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EFFECT OF APPLICATION OF RICE STRAW COMPOST AND BIO-FERTILIZER ON P AVAILABILITY IN CALCAREOUS SOILS: 2- IMPROVEMENT OF P UPTAKE AND P- Q/I PARAMETERS BY INORGANIC P FERTILIZATION IN HIGH $CaCO_3$ CALCAREOUS SOIL

[43]

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ABSTRACT

Effect of inorganic P fertilization on the response of barely growth and P uptake as well as different parameters expressing P availability including those of P- quantity- intensity relation ship was evaluated for a high $CaCO_3$ content calcareous soil (31 %) subjected to application of 0, 2 and 4 % mature rice straw compost with and without inoculation with ***Bacillus megatherium***, the phosphate dissolving bacteria (PDB). Measurements of plant growth and P uptake as well as evaluation of Olsen-P and P- Q / I parameters in the cultivated soil were followed up at 3, 6 and 9 weeks from cultivation. Obtained results indicated a significant positive action for P fertilization in increasing the significant activation of growth and P status in grown barley plants resulted from application of used rice straw compost and /or bio-fertilizer. Inorganic P fertilization also increased values of the different parameters describing P availability in the concerned soil and alleviated significantly the depressive action of high existence of $CaCO_3$ in P availability. This is true if the response was regarded to P fertilization or to the activating the roles of the application of both rice straw compost and used bio fertilizer. Equations calculated for regression of P uptake by different plant parts over the different parameters of P availability in the tested soil and as responded to P fertilization showed that the parameter of P capacity (Q_0) is more suitable, if compared to Olsen-P and other kinetic parameters such as equilibrium P potential (EPP) and P buffering capacity (PBC) and its sensitivity increased with inorganic P fertilization to this calcareous soil having high $CaCO_3$ content (31 %).

INTRODUCTION

Composting the huge amounts of rice straw in Egypt is going to be a must to face the harmful environmental pollution directly resulting from its burning in fields. Horizontal extension in the Egyptian agricultural policy added large areas of calcareous soils at the West Delta region. Such soils are usually characterized as to have nutrient problems particularly if phosphorus was taken in consideration regarding its chemistry in such soils. All of these reasons press farmers to use a lot of composts to these soils. Unfortinatly, composts generally can't meet or at least can't assure sufficient P requirements of grown plants (**Bahl and Toor, 2002**) particularly if the soil has low P test as the calcareous soil of high $CaCO_3$ content (**Abu-Hussin *et al* 2008**). Therefore, use of phosphate-based fertilizers in combination with an appropriate ratio of composts can prove to be beneficial since the composts and bio fertilizers, besides supplying small amounts of P, also help in mobilizing the native P in soils (**Toor and Bahl, 1997**). This mobilization occurs by conversion of insoluble Ca, Al and Fe forms of P to soluble forms through action

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of organic acids and chelates produced during decompositions of composts and manures (**El-Baruni and Olsen, 1979**).

It is well known that P supply to grown plants is governed by an essential key factor namely P intensity in soil solution. The quantity of fertilizer required to attain a specific soil solution P concentration is a useful variable for comparing soils of widely divergent properties or for judgment the role of different treatments in a particular soil. The phosphate sorption isotherm offers a means of estimating the amount of P availability as much as the amount required for a given soil- crop combination. Also, owing to the dynamic relationship between solid and solution P, the reliable P testing method is calculating the phosphorus buffering capacity in soil (**Hartikainen, 1991**). Moreover, the relationship between soil phosphorus status and plant growth is generally limited to the specification of soil type. These relationships require intensive empirical calibration for accurate diagnoses of phosphorus deficiency in a given soil type. In addition, soil phosphorus intensity, soil solution phosphorus, and $CaCl_2$ extractable-P represent an index for predicting P response in agricultural crops over a wide range of soil types (**Mendham *et al* 2002**).

Based on the previous information, the present investigation aims to evaluate the effect of inorganic P fertilization of the highly $CaCO_3$ content calcareous soil on the response of barley growth and its P uptake as well as soil P availability including the kinetic parameters, calculated from P quantity - intensity relationship, to application of rice straw compost and/or bio-fertilizer to a 31 % $CaCO_3$ content calcareous soil.

MATERIALS AND METHODS

Two sets of pot experiment were handled using a calcareous soil of 31% $CaCO_3$ content receiving 0, 2 and 4 % mature P enriched rice straw (5 kg super phosphate/100 kg plant residues) compost with and without inoculation with the bio-fertilizer ***Bacillus megatherium***, the phosphate dissolving bacteria (PDB). The bio-fertilizer was added at the rate of 20 ml / pot containing 4 kg soil with each 1 ml of the used bio-fertilizer containing 10^8 bacterium cells. The first set of pots received no P fertilization while the second subjected to inorganic P fertilization at a rate of 120 mg P_2O_5/ pot or 150 kg ordinary super phosphate/ fed with N and K fertilizers being added at the recommended rates for such conditions. The soil particle size distribution and $CaCO_3$ content (**Table, 1**) were determined as described by **Piper (1950)** while $CaCO_3$ fraction was determined as described by **Baruah and Barthakur (1997)**. The chemical analysis of used soil and compost materials, however, was performed according to **Jackson (1973)** while the available and total nutrients were determined according to **Page *et al* (1982)**. After good homogeneity of soil, compost and bio fertilizer, 15 barley grains (***Hordeum vulgare*, variety Giza 123**) were cultivated, to be then thinned to 10 seedlings after complete germination, in pots containing 4 kg soil samples under green house conditions. Each treatment was replicated 9 times; three out of them were taken out to represent a plant and soil sample at 3, 6 and 9 weeks, respectively, after cultivation. In each sample, plant shoots were separated from roots to be dried at 65-70 °C and dry weights were recorded and subjected to P determination after wet digestion was accomplished (**Page *et al* 1982**). Each soil sample was subjected to measurement of several parameters expressing P availability. Olsen-P was determined according to **Jackson (1973)** and (Q/I) parameters were determined according to **Baruah and Barthakur (1997)** and described by **Abu-Hussin *et al* (2008)**. The three parameters of P Q / I relationship were then calculated as the followings:-

