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Maximizing Available Phosphorus in Calcareous Soils by Addition Compost and Inorganic Phosphorus Forms

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Abstract: In calcareous soils, phosphorus (P) retention and immobilization take place due to precipitation and adsorption. Also, addition of organic manure could improve the soil physical and chemical conditions besides it might increase the efficiency of added P fertilizer and provide additional source of nutrients. Information on the availability of P following inorganic fertilizer and compost addition to calcareous soil may help in better management of P fertilization. The objective of this studied was to study the combination effect of organic fertilizers addition (compost) and different forms of inorganic phosphorus fertilizers on the improvement of phosphorus use efficiency by maximizing its availability in calcareous soil and accumulation in biological yield of wheat(cv Giza168). The treatments includedthree inorganic-P forms (*i.e*. calcium super phosphate15 % P_2O_5 (**P_1**), triple super phosphate 42% P_2O_5 (**P_2**) and phosphoric acid72.4% P_2O_5 (**P_3**) and control (without P) which combined with three rates of compost (0, 10 and 20 m^3.fed.$^{-1}$).The change in the amount of available P in soil was measured during wheat growth at three periods (*i.e.* tillering, spike development and maturity stages) in a field experiment on a calcareous soil.
The amount of availableP in soil was determined by Olsen and analyzed statistically.On the other hand, the wheat plant parameters (*i.e*. biological yield, grains quality and plant nutritional status) were measured and analyzed. Results indicated that mean values of available P in soil were significantly increased with increasing the rates of compost combined with inorganic P particularly at 10 m^3.Fed.$^{-1}$ with either triple super phosphate (**P_2**)or phosphoric acid (**P_3**),while the obtained increases of available P content with increasing the rats of compost addition up to 20 m^3.fed^{-1} were low compared to the rate 10 m^3.Fed.$^{-1}$. These decreasing may be attributed to the stimulatory effects of higher rate from compost in presence of these two forms (**P_2, P_3**)to enhance the precipitation and adsorption conditions or formation of less soluble complexes with Ca^{2+}cations, then showed significantly decreasing along with age of plant. Also, this increase reflected significantly increasing in most studied parameters of plants.
Finally, the data obtained for either percentage increase yield or phosphorous forms use efficiency (PFUE) appearedparallel trends. So,the highest percentage increases were at used the rate (10 m^3.Fed.$^{-1}$) combined with inorganic **P_2**and **P_3**,and then significantly decreased with increasing the rats of compost addition up to 20 m^3.Fed.$^{-1}$, this decreasing were highest at used **P_3**compared **P_2**.It is difficult to understand the difference between the role effect of **P_2** and**P_3** with compost.For these reason,it needs number of specific experimental for explain these process.
Key wards: Calcareous Soil, Compost amendment and Inorganic P forms.

Introduction:

Wheat (*TriticumstivumL.*) is the most important cereal crop in the world. InEgypt, increasing importance of wheat is due to the large increase in the gap between production and consumption, a huge increment of population and the low level of national income. Therefore, Egypt is considered the biggest importer of wheat in the world. Extensive efforts are continuously paid for increasing its productivity by means of vertical and/or horizontal planting. Increases of wheat production to contribute in solving food problem.In general, under such unfavorable conditions (in new reclaimed sandy calcareous soils) and in soil characterized as low fertile, low organic matter content and high leaching rate let the production of most crops not economic and farmers have to apply high rates of chemical fertilizers to maintain satisfactory yield[1]. There are several ways for increasing wheat production especially in the newly reclaimed areas; one of them is the appropriate application of integrated plant nutrient supply system following balanced fertilization needs to be developed for resource, poor farmers to sustain the potential productivity.

Phosphorus as one of the important nutritional elements in metabolic processes *i.e.,* plant growth, total and early fruits yield has a vital role as a main constituent of energy compounds, nucleic acids, phospholipids and co-enzymes. Many literatures such as[2, 3] and [4]who reported that, phosphorus fertilizer had a significant effect on plant growth and its yield. As well as the different forms of phosphorus affected the physical and chemical properties of vegetable fruits, [5]. In spite of, most literatures reported that, the effect of phosphorus varied according to its source. Whereas, the application of chemically treated source like calcium super-phosphate results in better plant growth, higher fruits yield compared to the addition natural phosphorus like rock phosphate[6]. Also, several studies [7] and [8]suggest that organic sources of P are more effective for plant absorption than inorganic ones.

Application of phosphorus fertilizers in agricultural calcareous soils has introduced some problems mainly due to P fixation, low recovery and accumulation in soil. Decrease in availability of P is suggested to be a complex function of several factors such as: soil chemical composition, amount and reactivity of silicate clays, $CaCO_3$, Fe oxides, P addition rates and time,[9]. In general, in calcareous soils major factor in decreasing phosphorus sorption capacity is phosphorus precipitation in form of calcium phosphate. Organic and biologic fertilizers increased uptake due to the increased solubility and decreased precipitation, [10]**.** Generally,manure application had an appreciable and different impact on the chemical fractions of P in calcareous soils as P from manure gradually turned into available forms over the time,[11].

Organic sources of P are known to increase P availability more than inorganic P fertilizers and enhance efficient use of applied P fertilizer,[12]. The synergistic effect of manure application along with P fertilizer on increasing soil test P concentration has been reported by[13],[14],[15]and[16]**.** Moreover,[17]reported that organic amendments consisting of a mixture of humic and fulvic acids increased recovery of applied P by bicarbonate (Olsen-P).This was due to decreases in the precipitation rate of poorly soluble Ca phosphate by organic amendments. Finally,[18]reported that application of organic and compost to the newly reclaimed lands maintain ecologicalbalance and develops biological processes to their optimum. In addition to preservation of soil structure, earthworm and microorganisms, addition of composts improve soil chemical propertiesincluding decrease soil pH, increase cation exchange capacity (CEC) and enhance the availability of the most nutrient important for plant growth and agricultural production. It increases the water holding capacity and improves the soil structure and aggregates.The intensive use of compost for increasing agricultural production, maintaining and enhancing soil fertility and decreasing pollution hazards is of vital importance especially in the newly reclaimed soil.

