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Effect of Sewage Sludge Liming on Its Characteristics

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LIMING Abou-Rawash Sanitary Station sludge at the levels of 0, 2.5 and 5%(w/w) has a positive effect on EC, pH, Soluble K and total of both P and K. On the other hand, its effect was negative on organic matter, total nitrogen, soluble P, DTPA extracted Pb, Ni, Co and the ratio of the DTPA extracted /aqua rejia extracted Pb, Ni and Co. The 2nd liming rate (2.5 %) can be recommended to avoid the hazardous effect of Co.

Keywords: Sewage sludge, liming, OM, pH, EC, N,P,K, Pb, Ni, Co.

The used sewage sludge was taken from Abou-Rawash Sanitary Station- Giza Governorate, Egypt. Raw sewage sludge is unpleasant and rich in both heavy metals and pathogenic. To reduce these problems, sludge must be treated and stabilized. Lime addition (CaO) is the most common, cheapest and effective process, in maintaining high pH and in reducing water soluble metals. Sufficient lime is added to sludge to obtain pH about 12 after two hours of contact (Morel and Guckert, 1981). According to Pietz *et al.* (1989), lime is considered the best reagent to treat sewage sludge. Since addition of a more soluble source of Ca^{++} for vegetation was expected. As sludge organic matter is decomposed, it's pH buffering capacity resulting from the exchange capacity of sewage sludge solids. The Ca could be recycled in plant residues and could react with sludge organic matter forming stable humate complexes. They reported also that lime is a good reagent since its ability to supply the required plant nutrients and its reaction with soil components, provide more favorable environment for plant growth. Kasatikov *et al.* (1995) found also that application of lime to sewage sludge reduced the concentration of exchangeable and water soluble nutrients

from different compounds such as phosphates, carbonates and hydroxides of heavy metals in dernopozolic sandy loam soil.

In field experiment, liming the soil, which is amended with a heavy application of sewage sludge to pH 7 prior to sowing significantly, reduced metal concentration in carrots and spinach plants. The reduction appeared to be greater for Cd, Ni, Zn than for Cu and Pb (Hooda and Alloway, 1996; Sterret *et al.*1996 Abd El-Naim *et al.* 1997). They found also that the data for winter wheat suggested that metal uptake into the grain of past liming, was not high enough to reduce metal uptake.

The present work is a trail to evaluate the effect of liming on some characteristics of sewage sludge.

Material and Methods

Sewage sludge

Some characteristics of the sludge are shown in Table 1. Raw sewage sludge (67% moisture content on weight basis) was converted, from Saintary Station in Abou- Rawash, to the cement basins. The lime was added to the basins at three levels 0, 2.5, and 5%(w/w) well mixed in July 1997. The treatments were left in air to dry. Untreated and treated air-dried sewage sludge were well crushed. Sludge characteristics are given in Table 1. Sludge EC, pH, organic matter, and bulk density were measured after Soleh (1983).

The total and available forms of some heavy metals (Pb, Ni, Co) were extracted using aqua rejia and DTPA, respectively. Their concentrations were measured using the atomic absorption as described by Lindsay and Norvel (1978).

Results and Discussion

The concentrations of heavy metals in sludge vary according to its lime content. Table 1 and Fig. 1 indicate the effect of liming on some characteristics of the applied sludge. Increasing the applied lime 2.5 - 5 % increased the EC, pH, soluble K and total P and K. The increase in these parameters were: 33.65; 48.82% in EC, 11.24; 14.19% in pH, 5.00,15.00% in soluble K, 9.87; 16.63 % in total K, and 3.00; 5.43 % in total P when sludge was treated with 2.5 and 5.0 % lime, respectively relative to the untreated one.

TABLE 1. Effect of liming on sludge characteristics.

Parameters	Lime content %				
	0	2.5	%of control	5.0	%of contol
EC d S m^{-1}	2.11	2.82	33.65	3.14	48.82
PH	7.12	7.92	11.24	8.13	14.19
Organic matter%	41.5	36.25	-12.65	31.42	-24.29
Total nitrogen%	2.10	1.81	-13.81	1.72	-18.81
Total P ppm	7400	7445	0.61	7480	
Soluble P ppm	31.70	32.65	3.00	33.42	5.43
Total ppm	2585	2840	9.85	3015	16.63
Soluble K ppm	40.00	42.00	5.00	46.00	15.00
Total Ca ppm	44000	45200	2.73	46500	5.68
Soluble Ca ppm	360	384	6.67	415	15.28
Extractable by DTPA					
Pb ppm	25.00	19.00	-24.00	17.00	-34.0
Ni ppm	30.00	23.00	-23.33	15.00	-50.00
Co ppm	1.40	0.80	-42.86	0.70	-50.00
Total by Aqua regia					
Pb ppm	638.00	-		-	
Ni ppm	119.50	-		-	
Co ppm	34.20	-		-	
(Available : Total) %					
Pb ppm	3.92	2.98		2.66	
Ni ppm	25.10	19.25		12.55	
Co ppm	4.09	2.34		2.05	

On the other hand, liming sludge decreased its organic matter content, total nitrogen and soluble P content. Increasing lime application rate from 2.5 to 5.0% caused a decrease in organic matter, total nitrogen and soluble P ranging from 12.65-24.29, 13.81 - 18.09 and 8.11 -28.38% relative to the control, respectively.