(1) Values of Q_0 which usually express labile P that would have to be added or removed to reduce I to zero were chosen as the intercept of Q when I = 0.
(2) Values of equilibrium phosphate potential (EPP or Ie) which usually express the need for P fertilization was chosen as the intercept of I when Q = 0.
(3) Values of phosphate buffering capacity (PBC) were calculated as the slope of yielded straight relationship ($\Delta Q / \Delta I$).

RESULTS AND DISCUSSION

Data presented in **Table (2)** indicated that application of P enriched rice straw compost increased significantly growth of barley plants grown on the tested 31 % $CaCO_3$ calcareous soil. This effect was more pronounced as the rate of compost application raised up to 4%. This is true throughout all tested growth period whatever shoots, roots or whole plants were taken in consideration. Using the bio fertilizer, phosphate dissolving bacteria (PDB), proved to be bio-activator for compost positive action. In fact, beside the prominent roles of decomposed organic matter in

Table 1. Some physical and chemical properties of the tested calcareous soil and rice straw compost

a) Soil Physical Properties

Particle size distribution (%)				Texture class	Total $CaCO_3$ (%)	$CaCO_3$ fraction (%)			
c. sand	f. sand	silt	clay			c. sand	f. sand	silt	clay
26.58	31.33	17.05	24.99	Sand Clay Loam	31.2	10.81	14.41	2.88	2.12

b) Soil Chemical Properties

ECe (dS/m)	pH soil paste	Soluble ions in saturated soil extract (meq/l)								Organic matter (%)	Olsen-P (mg/kg)	P- Q/I parameters		
		K^+	Na^+	Ca^{+2}	Mg^{+2}	Cl^-	HCO_3^-	CO_3^{-2-}	SO_4^{-2}			Q_0 (mg/kg)	EPP (µg/l)	PBC (L/kg)
2.60	7.92	0.64	7.00	14.0	4.40	15.1	2.90	0.00	8.04	0.51	4.75	6.10	61.9	99

c) Used Rice Straw Compost

pH 1:10 suspension	EC (d S/m) 1:10 extract	Organic matter (%)	Total Nutrients (%)			C/N ratio	Available nutrients (mg/kg)		
			N	P	K		N	P	K
8.02	1.81	54.7	1.30	0.61	2.44	24.5	295	373	472

Table 2. Effect of application of rice straw compost and bio-fertilizer on growth and P status in barely plants grown on highly calcareous soil (31% $CaCO_3$with and without inorganic P fertilization