So, this work aims to evaluate direct application of compost and inorganic phosphorus forms on the changes of availability of phosphorus in calcareous soil and his accumulation in biological yield of wheat. In addition to evaluate the phosphorus forms use efficiency and also to detect the availability of phosphorus following organic and /or inorganic phosphorus forms addition to soil may help to a better management of P fertilization of the crop in respect to plant growthin the newly reclaimed soil.

Materials and methods:

Filed experiment was conducted at Nubaria Agriculture Research Station, Behera Governorate, Egypt., during winter seasons 2012/2013 to study the response of wheat to the application different forms of phosphorus fertilizer individually or combined with compos tunder calcareous soil conditions. Wheat grains (*TriticumAestivum* L.) cv Giza 168 were sown. Soil samples were collected, air-dried and analyzed, texture was determined by the hydrometer method, soil organic C was analyzed using Walkley and Black method. Soil pH was determined in 1:2.5 soil/water suspension after 0.5 h.ECe was determined in a soil paste extract, cation exchange capacity was measured by 1MNaOAc buffered at pH 8.2 and total $CaCO_3$ was determined using the calcimeter method, according to[19]. Available Pwas determined by the Olsen method [20].The Murphy-Riley (MR) colorimetric method was widely used for environmental P determination, which uses ammonium molybdate, ascorbic acid, and antimony potassium tartrate to develop a blue color with P (absorption at 880 nm),[21].The chemical characteristics of the experimental soil are presented in Table (1) and compost analysis is shown in Table (2).

Table No.1: Some characteristics of the investigated soil at Nubaria Agriculture Research *Station.*

Depth (Cm)	O.M (%)	$CaCO_3$ (%)	Available Macro-nutrients ($mg.kg^{-1}$Soil)			Particle size Distribution (%)			Texture
			N	P		Sand	Silt	Clay	
0-20	0.41	23.72	12.7	2.14		56.64	23.13	20.23	**Sandy Loam**
20- 40	0.28	25.16	10.1	1.46		51.42	19.66	28.92	**Sandy Clay Loam**
Depth (Cm)	**pH (1:2.5)**	**EC (dS/m)**	**Soluble Ions (m.e/L)**						
			Cations				**Anions**		
			Na^+	K^+	Ca^{++}	Mg^{++}	$HCO_3^=$	Cl^-	$SO_4^=$
0-20	8.22	2.23	9.73	5.43	5.13	2.01	3.78	11.20	7.82
20- 40	8.29	2.49	10.62	3.80	7.18	3.30	3.85	12.43	8.62

The design of the experiment area was arranged in a split plot with three replicates. The main plots were three rates of compost (0, 10 and 20 m^3.fed.$^{-1}$.), the sub plots werefour treatments, 3 plots treated by the same recommended doses (45 kg P_2O_5 fed^{-1}) of phosphorus and each with one form of inorganicP fertilizer; $\mathbf{P_1}$calcium super phosphate 15 % P_2O_5, $\mathbf{P_2}$ triple super phosphate 46 % P_2O_5 and $\mathbf{P_3}$ phosphoric acid 72.4 % P_2O_5 and The fourth was without phosphorus (Control$\mathbf{P_0}$). The P additions were broadcasting and incorporated with soil after compost addition before planting. Each treatment was replicated three times. Nitrogen and Potassium fertilizers were added in the form of ammonium nitrate 33.5% N and potassium sulfate (48 % K_2O),at recommended doses (100 kg Nfed^{-1} and 24 kg Kfed.$^{-1}$ respectively)and the other usual agricultural practices were conducted as recommended by Ministry of Agriculture.

Table No.2:Some characteristics of the compost added to soil experiment.

O.M (%)	O.C (%)	C:N ratio	SP (%)	$CaCO_3$ (%)	Available Macro-nutrients ($mg.kg^{-1}$ Compost)			CEC meq.100 g Compost^{-1}
					N	P	K	
33.1	19	19	100	3.3	2180	22.23	6450	79
pH (1:2.5)	**EC (dS/m)**	**Soluble Ions (meq.100g Compost^{-1})**						
		Cations				**Anions**		
		Na^+	K^+	Ca^{++}	Mg^{++}	$HCO_3^=$	Cl^-	$SO_4^=$
7.2	24	9.73	8	9.9	2.8	2.75	20	14.5

Soil samples (0-20 cm) were collected from each treatment at tillering, spike development and maturity, air dried, crushed and passed through a 2-mm sieve for estimating available P by the Olsen method [20].Phosphorus concentration in extracts was determined by the colorimetric method of [22].Wheat plant samples were taken from each treatment at the studied growth periodswhich separated to shoots and roots at tillering stageand separated at maturity to grains and straw.Plant sample were dried at 70 C^0 and digested for chemical determinations according to [23].Nitrogen, P and K content in the digests straw and grains were determined according to the methods described by [24]and [25].

At harvesting time, the wheat plants were harvested from each plot.Grain andstraw were weighed andrelated to kg.fed.$^{-1}$. The following data of someparameters were recorded: such as plant height(cm), spike length (cm),1000grains weight (g)and biological yield(kg.fed.$^{-1}$). The percent increase in yield was calculated by using formula:

$$(\text{Increase in yield }\%) = \frac{(\text{Yield of Treatment} - \text{Yield of Control})}{\text{Yield of Control}}\ X\ 100$$

Plant analysis and dry matter data were utilized to calculate plant nutrient uptake, P forms use efficiency **(PFUE)** which was calculated by using formula:

$$PFUE = [(Pf - Pc) / P] \times 100.$$

Where Pf and Pc are total P uptake from fertilizer)inorganic Phosphorus)and control plots (without or with compost) respectively, and P is the applied forms of phosphorus in kg.Fed.$^{-1}$. Phosphorus uptake calculated from total P measured in plants (straw + grain) was multiplied by total yield in kg.fed^{-1}and then divided by 100,[26].

