INDUSTRIAL WASTE CONTAINING CALCIUM AND MAGNESIUM, AN UNCONVENTIONAL SOURCE OF ACID SOIL AMENDMENT

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Abstract: *The paper presents a possible modality of improving the fertility of acid soil by treating it with alkaline compounds, containing essential and trace elements, resulted in the industrial process of manufacturing magnesium carbonate and oxide from dolomites. The two mineral sources have resulted from the magnesium products industry and contain in their composition significant contents of magnesium and calcium as well as low contents of trace elements such as iron, copper, manganese and zinc. The difference between the two waste types lies in the double magnesium content, established for the crusts deposits. Because of their alkaline reaction and nutritive elements content, the two waste types can be revaluated in agriculture as amendment on acid soils. The experiment pursueds the effects of soil treatment with 2 waste types applied in different doses.The obtained results show a buffer effect on the acid soil reaction and an increase of the essential and trace elements content of the treated soil. The pH buffering process and the enrichment of essential and trace elements in soil by alkaline waste supplies establishes in soil the enhancement of global soil fertility. The paper shows the effects of soil treatment with four different doses of industrial waste concerning the soil reaction and calcium- magnesium content. The obtained results indicate that soil reaction turns from acid to neutral, while the established increase for calcium soil content reached 51% and 26% for magnesium content, both generated by the highest experimented waste dose. The originality of this paper consists in the utilization of these waste, resulted from the magnesium products industry in agriculture as soil amendment. The importance of this study lies in the fact that, on the basis of the obtained results, a new amendment technology can be conceived by specifying the suitable dose of waste, usage manner and application frequency.*

Keywords*: *alkaline waste supplies, waste doses, soil reaction, pH buffering, calcium-magnesium soil content

INTRODUCTION

The industrial process of magnesium carbonate and oxide manufacturing from dolomites by carbon dioxide leaching, generates important amounts of waste (KOHN, 1998; TAUBERT, 2001; TAUBERT, 2002). The composition of this waste includes precipitates calcium carbonate, as well as a considerable amount of precipitated magnesium carbonate besides impurities from the raw dolomite, namely iron, manganese, copper, zinc, chromium and nickel compounds (TAUBERT, RĂDULESCU, 2006). The crusts deposed on the walls of the equipment represent another source of mineral elements. The mentioned waste, as well as the crusts, can be tested as mineral supplements for the treatment of depreciated soils. The simultaneous presence of the above mentioned mineral elements in soil and soil solution creates a balance in the uptake process of mineral elements. The interaction of the ions in soil and soil solution influence the root absorption process, creating antagonistic effects between the ion couples. The alkaline reaction and the important mineral content – essential and trace elements – of these waste can be valuated in agriculture as soil amendment for acid soils and fertilizer for soils with low fertility (RĂDULESCU, 2007 ; TAUBERT, 2008, 2009).

The main objective of this study is to present the influence of the soil treatment, with several doses of waste and crusts from the magnesium products industry, on soil reaction and mineral content. The obtained results show changes in the mineral content of luvosoil, as well as in its reaction, proving a bettering of soil fertility.

MATERIAL AND METHODS

Luvosoil, having a pH value of 5,8 and a rather low fertility, was collected, air-dried, crushed, mixed thoroughly and put into pots, each containing 1 kg soil. The soil was treated with 2 types of mineral supplements, namely industrial waste (A) and industrial crusts (B), having the composition presented in table 1.

Table 1

Composition of the industrial waste(A) and crusts(B)

Specification	Ca (%)	Mg (%)	Fe (mg/g)	Zn (mg/g)	Mn (mg/g)	Cu (mg/g)	Cr (mg/g)	Ni (mg/g)
Waste (A)	28	7	1,93	0,16	0,136	0,042	0,054	-
Crusts (B)	19	14	0,88	0,05	0,051	0,051	-	0,0026

The applied waste doses and the experimental alternatives are described in table 2.

Table 2

Added waste amounts and mineral content into the experimental soil alternatives

Specification	Exp. alternative	Exp. alternative	Exp. alternative	Exp. alternative
Waste (A)	V1	V2	V3	V4
Amounts,(mg/kg)	180	360	720	1440
Ca content,mg/kg	50	100	200	400
Mg content,mg/kg	13	25	50	100
Fe content, mg /kg	0,347	0,695	1,390	2,780
Mn content,µg /kg	25	50	101	202
Cu content, µg /kg	7	15	30	60
Zn content, µg /kg	29	58	115	230
Cr content, µg /kg	10	19	39	78
Crusts (B)	V5	V6	V7	V8
Amounts,(mg/kg)	263	526	1053	2105
Ca content,mg/kg	50	100	200	400
Mg content,mg/kg	37	74	147	295
Fe content, mg /kg	0,23	0,46	0,93	1,85
Mn content,µg /kg	13,4	26,8	53,6	107,3
Cu content, µg /kg	13,4	26,8	53,7	107,4
Zn content, µg /kg	13,2	26,4	52,6	105,2
Ni content, µg /kg	6,8	13,6	27,3	54,7

Soil reaction was analyzed from water: soil 5:1 solution by help of a pH- meter. The soil mineral content was analyzed as follows: The samples brought in a powder stage were dried at 95˚C until a constant weight. Out of the dried sample, 0,2 g was weighed and introduced into a bomb of rayon, which was heated by microwaves. In the BERGHOF B apparatus the disintegration took place at 190˚C, preserved for 10 minutes. After cooling, the obtained solution was analyzed by means of an atomic emission spectrometer- JOBIN YVON 24 sequential ICP.