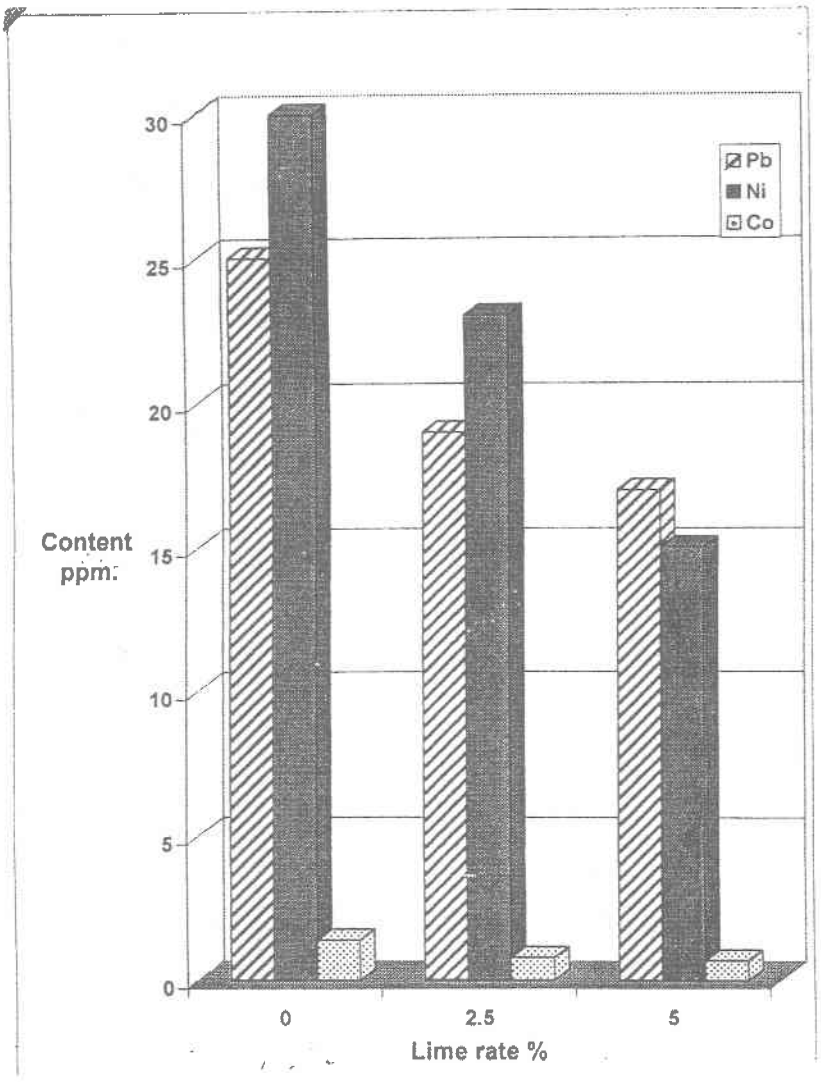

Fig .1. Liming effect on sludge Co, Ni and Pb content .

This may be due to the acceleration of organic matter decomposition by the added lime. Concerning the sewage sludge content from heavy metals (Pb, Ni, Co), data are given in Table 1. The total Pb, Ni and Co content in ppm were 638, 119.5 and 34.2 in sludge, respectively. According to Cottenie *et al.* (1982), the maximum recommended concentrations of Pb, Ni and Co in sludge to be applied

to cropland are 1200, 200 and 1.2 ppm, respectively. Comparing the figures of Cottenie *et al.* (1982) with those of Table 1, one can see that sludge content of both total and extractable Pb and Ni are below critical levels, while that of Co is above. Since liming sludge at the rate of 0, 2.5 and 5 % decreased the extractable Co from 1.4 to 0.8 and 0.7 ppm, respectively, the 2nd lime rate can be recommended to avoid Co hazardous effects. It is noticed also that lime application to sludge had negative effect on the available total ratio for the Pb, Ni and Co.

Decreasing sludge content of the extractable heavy metals under study may be due to one or more of the following reasons: i) Immobilization of Pb as sulfate or carbonate, ii) The higher pH led to their precipitation, and ii) Decreasing the extractability of trivalent cations chelated with organic matter and its biodegradation products. It can be concluded that:

The concentration of toxic elements in sludge varies according to its lime content. Increasing lime content in sludge 0-2.5-5 % increased the EC, pH, soluble K and total P and K. Liming sludge decreased its OM content, total N and soluble P content. Both total and extractable Pb and Ni are below critical levels. Lime addition at 2.5 and 5% decreased extracted Co from 1.4 (at 0% lime) to 0.8 and 0.7 ppm, respectively. Lime rate 2.5% can be recommended to avoid Co hazardous effect.

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تأثير معالجة الحمأة بالجير الحى على خواصها

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معاملة حمأة محطة الصرف الصحى - ابو رواش - جيزة - بالجير الحى ، عند مستويات صفر، ٢,٥ ، ٥ ٪ وزنا ، كان له تأثير ايجابى على EC وpH و البوتاسيوم الذائب وكل من الفوسفور والبوتاسيوم الكلى ومن جهه أخرى كان له تأثير سلبى على محتوى الحمأة من المادة العضوية والنتروجين الكلى والفوسفور الذائب ومستخلصDTPA لكل من Co و Ni و pb. وكذلك على النسبة بين مستخلص تلك العناصر بواسطة DTPA الى مستخلصها بالماء الملكى (الميسر من تلك العناصر : المحتوى الكلى منها) . المعدل الثانى من الجير ٢,٥ ٪ يمكن التوصية به لتجنب التأثير الخطير للكوبالت .