RESULTS REGARDING THE RECOVERY OF ALKALINE INDUSTRIAL WASTE FOR THE FERTILIZATION OF GREEN OAT PLANTS

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Abstract: *The study shows the impact of soil treatment with industrial waste on the nutrient content and growth process of green oat plants. The industrial process of carbon dioxide leaching from dolomites produces magnesium carbonate and oxide and calcium carbonate as waste. Both waste types result in the industrial processes of manufacturing magnesium compounds from dolomites as waste product and deposits on the industrial equipment. Besides calcium carbonate the waste contains magnesium carbonate. The difference between the two waste types lies in the double magnesium content, established for the crusts deposits. The research pursues the result of treating soil with industrial waste, managed as four different doses, on soil features like reaction and calcium-, magnesium content as well as on the nutrition process of oat plants, stand out as growth process and calcium- magnesium uptake. The experimental alternatives consists of treating soil with four different waste doses. The results praise that, after soil treatment with several doses of waste, acid soil becomes neutral, while an increase for calcium and magnesium content in soil was also observed. For green oat plants, the growth process by mean of some vegetation characteristics and essential elements uptake was studied. The impact of soil treatment with waste as fertilizer on plant content differs depending on the pursuit nutrient element. The results show that calcium uptake increased by 117% and 72% for magnesium uptake was established. The consequence on the development of green oat plants reveals a positive effect on germination and risen plants, simultaneous with dry matter content decrease. The originality of this paper consists in the revaluation of this industrial waste in agriculture both as a fertilizer and an amendment for acid soils. The importance of this study lies in establishing a new technology that can be used in agriculture by specifying the suitable dose of waste, usage manner and application frequency.*

Keywords: *magnesium products industry, mineral waste, waste doses, soil reaction, green oat plants growth, calcium –magnesium content*

INTRODUCTION

The presence of several nutrients in the industrial waste composition makes it useful for fertilizing and amending acid soil. This waste is the result of carbon dioxide leaching from dolomites. Burnt dolomites slurries generates magnesium bicarbonate, but calcium carbonate results also as waste (KOHN, 1998). Calcium carbonate, in form of precipitate, includes the impurities of the dolomite composition, besides important amounts of magnesium carbonate (TAUBERT, 2001). Because its composition, this waste can be used as soil treatment for increasing soil fertility (TAUBERT, 2002). The content of calcium and magnesium in its composition, awards the waste an amendment and fertilizer role for acid soils with low calcium and magnesium content and therefore low fertility. The alkaline reaction and the important mineral content of the waste can be valuated in agriculture (RADULESCU, 2005; TAUBERT, 2006, 2008, 2009). Calcium and magnesium take an important part in plant nutrition. Sometimes, soils can not ensure the calcium and magnesium plant demands during the vegetation period. The importance of magnesium in plant nutrition lies in its catalytic role, in the photosynthesis process and the circulation of some major nutritional elements. The role of calcium is to promote the development of the root system and cell division, also contributes

to the consolidation of the stem which becomes fall resistant (MOCANU, 1997; LIXANDRU, 1990).

This research aims to spotlight the results of treating acid soil with several waste doses, on some soil features like soil reaction and calcium- magnesium content, as well as on this soil seeded with oat, effects on the vegetation and nutrition process of green oat (*Avena sativa* L.) plants.

MATERIAL AND METHODS

The experiment took place in the laboratory using soil samples, in experimental pots, having a pH value of 5, 8. In each pot, containing 1 kg soil, the soil was prepared in order to become homogeneous after mixing it with the waste dose. The waste, used as powder for soil treatment, contains 29,5 % calcium and 6,5 % magnesium, also insoluble impurities in hydrochloric acid are 0,6- 1,35% and 0,83-1,05% iron and aluminum oxides.

The experiment is made up of four alternatives, respectively four different waste doses (V1, V2, V3, V4) used for soil treatment (Table 1) and a control alternative (V0) represented by untreated soil. To ensure the statistics all the experimental alternatives had three replicates.

Table 1

Description of the experimental alternatives, representing waste amounts added to soil.

Experimental alternative	Waste dose, mg/kg Amount	Waste dose, mg/kg Calcium content	Waste dose, mg/kg Magnesium content
V1	180	53	12
V2	360	106	23
V3	720	212	47
V4	1440	424	94

Each experimental pot, placed by the window, was sown with fifteen oat grains and watered every second day by 50 ml water. The studied period was that of green plant, while the growth and the development of the oat plants were studied. During the vegetation period the green oat plants were analyzed by establishing the number of risen plants, plant size, fresh and dry weight also dry matter (105˚C) of the harvested plant material. In order to establish the impact of soil treatment with waste as fertilizer on green oat plants, the total nutrient plant content for several essential elements was analyzed.

The uptake of calcium and magnesium uptake in green oat plants was analyzed using atomic absorption spectrophotometry (AAS). Soil samples were analyzed by establishing their pH values, calcium and magnesium content. Soil reaction, was determinate in watery soil solution (1:5) by mean of a pH-meter. The total essential elements content in plant was analyzed by using the dry ash method along with atomic absorption spectrophotometry.