Statistical analysis:

All data analysis of variance normally was assessingby using Minitab computer program and least significant difference(L.S.D) was calculated at level of 5% [27].

Results and Discussion:

Amount of available P in soil at different stages:

Data in Table (3) declared that increasing the rates of compost addition, caused increasing in availability of P in soil which was raised significantly from 8.74 mg.kg^{-1} at control to 12.40 and 12.42 mg.kg^{-1} with addition of 10 or 20 m^{3}compost.fed.$^{-1}$ respectively, without significant difference among them.On the other hand, the inorganic P-forms treatments appeared significant effect on increasing available P in soil compared to the control to 130.7%, 166.9% and 172.8% with P_1, P_2 and P_3, respectively.Those significant increasesmay be attributed to their compacting for precipitation and adsorption conditions in calcareous soil. These results are in agreement with those obtained by[28]who found that acidic P fertilizer (phosphoric acid) could result in low P adsorption compared to alkaline one. Although there is limited information available comparing the effect of acidic and alkaline P source on its adsorption/precipitation in soil.

Table No.3:Mean values and statistical analysis of studied individually and interactions treatments on the availability of P in soil (mg.kg^{-1}).

Treatments		Inorganic P-forms					LSD at 0.05 level
Growth Stage	Compost m^3.fed^{-1}	P0	P1	P2	P3	mean available P (mg.kg^{-1})	
Tillering	0	2.90	19.20	19.63	19.90	15.41	Compost (C) Posph. (P) Stages (S) ------------- C : 0.21 P : 0.24 S : 0. 21 CP : 0.42 CS : 0.42 PS : 0.36 CPS : 0.72
	10	7.40	22.00	21.90	22.77	18.52	
	20	10.93	24.07	23.63	24.23	20.72	
	mean	7.08	21.76	21.72	22.30	18.22	
Spike development	0	2.17	5.57	9.13	9.73	6.65	
	10	5.73	10.17	14.83	14.87	11.40	
	20	8.20	10.97	12.27	11.23	10.67	
	mean	5.37	8.90	12.08	11.94	9.56	
Harvesting	0	2.02	3.20	5.59	5.80	4.15	
	10	3.43	6.23	9.42	10.10	7.30	
	20	3.43	5.37	7.11	7.59	5.87	
	mean	2.96	4.93	7.37	7.83	5.77	
Compost mean	0	2.36	9.32	11.45	11.81	8.74	
	10	5.52	12.80	15.38	15.91	12.40	
	20	7.52	13.47	14.34	14.35	12.42	
	mean	5.13	11.86	13.72	14.02	11.19	

P_0 = Control (without phosphorus).	**P_2= (T**riple super phosphate)
P_1 = (Calcium super phosphate)	**P_3** = (Phosphoric acid)

The data of P concentration (mg.kg^{-1}soil) in soil which taken at different growth period presented in table (3) showed that strongly decreasing and highly significantly with the time, which the maximum concentration of available P was at the first stage (tilleringstage) and then decline with 47.4% at the spike development stageand 68.3% at maturitystage, from 18.21 to 9.57 then 5.77 mg. kg^{-1} respectively. thisdecrease may be attributed to increasing the consumption of P element with increasing plant growth, also increasing the role of Ca^{2+} which is dominant ion in soil solution of calcareous soils and it is possible to formless soluble complexes with weak acid anions like orthophosphate is due to unavoidable dominance of this ion. The dynamics of P is managed by calcite, which strongly holds P and consequently maintains low P concentration in soil solution. These notes were in agreement with those obtained by [29]who found that mineral P fertilization help increase the amount of available P in the soil in the first stage and then decreases as time of incubation goes on.

Data illustrated in table (3) indicated a clear response to studied treatment interactions on the availability of P.The increase in availability of P was greatly in case of compost addition.In this concern,[13]showed that the combined addition of poultry manure and fertilizer P had a synergistic effect and increased Olsen extractable P compared with fertilizer P alone. These finding are consistent with [30]who reported that application of manure combined with fertilizer P increased P recovery as Olsen-P compared with separate application of fertilizer. On the other hand, it's appear the same trend of inorganic P-forms , while the obtained increases of available P content with increasing the rates of compost addition up to 20 $m^3.fed^{-1}$ were slight compared to the rate 10 $m^3.fed^{-1}$ particularly at used both triple super phosphate (**P_2**)or phosphoric acid (**P_3**).This decrease may be attributed to the stimulatory effects of higher rate from compost in presence these forms (**P_2, P_3**)to enhance the precipitation and adsorption conditions or formation of less soluble complexes with Ca^{2+}cations, also these results may be attributed to character of compost addition, which the largely amount of phytate in higher rates of compost showed negatively effect on P solubility. These results were in agreements with [31]who showed that in the short term, manures with large phytate contents can demonstrate lower phosphorus solubility on calcareous soil.