Treatment	Without P fertilization						With P fertilization					
	Dry matter (g/pot)			P content (%)		Total P uptake mg/pot)	Dry matter (g/pot)			P content (%)		Total P uptake mg/pot)
	Shoots	Roots	Whole plants	Shoots	Roots		Shoots	Roots	Whole plants	Shoots	Roots	
1st growth period												
Control	2.27 p	2.00 p	4.27 g	0.110 n	0.086 j	4.24 o	2.41 q	2.06 p	4.47 m	0.161 j	0.170 h	7.39 m
2 % compost	2.46 n	2.11 o	4.57 p	0.172 m	0.131 g	7.01 n	2.65 p	2.36 o	5.01 l	0.271 e	0.223 d	12.47 l
4 % compost	3.30 i	2.61 m	5.91 n	0.184 l	0.142 f	9.81 k	3.52 m	2.81 l	6.32 j	0.276 e	0.154 i	14.02 k
PDB	3.41 k	2.12 o	5.53 o	0.204 k	0.113 h	9.36 l	3.61 l	2.30 m	5.91 k	0.220 g	0.170 h	11.86 m
PDB + 2 % compost	3.51 j	3.14 j	6.65 k	0.271 e	0.153 e	14.33 j	4.71 g	2.51 m	7.22 i	0.303 d	0.242 b	20.36 h
PDB + 4 % compost	4.41 g	2.33 n	6.74 j	0.259 f	0.167 c	15.36 h	3.81 k	3.72 g	7.23 h	0.324 c	0.172 h	18.76 i
Mean	**3.23 C**	**2.39 C**	**5.62 C**	**0.200 C**	**0.130 C**	**10.01C**	**3.45 C**	**2.63 C**	**6.07 C**	**0.260 C**	**0.190 C**	**14.14 C**
2nd growth period												
Control	3.06 n	2.71 l	5.77 m	0.201 k	0.113 h	9.11 l	3.12 o	2.81 4	5.93 k	0.214 g	0.206 e	12.42 lm
2 % compost	3.42 k	3.42 i	6.84 i	0.274 e	0.162 d	14.92 i	3.96 j	3.63 h	.590 h	0.326 c	0.230 c	21.29 g
4 % compost	4.52 f	3.51 h	8.03 g	0.280 d	0.163 d	18.59 e	4.84 f	3.82 f	8.66 f	0.321 c	0.243 b	24.84 e
PDB	4.31 h	3.14 j	7.45 h	0.250 g	0.175 c	16.33 g	4.54 i	3.41 i	7.95g	0.247 f	0.222 d	18.74 i
PDB + 2 % compost	4.73 d	3.71 f	8.44 e	0.323 a	0.215 a	23.31 c	5.54 e	3.91 e	9.45 d	0.332 c	0.244ab	27.99 d
PDB + 4 % compost	5.55 b	4.04 d	9.59 c	0.292 c	0.205 b	24.54 a	6.11 b	4.19 d	10.3 g	0.527 a	0.241 d	42.33 b
Mean	**4.27 B**	**3.42 B**	**7.69 B**	**0.270 A**	**0.171 A**	**17.76 B**	**4.69 B**	**3.63 B**	**8.31 B**	**0.330 A**	**0.225 A**	**24.60 B**
3rd growth period												
Control	3.22 m	2.89 k	6.11 l	0.174 m	0.077 i	7.84 m	3.4 n	3.01 j	6.41 j	0.203 h	0.182 g	12.41 lm
2 % compost	4.00 i	4.27 b	8.27 f	0.252 g	0.159 d	16.9 f	4.55 i	4.41 b	8.96 e	0.315 c	0.204 e	23.37 f
4 % compost	5.60 a	4.16 c	9.76 b	0.268 e	0.152 e	21.35 d	5.91 d	4.33 c	10.24 c	0.314 c	0.233 c	28.7 c
PDB	4.60 e	3.62 g	9.22 g	0.223 j	0.171 c	16.45 g	4.81 f	3.81 f	8.62 f	0.200 h	0.170 h	16.11 j
PDB + 2 % compost	5.14 c	3.91 e	9.05 d	0.311 b	0.207 b	24.1 b	6.5 a	3.90 e	10.42 b	0.331 c	0.191 f	29.06 c
PDB + 4 % compost	5.62 a	4.72 a	10.34 d	0.245 i	0.199 b	23.21 c	6.01 e	4.89 a	10.9 a	0.512 b	0.250 a	42.99 a
Mean	**4.70 A**	**3.93A**	**8.63 A**	**0.246 B**	**0.161 B**	**18.27 A**	**5.20A**	**4.06 a**	**9.25 A**	**0.313 B**	**0.205 B**	**25.44 A**

-Values having the same small latter(s) within a column are not significantly different at 95% confidence level.
-Values having the same capital latter(s) within a column are not significantly different at 95% confidence level.
- PDB refers to the used phosphate dissolving bacteria (Bacillus Megatherium).

improving physical, chemical and biological properties of the cultivated calcareous soils, obtained pattern could be attributed to the ability of used microorganisms to produce and secrete phytohormones which can stimulate root branching and root hair development throughout root hair formation and cortical cell differentiation as well as enhancement of root proliferation and boosting plant growth by subsequent increasing nutrient acquisition and growth accumulation **(Holguin *et al* 1999).** From speculating growth figures throughout all investigation period, it could be concluded that the increase in dry matter production due to compost application within a particular period is greater than the accumulated increase due to increasing growth stage. Inorganic P fertilization enhanced plant growth (Table, 2) where the dry matter production by whole plants increased from 5.62 to 6.07, 7.69 to 8.31 and 8.63 to 9.25 gm / pot at the first, second and third growth period, respectively.
As for as the response of P concentration in plant tissues was concerned, a similar pattern was clearly recorded where P content in shoots and roots significantly increased as a result to application of rice straw compost alone or combined with application of the used bio-fertilizer. Significant increases encountered in both plant growth and P contents were reflected on increasing the amounts of P taken up by grown plants particularly in the P fertilized plants. In fact, obtained data are in a great harmony with those of **Abu-Hussin *et al* (2003)** who found, in a field experiment, a significant influence for compost application to low test – P soils and P uptake by grown plants particularly when P fertilization rates were raised. In high test –P soils, however, **Paul and Beauchamp (1993)** reported that although the silage corn yields and total P uptake from organic-based fertilizer and inorganic fertilizer treatments were significantly higher than the control, the difference was not significant and no effect for increasing P fertilization rate could be concluded.

Increasing compost application rate generally and significantly increased P status in grown plants particularly when combined with application of the used bio fertilizer under conditions of inorganic P fertilization. In fact, this pattern wasn't unexpected due to the previously well documented roles of compost in transformation and releasing the hardly available P in soil solution (**Chein *et al* 2001**) as well as releasing some phytohormones, during compost decomposition, which can facilitate nutrient uptake by plant roots as well as translocation towards plant shoots via different mechanisms.

The promoting role encountered for using bio fertilizer could be, however, manifested on the bases of producing growth stimulating substances which can be reflected on the nutrient availability **(Chaykovskaya *et al* 2001)** and altering rhizosphere pH (**Besharati *et al* 2007**). Chelating of Ca^{+2} by organic hydroxyl acids (most notably lactic, glycolic, citric, succinnic and 2- ketogluconic acids) produced as products of organic substrates and may be more pronounced in areas such as plant rhizosphere can be also considered in explaining the obtained increases in P status in grown plants **(Kucey, 1983)**. Besides, **Rozycki and strzelezyk (1986)** added that the release of large amounts of oxalate and the presence of Ca-oxalate crystals on the surface of fungi hyphae in soil are now well documented with speculations that oxalate is involved in a number of processes including the acquisition of nutrients (e.g. P). The microbial product, ketogluconic acid, has also been identified in the plant rhizosphere; it is capable of mobilizing small amounts of soil P.

