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UTILIZATION OF EAST SEBAEYA (EL-MAHAMEED) PHOSPHATE PROCESSING PLANT TAILINGS AS PHOSPHATE FERTILIZER

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ABSTRACT

A greenhouse experiment using broad bean plant was carried out to evaluate the reuse of East Sabaeya phosphate processing plant tailings as phosphate fertilizer compared to the traditional super phosphate. Two soil samples were used for this experiment (sandy and calcareous soils). Phosphate tailings was pretreated either with 10 % concentrated HCl and/or HNO_3 and crushed to pass 250 micron sieve. Different samples of phosphate tailings were combined with different phosphorus activating agents; i.e. humic acid (HA), farmyard manure (FYM) and phosphate dissolving microbial (PDM).

In sandy and calcareous soils there is a highly significant difference in dry weights and P uptake between the control treatment and other treatments received phosphate sources. Also, there is a significant difference between treatment received traditional super phosphate (SP) alone and the RP (alone) treatment. On the other hand, there is no significant difference in dry weights of treatment received traditional super phosphate (SP) and the other treatments treated with HCl and/or HNO_3 in combination with activating agents.

In sandy soil it is possible to use phosphate tailings in combination with either FYM or PDM. In calcareous soil it is possible to use phosphate tailings in combination with PDM or HA instead of using super phosphate, mixed with different activators or phosphate tailings treated with different acids. This experiment showed the possibility of direct application of phosphate tailings in both sandy and calcareous soils after treating with the activating agents.

Keywords: East Sebaeya- phosphate processing- plant tailings- phosphate fertilizer

INTRODUCTION

Most phosphate rocks as mined are of low-grade and need beneficiation. Beneficiation plants produce large quantities of waste materials relatively high in P_2O_5 content, which are considered as environmental hazards and source of pollution for air, water and soil. In addition, disposal of these materials represents a loss of valuable natural resource and adds additional cost to the production for waste removal. Disposal of ore dressing plant tailings is a major environmental problem, which is becoming more serious with increasing exploitation of low grade ores and deposits due to depletion of rich ones (Shafic & Rampacek,1980; Negm & Abouzeid, 1997 and Negm,2001).

The methods used to dispose tailings have been developed due to the environmental pressure, changing milling practice and realization of profitable applications (Wills,1985). Utilization of waste of ore milling plants is becoming a common place practice to avoid pollution hazards and to improve the techno economic feasibility of new mining projects (Boulos *et al.,*1981).

In Sebaeya phosphate processing plant, there are large accumulation of tailings, which a sparingly soluble phosphate like phosphate rocks. The economic value of phosphate rocks increases considerably along with the increasing costs of super phosphate production. Consequently, there is a growing interest in ways of manipulating such materials to obtain a more valuable product. Common efforts include the use of chemico-physical means, that is, partially acidulating PRs (Hammond *et al.,* 1986; Goenadi, 1990; Lewis *et al.,* 1997; Rajan and Ghani, 1997), reacting with synthetic organic acids (Sagoe *et al.*, 1998) and/or natural organic acids (Singh and Amberger, 1998a, 1998b), organic manures can help to lower pH and increasing the availability of phosphate, phosphate dissolving microbes solubilize insoluble P by producing various organic acids (Rodriguez and Fraga,1999) and decreasing particle size (Babare *et al*., 1997).This research was carried out to evaluate the reuse of East Sabaeya phosphate processing plant tailings as phosphate fertilizer compared to the traditional super phosphate.

MATERIALS AND METHODS

Sample of East Sabaya phosphate processing plant tailings treated with 10% HNO_3 (RP_HNO_3) and/or 10% HCl (RP_HCl) were provided by the Department of Mining, Faculty of Engineering, Cairo University for testing in a greenhouse experiment for cultivating phosphorus indicator plant, broad bean. Traditional super phosphate fertilizer (SP) was used as a source of phosphate for comparison. The treated and untreated materials as well as SP samples were ground to pass 250 micron sieve. Total, available amounts of P and total contents of some heavy metals (Page, 1982) were determined in all phosphate sources.

Two different soils were used: sandy soil (from Cairo-Alex. desert road) and calcareous soil (from El-Nobarya area). Soil characteristics are presented in Table 1.

Table 1: Some physical and chemical properties of the experimental soils.

soils	C. Sand %	F. Sand %	Silt %	Clay %	Texture class	$CaCO_3$ %	O.M %	pH_e	EC_e dS/m
sandy	49.2	30.4	16.4	4.0	Sandy	3.6	0.3	7.5	1.56
calcareous	16.1	44.8	10.3	28.8	Clay loam	32.6	0.5	7.9	1.21

Chemical properties were determined according to Page (1982)

A greenhouse experiment was conducted with broad bean to study the effect of addition of phosphate sources as P fertilizer compared with traditional super phosphate. Phosphorous is added with a rate of 15 kg P_2O_5/fedden. The treatments were:

1- Control (without addition of P).
2- Raw phosphate material (RP).
3- Raw phosphate material treated with HNO_3 (RP_HNO_3).
4- Raw phosphate material treated with HCl (RP_HCl).
5- Traditional super phosphate (SP).