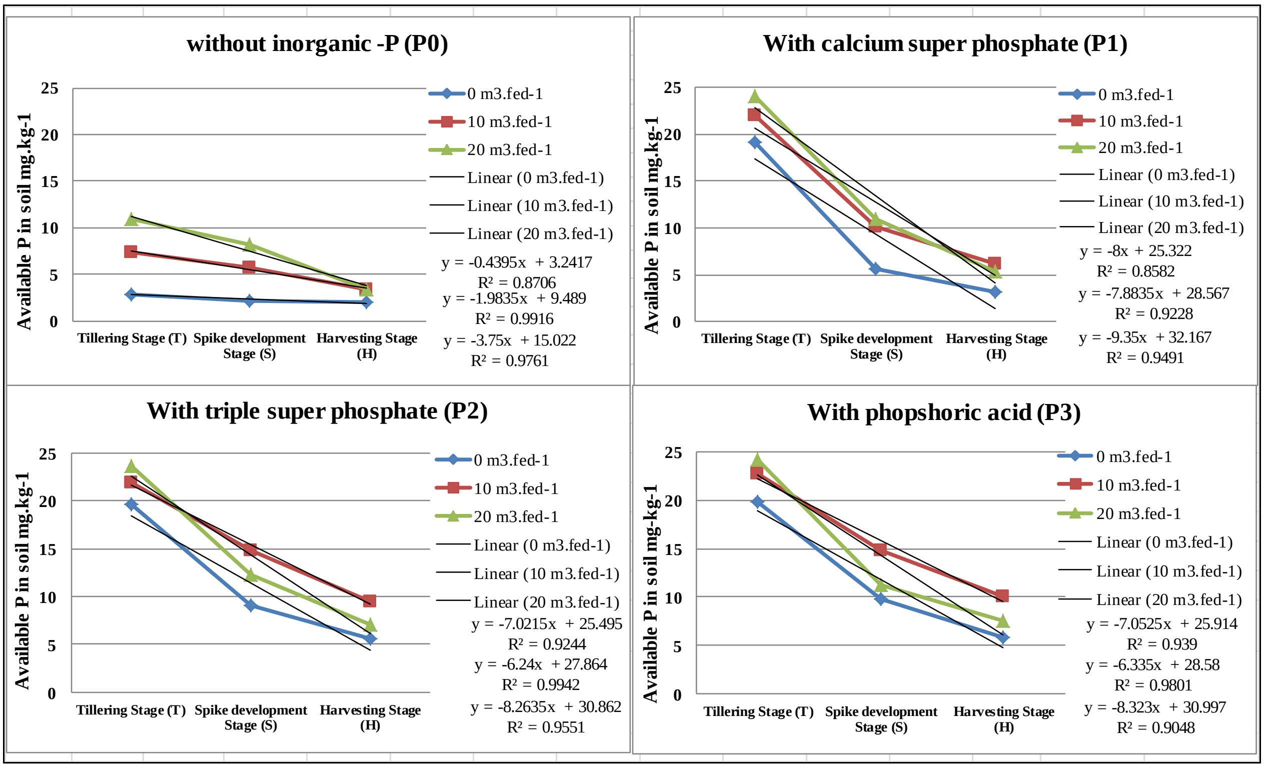

Figure No.1:Effect of applied treatments on the change of phosphorous availability in calcareous soil.

On the other hand, the means value of available P in soil which presented in table (3) and figure (1) as a results to the interactions between P- forms addition and age of plant growth or between rates of compost and growth period showed significant decrease with increasing age of plant (time). The high available P content in soil at the first growth stage of wheat began accelerate decreasing up to harvest. It is noteworthy to mention that increasing the available P in soil with increasing the rate of compost this increasing were gradually decreasing with the age of plant especially at high rate (20 m^3. $fed.^{-1}$) P availabilities were decreased to 48.5% , 71.67% at 20 $m^3.fed.^{-1}$, 38.44% and 60.58% at 10 $m^3.fed.^{-1}$and 56.84%, 73.07% at 0 $m^3.fed.^{-1}$for spike development stageand maturity stage compared with tillering stage respectively, these results indicated that the recommended rate of compost is 10 $m^3.fed.^{-1}$ for calcareous soil, which plant have been supplied by their requirements regularly through different growth period that have positive effect on plant productions. In the other hand, the progressively decreasing up to 73.07 % from P available until harvest at control (without compost) may be attributed to P deficiency and the quantity of P available isn't sufficient for plant growth, as soon as decreasing the use inorganic P efficiency under condition of calcareous soil. Also, the progressively decreasing up to 71.67 % from available P until harvest at high rates addition of compost (20 m^3. $fed.^{-1}$) may be attributed to the association of plant consumption and process of precipitation and adsorption for P element in present highly concentration of compost in calcareous soil.

Due to the interaction effect of inorganic P formsand different growth periodon the availability of P, there are decreasing down to 44.38%, 46.45% and 59.09% as a results to useP_2, P_3 and P_1forms respectivelyup to the spike development stage.On the other hand, there was another arrangement for these forms corresponding to their different effect on the availability of P in the period from spike development till harvest namely phosphoric acid **(P_3),** triple super phosphate (**P_2**) then calcium super phosphate (**P_1**) in the order; 64.88%, 66.06% and 77.34% respectively. These results indicated that the form (**P_2**) or (**P_3**) was superior to the (**P_1**).

Data in table (3) showed an obvious response for available P content in calcareous soil by application of (**P_2**) or (**P_3**) in presence the lowest addition rate of compost (10 m^3. $fed.^{-1}$), as best treatments. These peaks were regularly decreased with advancing plant age without limiting effect on plant growth. On the other hand, the highest values of available P content at the first age of plant when applied the same inorganic P forms with the highest rates of compost (20m^3.$fed.^{-1}$)which had negative effect on plant growth.

