CONSEQUENCES OF RESIDUAL SOIL TREATMENT ON THE NUTRITIVE ELEMENTS CONTENT OF PLANTS

Hortensia RĂDULESCU

Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Agricultural Sciences, Timisoara, Department of Sustainable Development and Environment Engineering, Aradului Street, no. 119, RO-300645, Romania
E-mail: hortensiaradulescu@yahoo.com.

Abstract: *The paper shows the influence of soil treatment with industrial residue on the nutrient content of wheat plants. Two industrial residues were tested as fertilizer, by treating luvosoil with different doses of residue. The two mineral sources have resulted from the magnesium products industry and contain in their composition significant contents of magnesium and calcium and low contents of trace elements such as iron, copper, manganese and zinc. Both residue types result in the industrial processes of manufacturing magnesium compounds from dolomites as waste product and deposits on the industrial equipment. The difference between the two residue types lies in the double magnesium content, established for the crusts deposits. Because of their alkaline reaction and nutritive elements content, the two residues can be revaluated in agriculture as fertilizer, mainly on acid soils. The experimental alternatives are represented by four different doses from each residue, added to soil without or with nitrogen supplement (ammonium nitrate). In order to establish the influence of soil treatment with residue as fertilizer on the nutrient plant content, the total essential and trace elements content in green wheat plants were determined. The total nutrient content in plant was analysed by using the dry ash method along with atomic absorbtion spectrophotometry. The impact of soil treatment with residue as fertilizer on plant content differs, depending on the pursuit nutrient element. The potassium content in green wheat plants shows an increase by 23% comparative with the control alternative only for residue B(B4) without nitrogen supplement. The calcium content in plant rises proportional with the administered residue dose for both residue types. Nitrogen contribution increases the values by 28% for residue A and 25% for residue B. The dynamics of magnesium plant content is similar to that of calcium content for both alternatives with or without nitrogen contribution. The highest increases were established for the experimental alternative* A_4*(37%) and* B_4 *(52%), both with nitrogen contribution. Analysing the trace elements content in plant, an increase of iron content proportional with the administered residue dose was determined. The increase of 24% was established for the experimental alternative with the highest dose of residue B and nitrogen addition. Meaningful increases were established in the plant copper content for both experimented residues. The originality of this paper consists in the utilization of these residues, resulted from the magnesium products industry, in agriculture as fertilizer. The importance of this study lies in the fact that, on the basis of the obtained results, a new fertilization technology can be conceived by specifying the suitable dose of residue, usage manner and application frequency. The usefulness of the research lies in transforming a residue in an useful material for agriculture.*

Key words: *magnesium products industry, mineral residue, fertilizer, nutrient plant content*

INTRODUCTION

The large amounts of waste generated by human activities are rapidly becoming a global problem for the environment protection because of their composition and storage manner. In order to avoid this situation, waste containing useful elements for soil amendment and fertilization are valuated in agriculture. Such an example is represented by the producing process of magnesium products from dolomites by carbon dioxide leaching. Thus, by carbonation of calcined dolomites slurries, the main product is magnesium bicarbonate in solution, calcium carbonate results as residue (TAUBERT, 2001). The composition of these residue include precipitated calcium carbonate and magnesium carbonate, together with other impurities, which are present in the raw material, such as iron, manganese, copper and zinc (TAUBERT, 2002). In the carbonation of calcined dolomites results two types of residue, one as waste product and the second one, as deposits on the industrial equipment (RADULESCU et al., 2005; TAUBERT et al., 2006). Calcium and magnesium are two important mineral elements for plant nutrition. Most of the soils do not fulfil plant nutrition demands during the vegetation period. Frequently, nutrients are leached out or become unavailable for plants. 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 (MOCANU et al., 1997).

The alkaline reaction and the important mineral content – essential and trace elements – of these residues can be valuated in agriculture as soil amendment and fertilizer (RADULESCU et al., 2007; TAUBERT et al., 2008; TAUBERT et al., 2008).

The main objective of this study is to present the influence of the residue type and doses on the nutrient plant content. The paper reports the effects of two residue types and several doses added to luvosoil, with or without nitrogen contribution and their potential role as fertilizer.

MATERIAL AND METHODS

Luvosoil, having a pH of 6.65 and a rather low soil fertility was collected, air-dried, crushed, mixed and put into pots, each containing 1 kilogram soil. The soil was treated with two types of residue (A, B) in different amounts, each having the compositions presented in table 1.

