treatment. The benefit cost ratio of the maximum yield and the economic classes are shown in Table 9. Although the maximum increase in total income of (3970 L.E) was realized by the application of HA3+RP+B followed by

HA2+RP+B, FA3 +RP+B and FA2 +RP+B, low benefit / cost ratio exists for those treatments. Data also clarified that profit follows the same trend of the total income. The maximum benefit / cost ratio of (33.2) was found with RP against the minimum benefit / cost ratio value of (1.99) in S2+RP+B treatment. The most economically treatment is RP followed by HA1+RP+B. The B/C ratio was in the following order illustrated in Table 9.

Table 9. The straw and grain yields of wheat crop (kg/fed.) and benefit to cost ratio for the studied field treatments

Treatment	Cost (L.E)	Grain		Straw		Total Income (L.E)	Profit (L.E)	Benefit / Cost Ratio	Order
		Kg	Price (L.E)	Kg	Price (L.E)				
Mineral fertilizer (NPK)	156	1736	1302	2564	615	1917	1761	11.3	8
RP	60	1690	1268	3259	782	2050	1990	33.2	1
C+RP	810	2144	1608	4462	1071	2679	1869	2.31	10
HA1+RP+B	118	2887	2165	2662	639	2804	2686	22.8	2
HA2+RP+B	168	3057	2293	4437	1065	3358	3190	19.0	4
HA3+RP+B	218	3530	2648	5509	1322	3970	3752	17.2	6
FA1+RP+B	118	2503	1877	3287	789	2666	2548	21.6	3
FA2+RP+B	168	2706	2030	5043	1210	3240	3072	18.3	5
FA3+RP+B	218	2812	2109	5067	1216	3325	3107	14.3	7
S1+RP+B	668	2354	1766	4123	990	2755	2087	3.12	9
S2+RP+B	918	2490	1868	3653	877	2744	1826	1.99	11

*RP. Rock phosphate C. compost HA. Humic acid FA. Fulvic acid S sulfur B. phosphate dissolved bacteria.

CONCLUSION

The application of organic acids especially humic and fulvic acid on rock phosphate and enriched with phosphate dissolved bacteria were more effective on p-availability, it could be related to the replacement or competition between humate and phosphate ions for sites on adsorption surfaces the formation of fulvic acids – metal phosphate and increase of P in soil and reflected positively on development of crop yield and its component, under the difficult condition in calcareous soil as compared to compost and sulfur. This emphases the importance of organic materials to minimize consuming chemical fertilizers and avoid environmental pollution hazards.

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انطلاق الفوسفور من صخر الفوسفات تحت تأثير المحسنات العضوية والغير عضوية على نبات القمح

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تهدف الدراسة الحاليه الى تقييم تأثير المواد العضوية مثل كمبوست قش الارز، حمض الهيوميك (HA)، حمض الفلفيك (FA) والكبريت الزراعى (S) والمضافة الى صخر الفوسفات على تيسر الفوسفور وبعض العناصر الكبرى في الارض الجيرية بمزرعة الجلاء غرب النوبارية المنزرعة بنبات القمح خلال الموسم الشتوى ٢٠٠٦-٢٠٠٧.

أظهرت النتائج المتحصل عليها وجود تأثير ايجابى لاضافة حمض الهيوميك والفلفيك للصخر الفوسفاتى وتلقيحة بالبكتريا على انطلاق الفوسفور، كما اعطت اعلى قيم لمفصولات كل من: H_2O-P, $NaHOC_3$-P, EDTA-P and Occ-P بزيادة فترات التحضين حتى ٢١ يوما كما أدت الى زيادة تدريجية في دليل التيسر (AI) وأكدت النتائج ان أضافة المواد العضوية له تأثير ايجابى في تحسين خواص التربة تحت الدراسة حيث احدثت نقص تدريجي في قيم كل من درجة التوصيل الهيدروليكى (EC). ودرجةالحموضة (pH). و زياده فى قيم المادة العضوية (OM).

بالاضافة الى ان المعاملة (HA+RP+B) ادت الى زيادة تركيز الميسر بالتربة من النتروجين والفوسفور والبوتاسيوم بحوالى ٨٤، ٨٧، ٣٩% على التوالى والتى كانت اكبر من معامله صخر الفوسفاتى بمفردة.

كما اشارت النتائج المتحصل عليها الى وحود تأثير كبيرً على تركيز العناصر في نبات القمح بتطبيق المعاملات الفردية او المركبة على كل من النتروجين والفوسفور والبوتاسيوم في كل من المجموع الخضرى والحبوب حيث يمكن ترتيبها كالاتى:

MF>HA+RP+B>FA+RP+B>S+RP+B للنتروجين بينما كانت لكل من الفوسفور والبوتاسيوم كالاتى: HA+RP+B>FA+RP+B>S+RP+B>MF

سجلت المعاملات تحت الدراسة خاصة المعاملات المركبة تأثير ايجابى على كمية و جودة حبوب القمح والقش (كجم / فدان)، وزن الـ ١٠٠٠ حبة وايضاً محتواة من النتروجين الفوسفور والبوتاسيوم والبروتين والاحماض الامينية ويرجع ذلك الى ثرائها بالمعادن و المركبات العضوية والحيوية النشطة والتى لها القدرة على خلب المغذيات فى صورة ميسرة مما ينعكس ايجابياً على انتاج نبات القمح ومكوناته وهذا يظهر اهمية المركبات العضوية في ترشيد استهلاك الاسمدة المعدنية وتفادى اضرار تلوث البيئة مع خفض التكلفة (عند عمل تقييم اقتصادى بحساب عامل المنفعة الى التكلفة B/C).