Vegetative growth parameters:

Table No.3:Effect of applied treatments on growth parameter and yield components:

Treatments			Inorganic P-forms					LSD at 0.05 level
Items Studied		Compost $m^3.fed^{-1}$	P0	P1	P2	P3	mean	
Parameters of wheat growth	Plant height (cm)	0	87.3	88.1	84.8	86.1	*86.6*	C : 3.4 P : ns CP : ns
		10	87.4	93.3	95.2	89.7	*91.4*	
		20	94.4	93.2	97.3	91.0	*94.0*	
		mean	***89.7***	***91.5***	***92.4***	***88.9***	***90.7***	
	Spike length (cm)	0	9.2	9.7	9.5	9.5	*9.5*	C : ns P : ns CP : ns
		10	9.1	9.3	9.8	9.8	*9.5*	
		20	10.5	8.8	10.9	10.7	*10.2*	
		mean	***9.6***	***9.3***	***10.1***	***10.0***	***9.7***	
Biological yield ($kg.fed^{-1}$)	Grains $kg.fed^{-1}$	0	2055.2	2828.0	3100.7	3012.8	*2749.2*	C : 224.7 P : 259.5 CP : ns
		10	2284.8	3096.8	3382.4	3371.2	*3033.8*	
		20	2340.8	2940.0	2940.0	2475.2	*2674.0*	
		mean	***2226.9***	***2954.9***	***3141.0***	***2953.1***	***2819.0***	
	Straw $kg.fed^{-1}$	0	3287.2	3948.0	4224.1	4071.2	*3882.6*	C : 338.8 P : 391.2 CP :731.2
		10	3315.2	4093.6	4821.6	6092.8	*4580.8*	
		20	3752.0	4205.6	4424.0	4356.8	*4184.6*	
		mean	***3451.5***	***4082.4***	***4489.9***	***4840.3***	***4216.0***	
	Total dray w. $kg.fed^{-1}$	0	5342.4	6776.0	7324.8	7084.0	*6631.8*	C : 500.7 P : 578.1 CP :1053.0
		10	5600.0	7190.4	8204.0	9464.0	*7614.6*	
		20	6092.8	7145.6	7364.0	6832.0	*6858.6*	
		mean	***5678.4***	***7037.3***	***7630.9***	***7793.3***	***7035.0***	
Wheat grain quality parametr	1000-grain weight (g)	0	44.5	45.7	45.5	45.3	*45.3*	C : ns P : ns CP : ns
		10	44.9	45.1	45.5	44.5	*45.0*	
		20	45.5	48.3	44.9	45.6	*46.1*	
		mean	***45.0***	***46.4***	***45.3***	***45.1***	***45.5***	
	Croud protine %	0	18.2	15.8	18.4	15.9	*17.1*	C : ns P : ns CP : ns
		10	16.1	16.6	16.5	16.8	*16.5*	
		20	16.4	18.3	18.1	15.3	*17.0*	
		mean	***16.9***	***16.9***	***17.7***	***16.0***	***16.9***	
Harvest Index %		0	38.5	42.0	42.3	42.6	*41.4*	C : 1.8 P : 2.1 CP :3.9
		10	41.0	42.8	41.1	35.6	*40.1*	
		20	38.4	41.2	40.1	36.3	*39.0*	
		mean	***39.3***	***42.0***	***41.2***	***38.2***	***40.2***	

The statistically analysis data presented in Table (4) and figure (2) showed the effect of applied inorganic -P forms and rates of compost (individually or combined) on some vegetative growth parameters i.e., plant height (cm), spike length (cm) of wheat plants and grains, straw, total yield, 1000 grain weight, crude protein and harvest index.

All measured parameters were slightly increased with addition of P forms either without or with compost compared to the control treatment. As the general, these increases may be due to the enhanced effect of P element in metabolic processes *i.e.,* plant growth, many of biological activities within plant tissues and early fruits yield and production. [2,3]and [4]However, the plants received triple super phosphate (**P_2**)resulted increasesin plant height (cm), spike length (cm), grains yield (kg. fed.$^{-1}$) and crude protein (%) either individually or combined with compost. Data also declared that application rates of compost particularly 10 m^3.fed^{-1}to the studied calcareous soil had positive effects on that studied parameters where it augmented the dry weights of wheat straw and grain yields. These increases were attributed to improving soil capacity to gradually liberate available plant nutrients that are still in maintained active forms for uptake by plant roots, but this role was dominated with increasing the rate of compost addition up to 20 m^3.fed^{-1}, which all biological yield parameter were decreased but almostly stile over the plants untreated with compost.

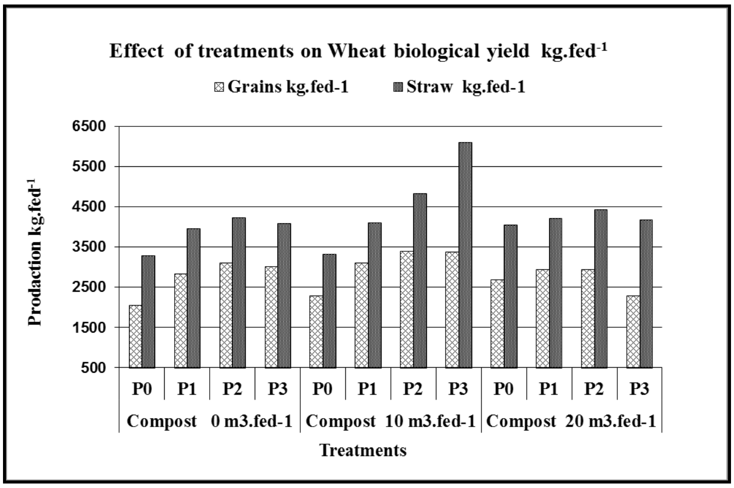

Figure No.1:Effect of applied treatments on wheat biological yield:

Table No.5:*Effect of applied treatments on wheat plant nutrient contents at different growth stage:*