Regarding the response of P availability in the cultivated soil, values of Olsen – P were generally and significantly increased **(Table, 3)** by rice straw compost application, particularly when mixed with the used bio fertilizer especially as inorganic P fertilization is adopted and the growth period gets advanced. This action could be explained on the basis of producing organic acids which may decrease soil pH and subsequently increase the dissolution of bound forms of phosphate; hydroxyl acids may also chelate calcium to finally solubilize, mobilize and utilize soil phosphates **(Lela, 2005)**. Another explanation was previously drawn by **Holford and Mattingly (1975)** who proposed a mechanism by which organic matter could decrease phosphorus fixation in soils where organic matter could partially occupy $CaCO_3$ surfaces. A decrease in the number of adsorption sites will be resulted in to finally increase the degree of P saturation of the remaining sites and therefore P availability to plants particularly as time progressed. **Cavigelli and Thien (2003)** added that incorporation of composts in soils can further increase P availability by releasing CO_2, forming H_2CO_3 in the soil solution and resulting in the dissolution of primary P –containing minerals. Also, organic acids released during decomposition may help dissolving soil mineral P. In soils with high P-fixing capacities, organic compounds released during decomposition processes may increase P availability by blocking P- adsorption sites or via anion exchange phenomenon.

Table 3. Effect of inorganic P fertilization on altering Olsen-P and P - Q/I parameters in highly calcareous soil (31% $CaCO_3$) subjected to rice straw compost and bio-fertilizer application at three successive periods of barely cultivation

Treatment	Olsen-P		Q_0		EPP(I_o)		PBC	
	mg/kg	% of no P*	mg/ kg	% of no P	µg / L	% of no P	L/kg	% of no P
Control	11.0 r	165	13.0 n	113	52.0 f	104	249 m	108
2 % compost	22.6 i	122	16.0 h	119	42.2m	107	378 f	111
4 % compost	24.4 k	149	18.4 b	106	35.9 o	126	514 b	84
PDB	17.0 q	132	13.2 m	93	46.7 k	102	283 j	91
PDB + 2 % compost	30.3 h	136	18.0 c	107	45.2 l	122	399 e	88
PDB + 4 % compost	34.2 f	190	21.4 a	103	33.6 q	120	635 a	86
Mean	**23.3 C**	147	**16.7 A**	106	**42.6 C**	112	**410 A**	91
Control	18.9 p	127	11.6 p	106	60.1 b	106	193 p	100
2 % compost	33.0 g	148	13.6 l	104	58.0 d	104	234 o	100
4 % compost	34.6 e	138	16.5 f	106	51.2 g	94	322 h	113
PDB	19.4 n	104	14.3 k	111	51.0 h	109	280 k	101
PDB + 2 % compost	42.6 d	156	16.6 e	120	48.0 j	104	344 h	115
PDB + 4 % compost	45.7 b	206	16.8 d	110	37.0 n	106	454 d	103
Mean	**32.3 B**	149	**14.9 B**	109	**50.9 B**	104	**305 B**	106
Control	19.0 o	134	11.0 r	122	62.2 a	101	176 q	121
2 % compost	27.6 i	144	11.2 q	120	58.5 c	103	192 p	117
4 % compost	25.8 j	118	12.4 o	113	52.7 e	95	236 n	119
PDB	20.1m	142	14.6 j	117	52.9 e	102	276 l	115
PDB + 2 % compost	44.5 c	188	15.3 i	120	50.6 i	110	302 i	109
PDB + 4 % compost	58.3 a	290	16.3 g	114	34.4 p	91	472 c	126
Mean	**35.6 A**	173	**13.5 C**	117	**51.9 A**	101	**276 C**	118

-Values having the same small letter(s) within a column are not significantly different at 95% confidence level.
-Values having the same capital letter(s) within a column are not significantly different at 95% confidence level.
-PDB refers to the used phosphate dissolving bacteria (Bacillus Megatherium).
* % of the indicated value in P fertilized soil to that in no P fertilized soil.

Values of the Q_0 (well known as labile P) increased significantly by compost application; the action seemed to be more pronounced as compost application rate was raised and bio fertilizer was added. Of course, the action of compost and bio fertilizer could be and possibly referred to increasing activity of microorganisms leading to solubilizing inorganic P. This action was previously described by **Jones (1998)** as resulting from (1) the formation of phosphohumic complexes which are more easily available, (2) anion replacement of the phosphate by humate ions, and (3) the coating of sesquioxide particles by humus to form a protective coverage and thus reducing the phosphorus fixing capacity of the soil. Of course, superiority of bio compost could be partially referred to activating soil microorganisms leading to reduce soil pH.

