ON THE USE OF RESIDUAL CALCIUM AND MAGNESIUM IN SOIL TREATMENT AND PLANT FERTILISATION

VALORIFICAREA CALCIULUI SI MAGNEZIULUI REZIDUAL IN AMENDAREA SOLULUI SI FERTILIZAREA PLANTELOR

Hortensia RĂDULESCU*, Lidia TAUBERT, N. BĂGHINĂ***

**Agricultural and Veterinary University of the Banat, Timişoara, România*
***Chemistry Institute of Romanian Academy, Timisoara, Romania*
Corresponding author:Hortensia RĂDULESCU, e-mail: hortensiaradulescu@yahoo.com

A b s t r a c t . *The industrial process of producing magnesium carbonate and oxide from dolomites by carbon dioxide leaching generates calcium carbonate as waste. Besides calcium carbonate, this precipitate contains magnesium carbonate, which can be useful in agriculture as a soil amendment and fertilizer for low fertile acid soils. The paper shows the effects of soil treatment with four different doses of industrial waste concerning the soil reaction and calcium - magnesium content, simultaneously with the growth process of green oat plants and their calcium - magnesium uptake. The obtained results indicate that soil reaction turns from acid to neutral, while the established increase for calcium soil content reached 51% and 260% for magnesium content, both generated by the highest experimented waste dose. For green oat plants, the results showed an increase by 117% for calcium uptake and 72% for magnesium uptake. The influence determined on the growth reveals a beneficial effect on germination and number of risen plants, a taller size of plants as well as a decrease of dry matter content at harvest time.*

Rezumat. *Procesul industrial de obţinere a carbonatului şi oxidului de magneziu din dolomite prin precipitarea bioxidului de carbon generează concomitent cantităţi importante de deşeuri sub formă de carbonat de calciu. În afara carbonatului de calciu deşeul conţine şi carbonat de magneziu, ceea ce face ca materialul să poată fi valorificat în agricultură drept amendament pentru soluri acide şi îngrăşământ pentru soluri slab fertile. Lucrarea prezintă efectele tratării solului, cu patru doze diferite de deşeu, asupra reacţiei solului şi a conţinutului acestuia în calciu şi magneziu concomitent cu dezvoltarea plantelor de ovăz şi a conţinutului acestora în macroelemente. Rezultatele obţinute evidenţiază modificarea reacţiei solului de la acid la neutru dar şi un conţinut crescut al acestuia în calciu (51%) şi magneziu (260 %) pentru doza maximă de deşeu. Conţinutul de calciu în planta de ovăz a crescut cu 117% şi respectiv 72% pentru conţinutul în magneziu. Influenţa asupra creşterii şi dezvoltării plantelor de ovăz relevă un efect benefic asupra germinaţiei şi a numărului de plante răsărite cât şi o talie mai înaltă a plantelor verzi. Se constată de asemenea scăderea conţinutului de substanţă uscată până la momentul recoltării.*

Key words: *waste doses, soil reaction, calcium - magnesium content, plant growth*
Cuvinte cheie*: doze de deşeu, reactia solului, conţinut de magneziu şi calciu, dezvoltarea plantei*

INTRODUCTION

Waste containing useful elements for soil amendment and fertilization are valuated in agriculture. Such an example is represented by the producing process of magnesium carbonate and oxide from dolomites by carbon dioxide leaching. Thus by carbonation of calcined dolomites slurries, the main product is magnesium bicarbonate, calcium carbonate results as waste (KOHNet al. 1998). The precipitate of calcium carbonate will include the impurities of the initial dolomite, as well as an important amount of magnesium carbonate (TAUBERT 2001). In order to enhance soil fertility, this waste can be used for soil treatment due to its composition. The presence of calcium and magnesium ions awards the waste an amendment and fertilizer

role for acid soils with low calcium and magnesium content. Magnesium has a catalytic role in plant nutrition taking part in the photosynthesis process and facilitating the circulation of some major nutritional elements. Calcium is used by plants in their physiological processes; it promotes the development of the root system and cell division, contributes to the consolidation of the stem which becomes fall resistant (AVARVAREI et al. 1997, LIXANDRUet al. 1990).