Farmyard manure (10 m^3 $fedden^{-1}$, humic acid (10 kg $fedden^{-1}$) and phosphate dissolving microbial were added with the P sources treatments. The experiment was carried out in triplicates in plastic pots. As reference, control pots were used containing only the pure soil.

After 80 days of planting, shoots of broad bean plants were harvested: dry weights were recorded and P concentrations were determined. Then, phosphorus uptake was calculated

Statistical analysis was carried out using the SAS program (SAS, Institute Inc., 1988). The GLM procedure of SAS was used to perform the one way analysis of variance between treatments.

RESULTS AND DISCUTION

Data in Table 2 show total and available P in the different phosphate materials used. It is clear from this Table that RP_HCl contains the highest concentration of P compared to the other materials. The phosphorus content of the materials used decreased in the following descending order; RP_HCl > RP_HNO_3 > RP > SP. Among the materials used RP_HCl contains the highest value of available P. It contains 499 mg P/kg compared with 393, 317 and 221 mg P/kg for SP, RP_HNO_3 and RP, respectively. Among the materials used, there are no differences between the total contents of some heavy metals in SP and other materials.

Table 2: Total, available phosphorus and total contents of some heavy metals (ppm) in the different materials used.

Materials	Total P_2O_5 %	Available P mg/kg	Cd	Cr	Ni	Pb
RP	15.1	221	1.6	4.6	3.2	6.9
RP_HCl	17.0	499	2.0	5.8	4.1	8.5
RP_HNO_3	15.4	317	1.9	5.1	4.4	7.2
SP	14.6	393	1.3	3.7	2.6	6.2

Data of plant dry weights as affected by addition of different treatments are presented in Table 3. Dry weights of broad bean plants grown in sandy soil ranged from 15.3 to 30.0 g/pot. The lowest value was recorded for the control treatment, whereas, the highest one was recorded for RP in combination with FYM. For calcareous soil, dry weight values ranged from 6.2 to 14.3 g pot^{-1}. The lowest value was recorded for the control treatment, whereas, the highest one was recorded for RP_HNO_3 in combination with PDM.

The response to P application was superior in the calcareous soil than in the sandy one. The magnitude of increase in the dry weights over the control treatment of sandy soil ranged from 20.9 % in the RP (alone) treatment to 96.0 % in the (RP+FYM) treatment. Moreover, it ranged from 32.2 % in (RP+FYM) to 130.6 % in (RP_HNO_3+PDM) treatment in the calcareous soil.

It is clear from the data of dry weights that there is a highly significant difference between the control treatment and the other treatments received phosphate application. Also, there is a significant difference between treatment received traditional super phosphate (SP) alone and the RP (alone) treatment. On the other hand, there is no significant difference in dry weights of treatment received traditional super phosphate (SP) and the other treatments treated with HCl and/or HNO_3 in combination with activating agents.

In the sandy soil there is a highly significant difference between RP in combination with FYM and SP, RP in combination with HA and/or RP_HCl in combination with HA or FYM. In the calcareous soil there is a highly significant difference between SP in combination with PDM and SP in combination FYM. Also the difference between RP in combination with PDM and RP in combination with HA or FYM are highly significant. Furthermore, the difference between RP_HNO3 or RP_HCl in combination with HA or PDM and RP_HNO3 or RP_HCl in combination with FYM are highly significant.

Table 3: Dry weights (g pot^{-1}) of broad bean plants grown in sandy and calcareous soils as affected by different treatments.

Treatments	Sandy soil	Calcareous soil
	mean	mean
control	15.3	6.2
RP (alone)	18.6	7.6
RP+HA	24.3	10.3
RP+FYM	30.0	9.3
RP+PDM	28.2	13.5
RP_HNO3+HA	27.1	12.2
RP_HNO3+FYM	27.0	9.6
RP_HNO3+PDM	26.9	14.3
RP_HCl+HA	25.1	12.9
RP_HCl+FYM	24.6	9.4
RP_HCl+PDM	27.2	12.5
SP (alone)	21.7	8.8
SP+HA	24.4	11.6
SP+FYM	28.0	9.4
SP+PDM	28.9	13.2

Sandy soil — **LSD (0.01) = 5.4**, **LSD (0.05) = 4.2**
Calcareous soil — **LSD (0.01) = 2.0**, **LSD (0.05) = 1.2**