Although values of Q_0 decreased significantly as growth period gets advanced, mainly due to increasing the depletion of P caused by plant uptake particularly as plants get older. Inorganic P fertilization kept high Q_0 values possibly due to addition of already dissolved P forms by inorganic fertilization. This pattern was reflected on the

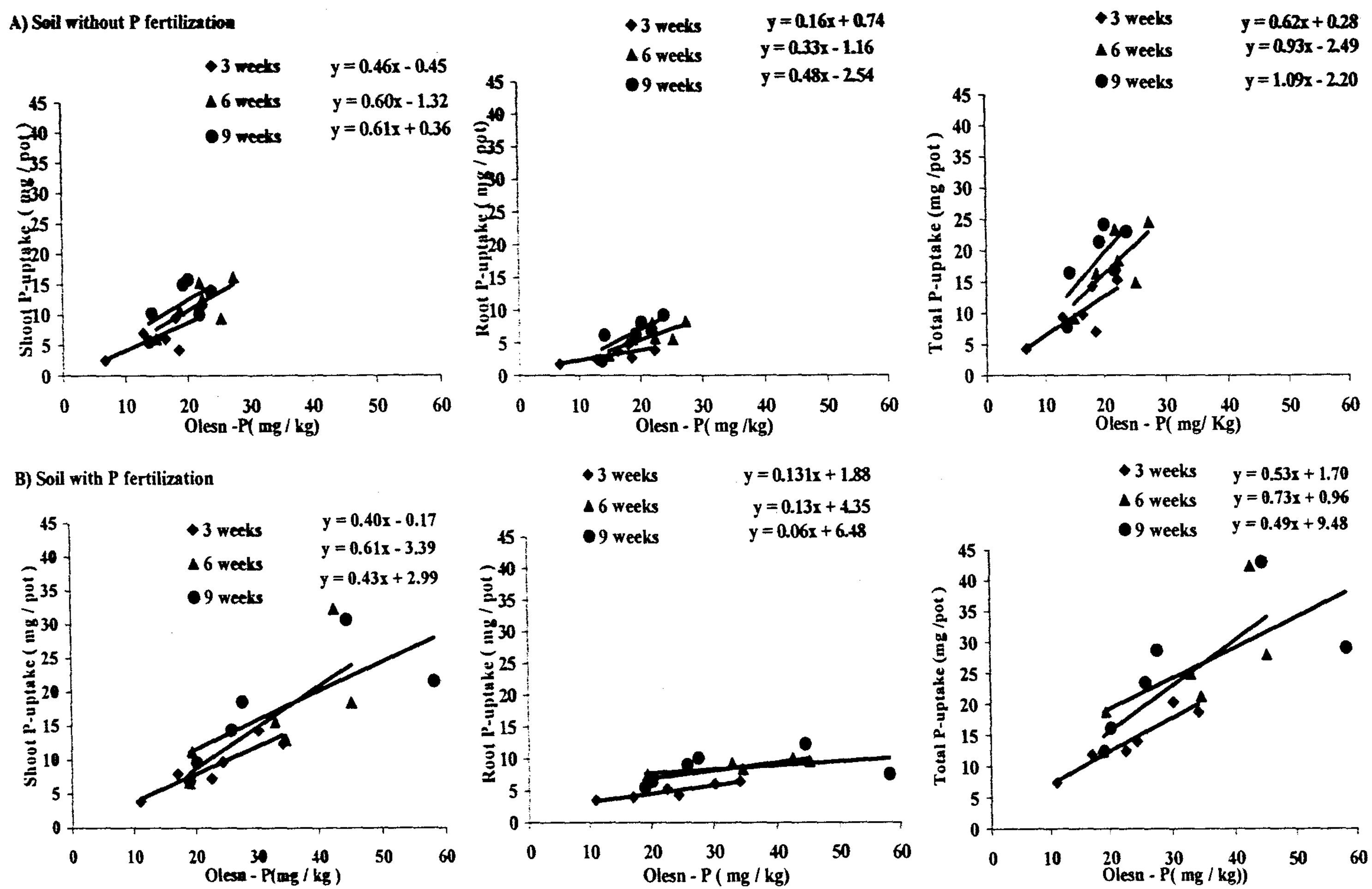

Fig. 1. Regression of P-uptake by barley plants to Olsen-P in highly calcareous soils (31.4 % $CaCO_3$) with and without P-fertilization