Treatments		Tillering Stage				Harvesting Stage					
		Shoot		Root		Strow			Grains		
		P %	K%	P %	K%	N%	P %	K%	N%	P %	K%
Compost m^3. fed^{-1} (C)	0	0.28	4.12	0.12	0.97	2.02	0.20	4.37	2.88	0.39	4.99
	10	0.29	3.99	0.12	1.09	1.98	0.22	4.22	2.77	0.42	4.95
	20	0.26	3.82	0.13	0.93	1.85	0.21	4.22	2.86	0.39	4.95
LSD at 0.05 level (C)		***ns***	***0.16***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***
P- forms (P)	P0	0.28	3.89	0.12	1.06	2.04	0.20	4.32	2.84	0.37	4.98
	P1	0.28	4.07	0.12	1.02	2.01	0.21	4.24	2.85	0.41	4.91
	P2	0.27	4.00	0.13	0.93	1.89	0.23	4.24	2.97	0.39	4.99
	P3	0.27	3.94	0.12	0.98	1.87	0.20	4.29	2.69	0.43	4.97
LSD at 0.05 level (P)		***ns***	***ns***	***ns***	***ns***	***ns***	***0.02***	***ns***	***ns***	***0.03***	***ns***
Compost 0 m^3.fed^{-1}	P0	0.29	4.19	0.12	1.02	2.02	0.18	4.41	3.07	0.34	4.99
	P1	0.29	4.14	0.12	0.97	2.11	0.20	4.27	2.66	0.38	4.96
	P2	0.27	4.11	0.13	0.97	2.01	0.23	4.61	3.10	0.39	5.01
	P3	0.25	4.03	0.12	0.93	1.96	0.21	4.20	2.68	0.46	5.02
Compost 10 m^3.fed^{-1}	P0	0.29	3.90	0.12	1.25	2.21	0.21	4.32	2.70	0.38	5.05
	P1	0.29	4.12	0.12	1.06	1.92	0.22	4.12	2.79	0.44	4.85
	P2	0.29	4.08	0.12	0.95	1.83	0.24	3.90	2.77	0.41	5.00
	P3	0.30	3.85	0.12	1.09	1.94	0.21	4.53	2.82	0.44	4.91
Compost 20 m^3.fed^{-1}	P0	0.27	3.57	0.13	0.92	1.88	0.21	4.23	2.76	0.40	4.91
	P1	0.28	3.95	0.13	1.03	1.99	0.22	4.32	3.08	0.41	4.93
	P2	0.25	3.81	0.12	0.86	1.81	0.23	4.21	3.04	0.38	4.97
	P3	0.26	3.94	0.12	0.91	1.71	0.19	4.13	2.57	0.39	4.99
LSD at 0.05 level (C P)		***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***0.05***	***ns***

The significant response of biological yield to the applied inorganic -P forms in combination with compost may be due to the positive effect of both of them.All observations emphasized the beneficial effect on plant growth by enhancing the availability of nutrients in soil as a result of this combination. On the other hand, compost application had an appreciable and different impact on the chemical fractions of P in calcareous soils which increased P availability and enhanced efficient use of applied P fertilizer. This phenomena was limited with increasing compost addition, where the obtained increases in biological yield due tothe treatment of 10 m^3.fed.$^{-1}$ were higher than those of 20 m^3.fed.$^{-1}$ particularly with P forms (**P_2 or P_3**) compared with control (without P and compost)**.** These increases were (64.5, 46.7 %) and (64,85.3%) for grains and straw at addition of **P_2** and **P_3**combined with 10 m^3. compostfed^{-1}and the harvest index for these treatments was 41.1% and 35.6%, respectively.

The data presented in Table (5) showed insignificantly effect due to applied inorganic P forms and rates of compost (individually or combined) on macronutrients studied at most of plant stages, except addition either P_2 or P_3forms individually on P content in plant, while it had significant effect on P content in straw and grains respectively.

Table No.6:Statistical analysis of macronutrients uptake by straw and grains of wheat as affected by studied treatments:

Treatments		Straw			Grains			Total uptak by wheat plant		
		N kg.fed^{-1}	P kg.fed^{-1}	K kg.fed^{-1}	N kg.fed^{-1}	P kg.fed^{-1}	K kg.fed^{-1}	N kg.fed^{-1}	P kg.fed^{-1}	K kg.fed^{-1}
Compost m^3. fed^{-1} (C)	0	78.2	8.0	169.9	78.9	10.9	137.3	157.1	18.9	307.2
	10	90.0	10.0	194.3	84.4	12.7	150.1	174.4	22.7	344.4
	20	76.9	8.9	176.5	77.2	10.5	132.4	154.2	19.4	308.9
LSD at 0.05 level (C)		*9.5*	*1.0*	*19.9*	*ns*	*0.9*	*11.9*	*ns*	*1.3*	*27.6*
P- forms (P)	P0	70.0	7.0	148.9	63.2	8.3	110.9	133.2	15.3	259.8
	P1	82.0	8.7	173.8	84.7	12.1	145.0	166.7	20.7	318.8
	P2	84.3	10.5	189.5	93.0	12.3	157.1	177.3	22.8	346.6
	P3	90.6	9.8	208.7	79.8	12.7	146.7	170.4	22.5	355.4
LSD at 0.05 level (P)		*11.0*	*1.2*	*23.0*	*15.1*	*1.1*	*13.7*	*23.2*	*1.5*	*31.9*
Compost 0 m^3.fed^{-1}	P0	66.1	6.0	144.6	63.0	7.1	102.5	129.1	13.1	247.1
	P1	82.5	7.7	169.6	75.5	10.7	140.3	158.1	18.5	309.9
	P2	85.1	9.7	194.6	96.1	12.0	155.2	181.2	21.7	349.9
	P3	79.3	8.4	170.8	80.9	13.8	151.3	160.2	22.2	322.0
Compost 10 m^3.fed^{-1}	P0	73.2	6.8	143.2	61.5	8.6	115.3	134.7	15.4	258.5
	P1	80.2	8.9	170.2	87.6	13.5	149.8	167.8	22.4	320.0
	P2	88.4	11.7	187.9	93.3	14.0	169.9	181.7	25.7	357.8
	P3	118.2	12.6	276.0	95.1	14.9	165.4	213.3	27.5	441.4
Compost 20 m^3.fed^{-1}	P0	70.7	8.0	158.8	65.2	9.4	114.9	135.9	17.4	273.8
	P1	83.4	9.4	181.6	90.9	11.9	145.0	174.3	21.3	326.7
	P2	79.3	10.1	186.0	89.5	11.1	146.2	168.8	21.2	332.1
	P3	74.4	8.3	179.5	63.3	9.6	123.4	137.7	17.8	302.9
LSD at 0.05 level (C P)		*19.0*	*2.0*	*39.8*	*ns*	*1.9*	*ns*	*ns*	*2.5*	*55.2*