The soil samples were collected after a vegetation period on oat of 8 weeks and analyzed in comparison with an untreated soil sample (V0). All the experiments were done in triplicate to have a statistic assurance.

RESULTS AND DISCUSSIONS

The obtained results of the analyzed soil samples are presented in table 3.

Table 3

Soil reaction and mineral content of the experimental alternatives

Content	M.U.	Contr-V0	A/V1	A/V2	A/V3	A/V4	B/V5	B/V6	B/V7	B/V8
pH	pHunits increase	5,80 -	6,40 0,60	6,45 0,65	6,66 0,86	6,93 1,13	6,20 0,40	6,30 0,50	6,50 0,70	6,80 1,00
Ca	mg/kg %	2136 100	2267 106	2261 105	2440 114	2674 125	2122 99	2164 101	2254 106	2717 127
Mg	mg/kg %	327 100	348 106	352 108	400 122	464 142	343 105	361 110	412 126	566 173
Fe	mg/g %	235 100	250 106	245 104	260 111	257 109	233 99	243 103	235 100	254 108
Mn	mg/g %	88 100	84 95	80 91	87 99	73 83	76 86	71 81	94 107	93 106
Cu	mg/g %	3,40 100	3,49 103	3,67 108	3,46 102	3,67 108	3,46 102	3,36 99	3,79 111	3,73 110
Zn	mg/g %	110,4 100	33,1 30	31,2 28	14 13	12,9 12	4,42 4,0	4,83 4,4	4,57 4,1	4,43 4,0
Cr	mg/g %	0,1 100	0,14 140	0,11 110	0,14 140	0,20 200				
Ni	mg/g %	1,14 100					0,94 82	0,93 81	1,15 101	1,27 111

For each experimental waste (A) and crusts (B), 4 different doses were applied on soil. They were V1, V2, V3, V4 for waste (A) and V5, V6, V7, V8 for the crusts (B). The results were finally compared with an untreated soil sample (Control- V0).

Taking into account the composition of each waste and the administered doses, the results show an improvement in the mineral content of soil once with the increase of the waste dose and a buffering effect of the acid soil reaction. For the highest dose of waste (A) the pH increase represents 1,13 pH units comparative with an increase of only 1,00 pH unit for the highest crusts (B) dose.

An improvement of mineral soil content was established once with the increase of the waste dose. The highest dose of waste (A) generates a calcium increase in soil content of 25% and 42% for magnesium. The increase is also evident for iron (11%), copper (8%) and the highest value registered for chromium (100%). Manganese and zinc in soil content show a decrease of 17% and 88% respectively, because of the antagonistic effects created by high amounts of calcium and magnesium in soil content.

The soil samples treated with crusts (B) show similar results to the treatment with waste (A). The highest dose of crusts (B) added to soil, generates a calcium content increase in soil of 27% and 73% for magnesium. The higher value for magnesium content in soil can be explained because of the higher magnesium amount in the crusts (B) composition. The increase for the other mineral elements of the crusts (B) composition is as follows: 8% for iron, 7% for manganese, 10% for copper and 11% for nickel. An evident decrease shows the zinc content in soil, representing 86%, which can be explained again, because of the antagonistic effects created by high amounts of calcium and magnesium. A similar buffering effect of the soil reaction was also established, the pH value increase for the highest crusts dose being of 1pH unit.

CONCLUSIONS

The obtained experimental results confirmed that the two tested waste (A) and crusts (B) can be successfully used in agriculture as soil amendment and to improve soil fertility.

Soil treatment with the tested waste doses had a positive effect on the soil quality by raising its content of essential and trace elements and its pH value.

The high amounts of calcium and magnesium in soil, as well as the rising amounts of iron and copper from the waste composition creates antagonistic effects, which decrease the concentration of manganese and zinc in soil.

All other mineral elements such as essential elements like calcium and magnesium, as well as trace elements like iron and copper, also chromium and nickel, present in the waste composition, improve their concentration in soil by adding the tested doses of industrial waste (A) and crusts (B).

Considering the obtained results, the two experimented industrial waste can be used in certain doses as soil amendment for acid soils and as calcium- magnesium fertilizer.

The presence of magnesium and calcium in the waste composition induces an alkaline reaction by both types of waste. There for, the acid soil reaction can be neutralized by treating soil with the suitable waste dose.

Because of their composition, both waste types can be used as fertilizer containing calcium and magnesium. The enhance of the available essential nutrient soil content by treating soil with the suitable waste dose maintains its role as fertilizer.

The increase of the available iron content in presence of nitrogen addition, conditioned by a suitable waste dose, completes its fertilizer role.

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