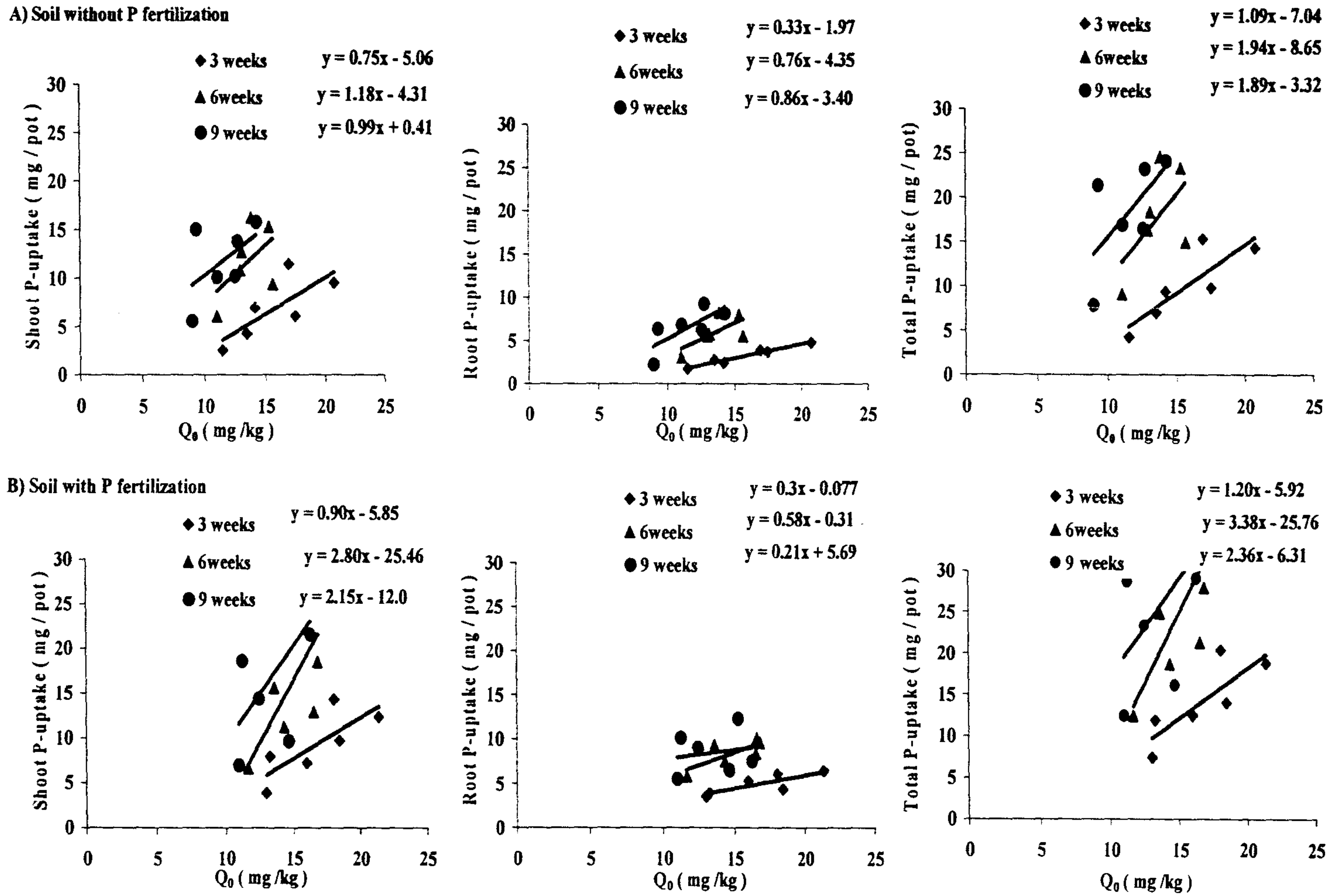

Fig. 2. Regression of P-uptake by berley plants to Quantity (Q_0) in highly calcareous soils (31.4% $CaCO_3$) with and without P-fertilization