Data in Table 4 illustrate phosphorus uptake (mg pot^{-1}) in broad bean plants grown in sandy and calcareous soils as affected by various treatments. It is obvious from the data that phosphate application greatly influenced the P uptake. In all treatments received P application, P uptake increased significantly with the addition of P over the control treatment. The data showed also that those plants grown in sandy soil showed higher values of P uptake as compared with that of the calcareous one. The differences in P uptake between plants grown in the sandy and calcareous soils were highly significant. Values of P uptake in the sandy soil ranged from 12.8 to 29.1

mg/pot, the lowest value was recorded for the control treatment while the highest one was for treatment of SP in combination with FYM. In the calcareous soil, values of P uptake ranged from 7.3 to 14.8 mg/pot. The lowest value was for control treatment while the highest one was for treatment of SP in combination with PDM.

With respect to data of P uptake in the sandy soil, there is a significant difference between SP+FYM treatment and other treatments except SP+PDM and RP+FYM. In the calcareous soil, the obtained results showed significant increases between SP+PDM and other treatments except RP+PDM. This result was confirmed by Goenadi (1996) who found that combined direct application of rock

Table 4: Phosphorus uptake (mg pot^{-1}) of broad bean plants grown in sandy and calcareous soils as affected by different treatments.

Treatments	Sandy soil	Calcareous soil
	mean	mean
control	25.9	14.7
RP (alone)	36.6	17.0
RP+HA	50.6	24.1
RP+FYM	54.9	20.4
RP+PDM	49.2	27.7
RP_HNO3+HA	50.6	24.6
RP_HNO3+FYM	41.7	23.1
RP_HNO3+PDM	51.3	25.9
RP_HCl+HA	43.8	24.3
RP_HCl+FYM	47.1	20.4
RP_HCl+PDM	48.0	25.1
SP (alone)	41.8	18.5
SP+HA	49.2	25.2
SP+FYM	58.6	25.1
SP+PDM	54.8	29.7

Sandy soil
LSD (0.01) = 6.2
LSD (0.05) = 4.5

Calcareous soil
LSD (0.01) = 3.2
LSD (0.05) = 2.3

phosphate and phosphate solubilizing microbes has produced mixed results on plant growth response. This was perhaps attributed to differences in microbial strains and/or soils being treated. Inoculation of phosphate solubilizing microbes onto RP may be considered a better means to overcome the low solubility problems of RP.

In conclusion in sandy soil it is possible to use rock phosphate in combination with either farmyard manure (FYM) or phosphate dissolving microbial (PDM). In calcareous soil it is possible to use RP in combination with PDM or HA instead of using SP, mixed with different activators or RP treated with different acids in both two soils.

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استخدام نفايات مصنع تركيز خام فوسفات السباعية شرق (المحاميد) كسماد فوسفاتى

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اجريت تجربة زراعة الفول البلدى فى صوبة لتقييم استخدام نفايات مصنع تركيز خام فوسفات السباعية شرق كسماد فوسفاتى مقارنة بسماد السوبر فوسفات العادى. استخدم فى التجربة عينتين تربة رملية وجيرية. تم معاملة نفايات خام الفوسفات ب 10% حامض هيدروكلوريك و/او حامض نيتريك مركز. طحنت عينات مصادر الفوسفور المختلفة لتمر من منخول 250 ميكرون. خلطت العينات ببعض مواد تنشيط الفوسفور مثل حامض الهيوميك , سماد المزرعة العضوى والبكتيريا المذيبة للفوسفات.

وجدت علاقة عالية المعنوية لقيم الأوزان الجافة والفوسفور الممتص بواسطة النبات بين كلا من المعاملات المختلفة التى اضيف إليها فوسفور ومعاملة الكونترول (بدون إضافة فوسفور). كما وجدت علاقة معنوية بين كلا من معاملة إضافة السوبر فوسفات بمفردة ومعاملة إضافة الفوسفات الخام (بدون معاملة بالأحماض). وعلى الجانب الأخر لم توجد فروق معنوية بين معاملة السوبر فوسفات والمواد الفوسفاتية المعاملة بالأحماض.

فى التربة الرملية يمكن استخدام نفايات المصنع مخلوطة مع البكتيريا المذيبة للفوسفات او سماد المزرعة العضوى اما فى التربة الجيرية فيمكن استخدام نفايات المصنع المخلوطة مع البكتيريا المذيبة للفوسفات او حامض الهيوميك. كما أوضحت هذه التجربة انه يمكن إضافة نفايات مصنع تركيز خام الفوسفات مباشرة للتربة بدون المعاملة بالأحماض ومخلوطا مع المواد المنشطة للفوسفور.