The results of the analyzes performed for all experimental variants (V1- V4) are representing average values of the three replicates and were interpreted by comparison with the control variant (V0).

RESULTS AND DISCUSSION

Influence of waste doses on soil

Because its composition, treating soil with industrial waste has led to important changes in soil fertility. The important content of calcium and magnesium of the waste, improves the calcium and magnesium soil content and its reaction by turning it to neutral. The

determined values are distinct depending on the administered dose for each experimental alternative. They are shown in table 2.

Table 2

Effect of soil treatment on soil reaction, calcium and magnesium content

Experimental alternative	Soil reaction pH	Soil reaction increase	Calcium content mg/kg	Calcium content %	Magnesium content mg/kg	Magnesium content %
V0	5,80	-	87	100	10	100
V1	6,40	0,60	90	103	21	210
V2	6,45	0,65	100	115	26	260
V3	6,66	0,86	118	136	34	340
V4	6,93	1,13	218	151	36	360

The presence of the waste dose, by adding it to soil, generates a neutral pH on acid soil. The pH values rise becoming neutral once with the increase of the waste dose. The increase of the soil pH value by 1, 13 pH units was established for treating soil with the highest tested waste dose (V4). Simultaneous, by rising the given waste dose an improvement of the calcium content of soil was found. The improvement of the soil calcium content took place proportional with the increase of the waste dose, representing 51% for the highest dose (V4). The values obtained for the magnesium soil content indicate a more significant increase as for the calcium content Thus, an increase of 110% for the magnesium content in soil was registered for the lowest experimented waste dose (V1), reaching an increase of 260% for the highest waste dose (V4) administered to soil.

Impact of the soil treatment with industrial waste on oat plants

The results generated by different doses of waste addition to soil on the growth process of oat plants is presented in table 3.

Table 3

Influence of different waste doses on some vegetation characteristics of green oat plants

Vegetation characteristics	V0	V1	V2	V3	V4
Risen plants Number / %	11,0 / 73,0	13,0 / 87,0	13,0 / 87,0	13,0 / 87,0	14,0 / 93,0
Size of green plants cm / %	27,3 / 100	29,0 / 106,0	28,3 / 104,0	31,3 / 115,0	31,3 / 115,0
Fresh weight mg piece / %	268,0 /100	233,7 / 87,2	195,2 / 72,8	221,3 / 82,6	213,3 / 79,6
Dry weight mg piece / %	95,0 / 100	74,6 / 78,5	56,6 / 59,5	54,6 / 57,6	47,2 / 49,9
Dry matter %	35,7	32,0	29,3	23,2	22,6

Rising the waste amounts administered on soil improves grain germination and sprouted oat plants. The increase of the sprouted oat plants number was 20% for the highest waste dose (V4). Enhancing the waste dose, green oat plants grew taller, meaning 4 cm (15%) for V4. At the end of the experiment, the green oat plants were taller, thinner and had a lower dry matter content for all alternatives compared to the control alternative.

Table 4 shows the influence of treating soil with the tested waste doses on the calcium and magnesium content as well as on the potassium and phosphorus uptake of the green oat plants.

Table 4

Impact of waste doses on essential elements content in green oat plants

Experimental alternative	Calcium		Magnesium		Potassium		Phosphorus	
	mg/kg	%	mg/kg	%	mg/kg	%	mg/kg	%
V0	4002	100	2117	100	1350	100	800	100
V1	4723	118	2410	114	1900	140	1180	147
V2	5450	136	3175	150	1970	146	1505	188
V3	6517	163	3412	161	2610	193	1725	215
V4	8672	217	3645	172	2600	193	1665	208

The addition of rising waste doses on soil improves the plant uptake of essential elements during the nutrition process. The enhance of the calcium content in green oat plants is proportional to the added waste dose. The highest waste dose (V4) generated an increase of 117% for the calcium concentration in green oat plants. For the same waste dose added to soil, all the other essential elements plant content rises improving the plant uptake of essential elements. The established increase was by 72% for magnesium, 93% for potassium and 115% for phosphorus determined in the experimental alternative V3.

CONCLUSIONS

The paper highlights the beneficial effect of treating soil with the industrial waste presented above precisely due to its composition. Testing the effects of industrial waste on soil features meaningful results were obtained regarding the fertility of acid soils. It was established the existing correlation between the applied waste dose on soil and the neutralizing effect on soil pH as well as the rise of calcium and magnesium soil content. The increase of the waste dose, leads to the improvement of magnesium content in soil, more significant than that of the calcium content.

The experimented waste doses had an important effect on grain germination enhancing the number of sprouted oat plants. The plants were taller and thinner for all experimental alternatives comparative to the control alternative. The uptake of calcium and magnesium by green oat plants is similar, for all the experimental alternatives. Rising the waste dose generates an increase not only of calcium and magnesium content but also for other essential elements like potassium and phosphorus in the green oat plants.

The simultaneous presence in soil of the elements found in the waste composition has a crucial effect on their uptake in the nutrition process of the oat plants.

Given the obtained results, the experimented waste doses can be used depending on soil characteristics as soil amendment for acid soils and fertilizer for low fertile soils enhancing crop production.

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