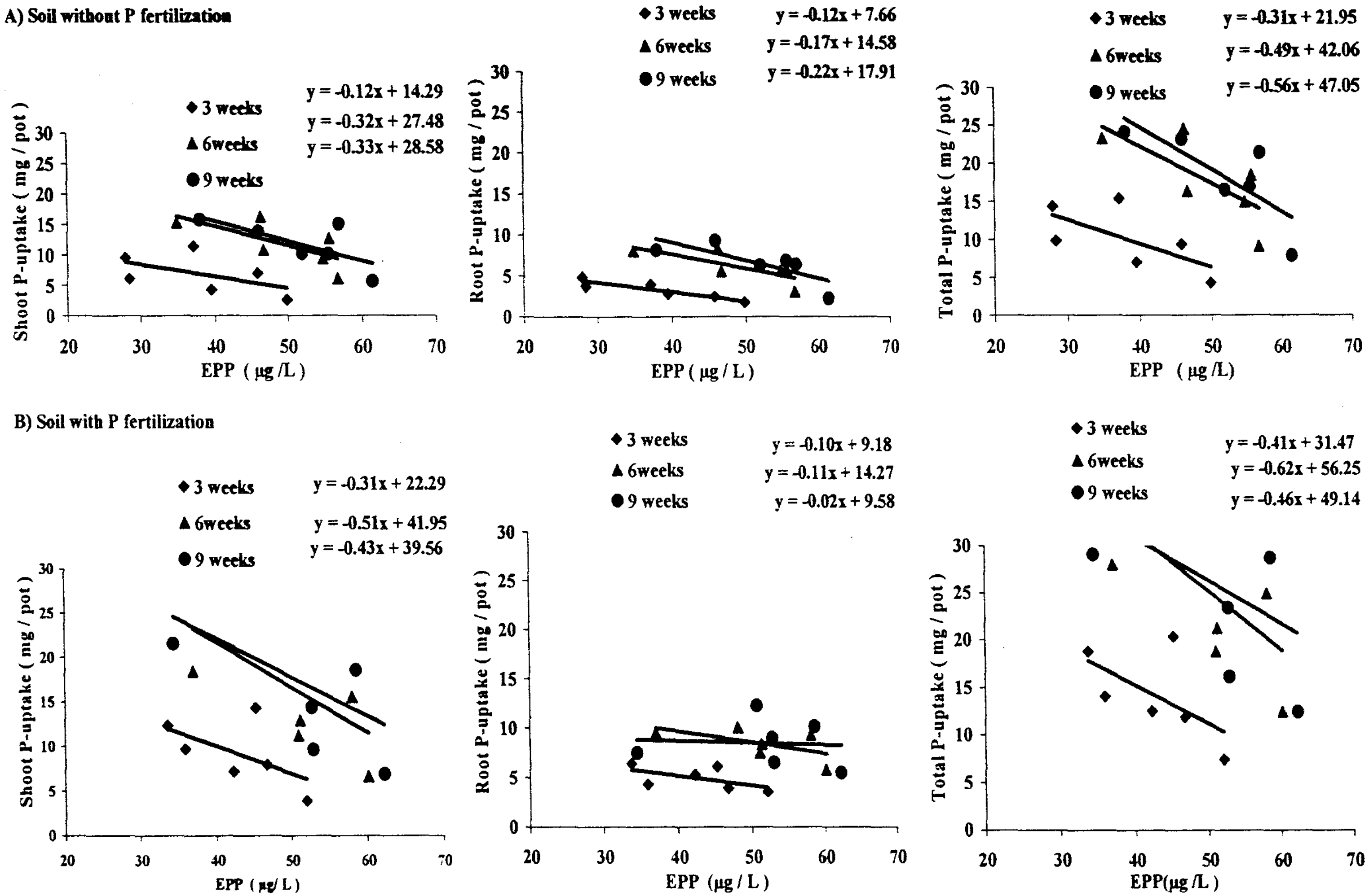

Fig. 3. Regression of P-uptake by barley plants to Equilibrium Phosphate Potenial (EPP) in highly calcareous soils (31.4% $CaCO_3$) with and without P-fertilization

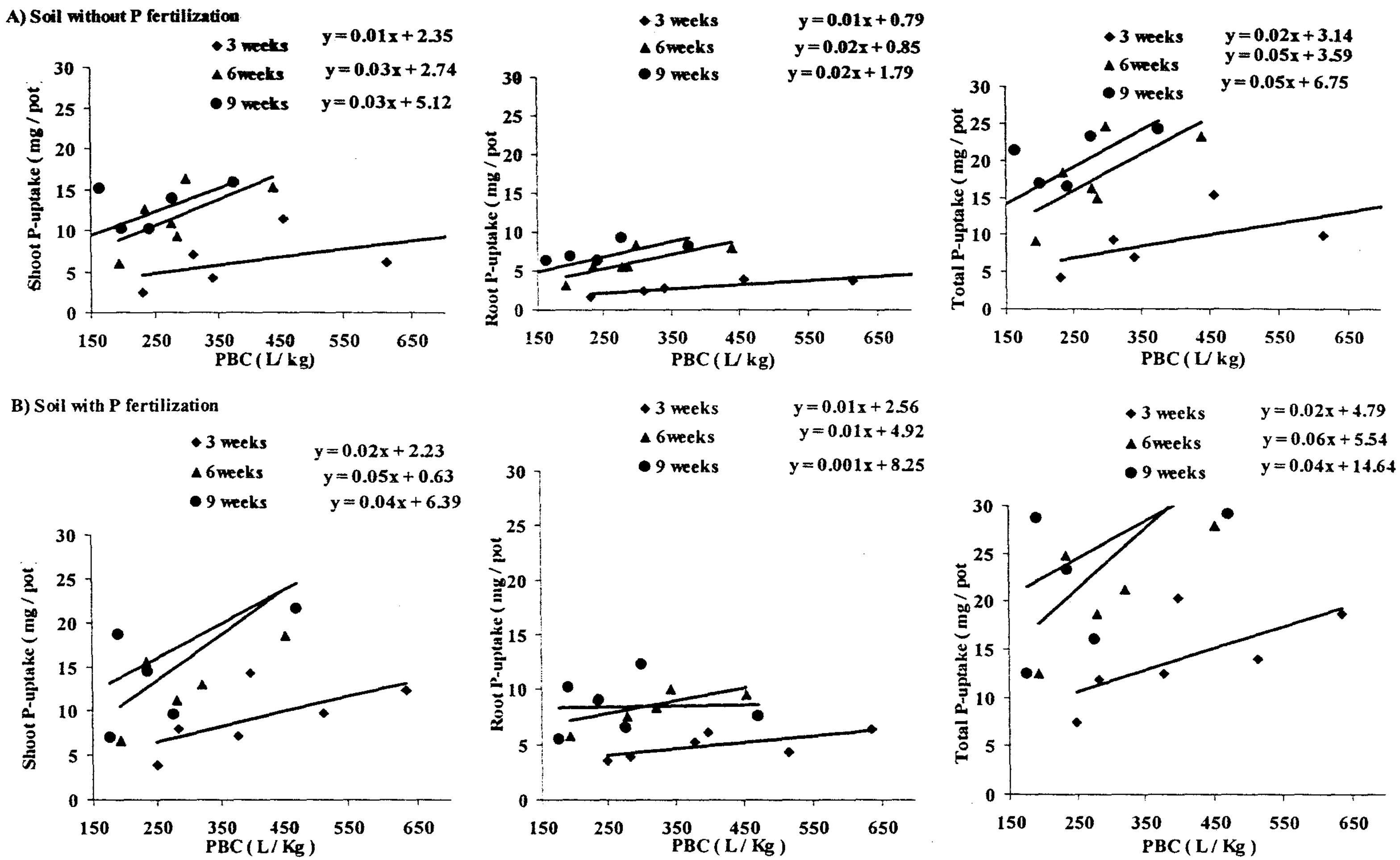

Fig. 4. Regression of P-uptake by barley plants to Phosphorus Buffering Capacity (PBC) in highly calcareous soils (31.4% $CaCO_3$) with and without P-fertilization

phosphate buffering capacity (PBC) whose calculated values responded to inorganic P fertilization in a manner similar to that of the P capacity, Q_0, factor. This may be attributed to the observed low response of EPP values, opposite to that of Q_0, to P fertilization. The decrease in the values of Q_0 and PBC encountered at late growth periods could be explained again by statement of **Lindsay (1979) and Tisdale *et al* (1993)** who reported that the presence of $CaCO_3$ in soil is responsible for decreasing phosphorus activity and the greater the time of contact of phosphate with soil phase, the greater the fixation of phosphorus in soils occurred.