The main objectives of this study are to present the effects of soil treatment by different waste doses concerning soil reaction and calcium - magnesium content of luvosoil, as well as the growth process and calcium - magnesium uptake of green oat *(Avena sativa L.)* plants.

MATERIALS AND METHODS

The soil in the experimental plots is luvosoil, a rather low fertility soil, characterized by some data mentioned in Table 1.

T a b l e 1

Soil characteristics

No	Characteristics	M.U.	Value
1.	Particle size distribution:		
	- Sand (2.0 - 0.2 mm)	%	3.5
	- Fine sand (0.2 - 0.02 mm)	%	49.6
	- Silt (0.02 - 0.002 mm)	%	33.1
	- Clay (under 0.002 mm)	%	13.8
2.	pH in water		5.8
3.	Macroelement content:		
	Ca^{2+}	me/100	70
	Mg^{2+}	me/100	48

Luvosoil was collected, air-dried, crushed, mixed thoroughly with the waste dose and put into pots, each containing 1 kilogram soil. The waste used as powder for soil treatment had an average composition including 29.5% calcium and 6.5% magnesium. Like in the initial dolomites, the same inconstancy of the waste composition is noticed. The calcium carbonate content lies between 70.6-75.5%, the magnesium carbonate content expressed as MgO is 8.8-14.0%, insoluble impurities in hydrochloric acid are 0.6-1.35% to which 0.83-1.05% iron and aluminium oxides are added.

The experimental alternatives pursued by the research consist of four different waste doses (V_1, V_2, V_3, V_4) used as soil treatment (Table 2) and one control alternative (V_o) represented by untreated soil. All the experimental alternatives took place in three replicates.

T a b l e 2

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

Experimental alternative	Waste dose, mg/kg soil		
	Amount	Calcium content	Magnesium content
V_1	180	53	12
V_2	360	106	23
V_3	720	212	47
V_4	1440	424	94

All the pots were sown with fifteen oat grains on the 22nd March 2007. They were watered every second day by 50ml water. The pots were placed near the laboratory window. The pursued vegetation period was that of green plant, until 10th May 2007, while the growth and development of the oat plants were studied. Some morphological and chemical parameters of the green oat plants along the vegetation period was established (number of risen plants, plant

size, fresh and dry weight, also dry matter (at 105°C) of the harvested plant material). At harvest time, the calcium and magnesium uptake in green oat plants was determined by use of atomic absorption spectrophotometry (AAS). Soil samples were collected at harvest time and analysed for their pH values and calcium, magnesium content. In order to determine the soil reaction, a watery soil solution (1:5) was used; the pH values were red by a pH-meter. Calcium and magnesium soil content was established by complexometric measurement with complexon III.

All the obtained alternative results, representing average values of the three replicates, were compared with the control alternative.

RESULTS AND DISCUSSION

Influence of waste doses on soil

The treatment of luvosoil with four different doses of industrial waste showed important changes regarding soil fertility. Due to its composition, consisting mainly of calcium and magnesium carbonates, this waste had an important effect on soil reaction, improving calcium and magnesium content. The established values are distinct for each experimental alternative being shown in Table 3.

Table 3

Effect of soil treatment with different waste doses on soil reaction, calcium and magnesium content

Experimental alternative	Soil reaction		Calcium content		Magnesium content	
	pH	increase	mg/kg	%	mg/kg	%
V_0	5.80	-	87	100	10	100
V_1	6.40	0.60	90	103	21	210
V_2	6.45	0.65	100	115	26	260
V_3	6.66	0.86	118	136	34	340
V_4	6.93	1.13	218	151	36	360

The presence of this waste in soil had a neutralizing effect on soil reaction. Luvosoil, which had an acid pH, became neuter once with the increase of the waste dose. For the highest tested waste dose (V_4), the soil pH value increased by 1.13 pH units and became neuter (6.93). The calcium content of luvosoil improved once with the increase of the administered waste dose; this increase took place proportional by the rise of the waste dose being of 51% for the highest dose (V_4). Values for magnesium content in soil were lower, but the increase is much more significant as for calcium; the lowest experimented waste dose generates an increase of 110% for magnesium content, reaching an increase of 260% for the highest waste dose.