Table No.7:*Effect of studied treatments on relative increase in wheat yield and (PFUE):*

Treatments		% increase in yield				P forms use efficiency (PFUE) %			
		P0	P1	P2	P3	P0	P1	P2	P3
Compost m^3.fed^{-1} (C)	0	Control	37.60	50.87	46.59	-	12.01	19.12	20.24
	10	11.17	50.68	64.58	64.03	-	15.42	22.73	26.67
	20	13.90	43.05	43.05	20.44	-	8.83	8.49	1.02

Concerning the applied of different P forms individually, data in table(7) indicated that the increase in yield obtained from using P_2> P_3> P_1 compared to the control, these values were greatly increased with10 m^{-3}. fed.$^{-1}$addition rate which appeared the same trend (P_2> P_3> P_1), while increasing rate of compost up to 20 m^-

^{3}.fed.$^{-1}$decreased these percentage particularly at using P_3form. Also the values of PFUE were highest due to application P_3 when compared with both P_2 and P_1 respectively without compost addition. The same trend was detected when P application at different forms combined with compost at rate of 10 m^{-3}. fed.$^{-1}$but the values were highest in case ofadditions individually. It worth to mention that the application of compost at rate of 20 m^{-3}.fed.$^{-1}$combined with different P forms in this work caused a decreased in PFUE up to minimum values particularly at used form acid fertilizer (P_3). These results were attributed to number of reasons: *ie*, addition of this rate of compost will increase the total surface area for calcareous soil, [32]found that the reactivity of $CaCO_3$in soils depends upon the specific surface area of the carbonate and on its total surface area. It has been demonstrated that $Ca^{2+}$is dominant ion in soil solution of calcareous soils and it is possible that formation of less soluble complexes with weak acid anions like orthophosphate is due to unavoidable dominance of this ion. The dynamics of P is managed by calcite, which strongly holds P and consequently maintains low P concentration insoil solution,[33]. Also, addition of highest rate of compost may be contain large amount of phytatewhich showed negative effect on P solubility.

Conclusion:

Application of compost combined chemical phosphorus fertilizer increased Olsen P valueand enhanced the efficiency of added phosphorus as compared to separate P forms application.These values were decreased differently at used rate of 20 m^{-3}. fed.$^{-1}$combined with different P forms.Therefore, it may be concluded that interaction with treatment application in this work had an appreciable and different impact on the availability of P in calcareous soils.These phenomena complexes need to laboratory quantitative and qualitative specific studies using ^{32}P to identify whether plant consumption or process of precipitation and adsorptionhas the positive effect in Pstatus in soil solution and plant tissues.

References:

1. Zeidan E.M.,Abd El-HameedI.M.,BassiounyA.H. and WalyA.A.,Effect of irrigation intervals, nitrogen and organic fertilization on yield, yield attributes and crude protein content of some wheat cultivars under newly reclaimed saline soil condition.4th Conference on Recent Technologies in Agriculture,2009.
2. MahmoudH.A.F. and AmaraM.A.T., Response of tomato to biological and mineral fertilizers under calcareous soil conditions. Cairo, Egypt. Bulletin of Faculty of Agric. Cairo Univ.2000, 51, (2), 151-174.
3. Anil-More S.A.,HiremathB.M.,Chittapur and ChimmadV.P., Effect of green manuring and forms of phosphorus on the productivity of chillit cotton intercropping system. Krnataka Journal of Agric. Sciences, 2005, 18, (2), 297-301.
4. Choudhuy, M.R.,TalukdarN.C. and SaikiaA., Effect of integrated nutrient management on growth and productivity of brinjal. India Crops, 2005, 6, (3), 551-554.
5. Aliyu, L.S., SingA.,MagajiM.D. and UmarM.S., Variety and phosphate effects on yield and yield components of cowpea. Journal of Plant Sciences, 2007, 2, (6), 583-591.
6. Hafez, Magda M. and Asmaa R. Mahmoud, Effect of the Natural and Chemical Phosphorus Fertilization as Individually And/or Mixed on the Productivity of Eggplant. Res. J. Agric. & Biol. Sci., 2009,5, (4), 344 - 348.
7. Courtney R.G. and MullenG.J., Soil quality and barley growth as influenced by the land application of two compost types. Biores. Technol., j.biortech.2007.06.034
8. Gil M.V.,CarballoM.T. and CalvoL.F., Fertilization of maize with compost from cattle manure supplemented with additional mineral nutrients. Waste Manag., doi:10.1016/j.wasman.2007.05.009
9. Afif, E.,MatarA.and Torrent J.,Availability of phosphate applied to calcareous soils of west Asia and North Africa. Soil Sci. Soc. Am. J. 1993,57, 756–760.
10. VahidSarvi, Mohammad Feizian, AzadeMikhak, ArezoMahdavi Effect of biologic fertilizers on different forms of phosphorus and corn yield in Moghan region. 9th international soil Science Congress on the Soul of Soil and Civilization"14-16 October, Side, Antalya/ Turkey 2014.
11. Halajnia, A.,HaghniaG.H.,FotovatA.,KhorasaniR., Phosphorus fractions in calcareous soils amended with P fertilizer and cattle manure. Geoderma2009, 150, 209–213.
12. Mohanty, S.,PaikarayN.K.,RajanA.R., Availability and uptake phosphorus from organic manures in groundnut (Arachis hypogea L.) and corn (Zea Mays L.) sequence using radio tracer technique. Geoderma2006,133, 225–230.