Finally, to obtain a good comparison between non and P fertilization conditions, and to make results more beneficial, obtained values of different parameters expressing P availability were regressed against values of P uptake by different plant tissues at the successive indicated growth periods irrespective the compost treatment. The regression equations were calculated. From speculating data illustrated in **Fig. (1)**, it is easy to conclude a positive regression for P taken up by different plant parts to the increasing the Olsen –P in the cultivated soil. Such trend seemed to be increased generally as growth period progressed where values of regression slopes increased. Comparing such calculated values in none and P fertilized soils indicated that inorganic P fertilization decreased the regression slopes particularly when total P uptake by whole older plants was concerned. This pattern may be referred to the addition of a dissolved P ready to be absorbed by grown plants. In other words the dependence on native P forms in soils declined when P inorganic fertilizers were being added. When P uptake regressed to increasing values of Q_0 **(Fig. 2)**. It is easily to notice that although values of regression slopes increased generally as the plants get older, P fertilization increased the rate of slope (slope coefficient) particularly when shoots or whole plants, opposite to roots, were taken in consideration. This action was more obvious at the second growth period compared to the early and late ones. This can lead to conclude that Q_0 parameter is better than Olsen- P one when predicting P status in high $CaCO_3$ calcareous soil. Regression of P uptake to increasing values of EPP **(Fig. 3)** and PBC **(Fig. 4)** behaved in a manner greatly similar to that of Q_0 particularly when the response to P fertilization was concerned where slope coefficients increased for P uptake by whole plants and shoots, opposite to roots, by P fertilization particularly at the middle growth period. So and from aforementioned patterns, it could be conclude that the kinetic parameter of Q_0 is more confident to express P status in the calcareous soil high in $CaCO_3$ content. In fact, such findings are in great harmony with those obtained by **Abu-Hussin *et al* (2008)** who found that only the kinetic parameter Of Q_0, out of other used parameters correlated significantly with P uptake by barely plants grown on calcareous soils irrespective of their contents of $CaCO_3$.

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تأثير إضافة كمبوست قش الأرز و السماد الحيوي على تيسر الفوسفور فى الأراضى الجيرية

٢- تحسن امتصاص الفوسفور ومقاييس الكمية-الشدة بالتسميد الفوسفاتى في الأراضى الجيريةعالية المحتوى من كربونات الكالسيوم

[٤٣]

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تم تقييم استجابة نمو نبات الشعير وامتصاص الفوسفور وكذلك مقاييس تيسر الفوسفور متضمنه المعايير الكينيتيكية لعلاقات الكمية والشدة فى الأراضى الجيرية العالية فى محتواها من كربونات الكالسيوم (٣١ %) لإضافة كل من كمبوست قش الأرز والسماد الحيوى تحت ظروف اضافة وعدم أضافة التسميد الفوسفاتي. وتم قياس نمو النبات وامتصاص الفوسفور وكذلك تقييم الفوسفور المستخلص بأولسن والمقاييس الكينيتيكية لعلاقات الكمية - الشدة فى الأرض بعد ٣, ٦ و ٩ أسابيع من زراعة نباتات الشعير فى تجربة أصص تحت ظروف الصوبة . ودلت النتائج المتحصل عليها على :

١- أن للتسميد الفوسفاتى تأثير مخفف للفعل السيء لزيادة كربونات الكالسيوم فى الأرض على النمو وامتصاص الفوسفور بالنبات النامي وكذلك فقد حسن التسميد الفوسفاتى من الاستجابة الموجبة لإضافة الكمبوست والسماد الحيوى.

٢- زاد التسميد الفوسفاتى من قيم الفوسفور المستخلص بأولسن من الأرض خاصة بمضى الوقت كما شجع من تأثير إضافة كل من الكمبوست والسماد الحيوى على القيم المستخلصة.

٣- تحسنت القيم الكينيتيكية لمقياس الكمية (Q) والسعة التنظيمية للفوسفور(PBC) بشدة، بينما كانت الزيادة طفيفة فى مقياس الشدة (EPP) تحت ظروف التسميد الفوسفاتى مقارنة بعدم إضافة التسميد الفوسفاتى خاصة بتقدم الوقت. هذا، وقد حسن التسميد الفوسفاتى أيضاً من استجابة تلك المقاييس لإضافة كل من كمبوست قش الأرز والسماد الحيوى.

٤- أظهرت معادلات الانحدار المحسوبة لامتصاص الفوسفور بالنباتات النامية على قيم المقاييس المختلفة لتيسر الفوسفور فى الأرض تحت الدراسة (الجيرية المرتفعة فى محتواها من كربونات الكالسيوم) أن مقياس الكمية أكثر ملاءمة من المقاييس الأخرى للتنبؤ بحالة الفوسفور الأرضى ، وقد زاد التسميد الفوسفاتي من حساسية هذا المقياس تحت هذه الظروف.

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