Influence of the soil treatment on plants

The effects of soil treatment, with different doses of waste, on the growth process of oat plants are shown in Table 4.

Table 4

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

Vegetation characteristics	Experimental alternative				
	V_0	V_1	V_2	V_3	V_4
Risen plants (number) / %	11.0	13.0	13.0	13.0	14.0
	73.0	87.0	87.0	87.0	93.0
Size of green plants (cm) / %	27.3	29.0	28.3	31.3	31.3
	100.0	106.0	104.0	115.0	115.0
Fresh weight (mg/piece) / %	268.0	233.7	195.2	221.3	213.3
	100.0	87.2	72.8	82.6	79.6
Dry weight (mg/piece) / %	95.0	74.6	56.6	54.6	47.2
	100.0	78.5	59.5	57.6	49.9
Dry matter (%)	35.7	32.0	29.3	23.2	22.6

The enhancing of the waste amounts in soil treatment had a beneficial effect on the grain germination praised by a higher number of risen oat plants. The increase of the risen plants number was of 20% for the highest waste dose administered on soil (V_4). Green oat plants grew taller once with the increase of the waste dose; the plants size was taller by 4 cm (15%) for V_4. At harvest time, the green oat plants were taller, thinner and had reduced dry matter content for all experimental alternatives in comparison with the control alternative. Table 5 shows the influence of soil treatment with different waste doses on the calcium and magnesium uptake by plants and their content at harvest time in calcium and magnesium.

Table 5

Impact of the waste doses on some macroelements content in green oat plants

Experimental alternative	Ca		Mg		K		P	
	mg/kg	%	mg/kg	%	mg/kg	%	mg/kg	%
V_0	4002	100	2117	100	1350	100	800	100
V_1	4723	118	2410	114	1900	140	1180	147
V_2	5450	136	3175	150	1970	146	1505	188
V_3	6517	163	3412	161	2610	193	1725	215
V_4	8672	217	3645	172	2600	193	1665	208

Treating soil with higher waste doses increases the plant uptake of calcium and magnesium. The increase of calcium concentration in green oat plants took place proportional to the waste dose. The highest waste dose (V_4) determined an increase by 117% of the calcium concentration in plant at harvest time; for the same waste dose, the increase of magnesium content was of 72%.

CONCLUSIONS

1. The research shows that soil treatment with this industrial waste has a beneficial effect on soil quality and on the fertility of acid soils. It was established that there is a direct correlation between the increase of the applied waste dose in soil and the neutralizing of soil acidity also improving calcium and magnesium content. Once with the increase of the waste dose, the improvement of magnesium content in soil is much more significant than that of the calcium content.

2. The experimental waste doses had a beneficial effect on grain germination improving the number of risen oat plants. The green oat plants were taller and thinner for all applied waste doses comparative to the control alternative of untreated soil. The uptake of calcium and magnesium by the green oat plants is very similarly; for all the experimental alternatives, the enhancement of the applied waste dose leads to an increase of the calcium and magnesium concentration in the green oat plants at harvest time.

3. Considering the obtained results, the tested industrial waste can be used in certain doses as an amendment and fertilizer for acid, low fertile soils.

LITERATURE

1. AVARVAREI I., DAVIDESCU V., MOCANU R., GOIAN M., CARAMETE C., RUSU M. 1997, Agrochemistry, Ed. Sitech, Craiova, Romania.
2. LIXANDRU GH., CARAMETE C., HERA G., MARIN N., BORLAN Z., CALANCEA L., GOIAN M., RAUTA C, 1990, Agrochemistry, Ed. Didactica si Pedagogica, Bucuresti, Romania.
3. KOHN D., TAUBERT L. M., POLICEC S. L., ROMANU E., l998, Verbesserung der Filtration durch Vorbehandlung der Suspension mit Polymeren Flockungsmitteln, Fiitrieren und Separieren F&S, 12(4): 161
4. TAUBERT L. M., 2001, Utilization of calcium carbonate waste from the magnesium products industry, 12th Romanian International Conference on Chemistry and Chemical Engineering. Inorganic Chemical Technology, Bucharest-Romania: 201-206.