13. Toor, G.S. and BahlG.S., Effect of solitary and integrated use of poultry manure and fertilizer phosphorus on the dynamics of P availability in different soils. Bioresour. Technol.,1997,62, 25-28.
14. Reddy, D.D.,SubbaRaoA.,Sammi Reddy K. and TakkarP.N., Yield sustainability and phosphorus utilization in soybean–wheat system on Vertisols in response to integrated use of manure and fertilizer phosphorus. Field Crops Res. 1999, 62, 181–190.
15. Mkhabela, M.S. and WarmanP.R., The influence of municipal solid waste compost on yield, soil phosphorus availability and uptake by two vegetable crops grown in a Pugwashsandy loam soil in Neva Scotia. Agric. Ecosyst. Environ. 2005, 106, 57–67.
16. Garg, S. and BahlG.S., Phosphorus availability to maize as influenced by organic manures and fertilizer P associated phosphatase activity in soils. Bioresour. Technol. 2008,99, 5773–5777.
17. Delgado, A., Madrid A.,KassemS.,AndreuL., and CampilloM.C., Phosphorus fertilizer recovery from calcareous soils amended with humic and fulvic acids. Plant Soil 2002, 245, 277–286.
18. Kandil, Hala, El- KherbawyM.I., IbrahimS.,Abd-ElfattahA.,Abd El-MoezM.R. and BadawyS.H.,Effect of Different Sources and Rates of Some Organic Manure on Content of Some Heavy Metals in Different Soils and Plants Grown Therein: II. Effect on Corn Plants. Soil Forming Factors and Processes from the Temperate Zone,2012,11, 19-32.
19. Nelson, R.E., Carbonate and gypsum. In: Page, MillerA.L., KeeneyR.H.,, D.R. (Eds.),Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties, 2nd editionAmerican Society of Agronomy, Madison, Wisconsin, USA, 1982, 181–198.
20. Olsen, S. R., Cole C. V., Watanabe F. S. and DeanL. A., Estimation of Available Phosphorus in Soils By Extraction with Sodium Bicarbonate,1954, 939, U.S. Department of Agriculture, Washington, DC, USA.
21. Drummond L. and MaherW., Determination of phosphorus in aqueous solution via formation of the phosphoantimonylmolybdenum blue comples re-examination of optimum conditions for the analysis of phosphate.AnalyticaChimicaActa 1990, **302:**69-74.
22. Murphy J.and RileyJ P., A modified single solution method for the determination of phosphates in natural waters. Anal. Chem. Acta, 1962,27, 31-36.
23. Ryan, J.,GarabetS.,HarmsenK. and RashidA., A soil and plant Analysis Manual Adapted for the west Asia and North Africa Region. ICARDA, Aleppo, Syria, 140 pp.1996
24. Cottenie, A.,VerlooM.,KikensL.,VelgheG. and CamerlynckR., Analytics Problems and Methods in Chemical Plant and Soil Analysis. Handbook, Ed. A. Cottenie, Gent, Belgium.1982
25. Page, A. L.,Miller R. H. and KeeneyD.R.,"Methods of Soil Analysis". II. Chemical and Microbiological Properties 2nd Ed. Madison, Wisconsin, U.S.A.1982
26. Panhwar Q. A., RajputA.,NaherU. A., and JusopS., Assessment of phosphorus use efficiency and various phosphorus applicationmethods on wheat in calcarious soil. Journal of Food, Agriculture & Environment,2014,12, 2, 1 3 1 8 - 1 3 2 2.
27. Barbara, F.R. and BrainL.J., ‘’Minitab Hand book’’. Duxbury press. AnImprint of Wad Sworth Publish. Comp. Belonont California, U.S.A.1994
28. Naeem, A.,AkhtarM. and WaqarA., Optimizing Available Phosphorus in Calcareous Soils Fertilized with Diammonium Phosphate and Phosphoric Acid Using Freundlich Adsorption Isotherm. Hindawi Publishing Corporation The Scientific World Journal 2013,, 5 pages http://dx.doi.org/10.1155/2013/680257.
29. Al-Rohily, K.M.,GhoneimA.M.,ModaihshA.S.andMahjoubM.O., Phosphorus availability in calcareous soil amend with chemical phosphorus fertilizer, cattle manure compost and sludge manure. International Journal of Soil Science,2013,8 ,1, 17-24.
30. Turner, B.L., Cade-MenunB.J. andWestermannD.T., Organic phosphorus composition and potential bioavailability in semi-arid arable soils the Western United States. Soil Sci. Soc. Am. J. 2003,67, 1168–1179.
31. Leytem, A.B., SmithD.R., Applegate T.J.and ThackerP.A., The influence of manure phytic acid on phosphorus solubility in calcareous soils.Soil Sci. Soc. Am. J. 2006,70, 1629-1638.
32. Rashid, A. and RowellD. L., “Phosphate sorption and release: 1. Isotopically exchangeable and non-exchangeable adsorbed phosphate in relation to soil properties,” Pakistan Journal of Soil Science, 1988,3, 1-2, 17–20.
33. Bertrand, I.,HinsingerP.,JaillardB. and ArvieuJ.C.,“Dynamics of phosphorus in the rhizosphere of maize and rape grown on synthetic, phosphated calcite and goethite,” Plant and Soil, 1999, 211, 1, 111–119.