Table 1

Composition of the tested industrial residues

Specification	Residue A	Crusts B
Ca content, %	28	19
Mg content, %	7	14
Fe content, mg/kg	1850	880
Cu content, mg/kg	1.9	51
Mn content, mg/kg	136	51
Zn content, mg/kg	2.6	50

The experimental alternatives pursued by this research consist of four different doses of each residue (A_1 - A_4 ; B_1 - B_4) and also a control alternative (C_0) - represented by untreated soil. All the experimental alternatives took place in three replicates, without nitrogen addition or treated with 134 mg N/ kg soil as ammonium nitrate. The description of the experimental alternatives is shown in table 2, in which R represents the replicates without nitrogen contribution and R_N–the replicates treated with nitrogen as ammonium nitrate.

Table 2

Description of the experimental alternatives

Experimental alternative		N contrib. mg/kg	Mineral supplement / kg soil						
			Dose mg	Ca mg	Mg mg	Fe mg	Mn µg	Zn µg	Cu µg
A 1	R	-	179	50	13	0.33	24.3	0.47	0.34
	R_N	134	179	50	13	0.33	24.3	0.47	0.34
A 2	R	-	357	100	25	0.66	48.7	0.93	0.68
	R_N	134	357	100	25	0.66	48.7	0.93	0.68
A 3	R	-	714	200	50	1.32	97.4	1.86	1.36
	R_N	134	714	200	50	1.32	97.4	1.86	1.36
A 4	R	-	1429	400	100	2.64	194.7	3.72	2.72
	R_N	134	1429	400	100	2.64	194.7	3.72	2.72
B 1	R	-	263	50	37	0.23	13.4	13.2	13.4
	R_N	134	263	50	37	0.23	13.4	13.2	13.4
B 2	R	-	526	100	74	0.46	26.8	26.4	26.8
	R_N	134	526	100	74	0.46	26.8	26.4	26.8
B 3	R	-	1053	200	147	0.93	53.6	52.6	53.6
	R_N	134	1053	200	147	0.93	53.6	52.6	53.6
B 4	R	-	2105	400	295	1.85	107.3	105.2	107.3
	R_N	134	2105	400	295	1.85	107.3	105.2	107.3

All the pots were sown with thirty wheat grains. The vegetation period pursued was that of green plant during 12 weeks, in order to establish the influence of residue treatment on nutrient plant content at harvested time.

In order to establish the consequences of soil treatment with residues as fertilizer on green wheat plants, the total nutrient plant content for several essential and trace elements was determined.

The total nutrient content in plant was analysed by using the dry ash method along with atomic absorbtion spectrophotometry. The metal element content in plant at harvest time was established by AAS-ICP method. As essential metal elements were pursued potassium, calcium and magnesium, as well as iron, manganese, copper and zinc as trace elements.

RESULTS AND DISCUSSIONS

The impact of residue revaluation as fertilizer on green wheat plants was studied by analysing the influence of residue type and doses on the nutrient plant content. Because of the two residue composition and the effect of nitrogen contribution on nutrient uptake by green wheat plants, the potassium, calcium and magnesium plant content as macroelements (table 3), as well as iron, manganese, copper and zinc content as trace elements (table 4) were determined.In both tables R represents average values for 3 replicates and R_N average values for the replicates treated with nitrogen supplement as ammonium nitrate.

Table 3

Results regarding the macroelements total content of plant

Experimental alternative		K content		Ca content		Mg content	
		% K_2O	%	% CaO	%	% MgO	%
C_0	R	5.05	100	0.50	100	0.25	100
	R_N	4.74	100	0.68	100	0.27	100
A_1	R	4.82	95	0.56	112	0.25	100
	R_N	4.73	100	0.83	122	0.33	122
A_2	R	4.54	90	0.57	114	0.24	96
	R_N	4.37	92	0.87	128	0.34	126
A_3	R	4.56	90	0.60	120	0.26	104
	R_N	4.47	94	0.83	122	0.34	126
A_4	R	5.00	99	0.60	120	0.29	116
	R_N	4.36	92	0.77	113	0.37	137
B_1	R	4.09	81	0.48	96	0.22	88
	R_N	4.61	97	0.78	115	0.32	119
B_2	R	3.86	76	0.48	96	0.22	88
	R_N	3.14	66	0.61	90	0.28	104
B_3	R	5.49	109	0.66	132	0.30	120
	R_N	5.14	108	0.85	125	0.37	137
B_4	R	6.23	123	0.73	146	0.38	152
	R_N	5.61	118	0.85	125	0.41	152

The influence of addings on plant macroelements content is shown in table 3.

The potassium content in green wheat plants shows an increase comparative with the control alternative only for soil treatment with residue B, for both situations, with or without nitrogen contribution. The highest increase represents 23% for B4. The calcium content in plant rises proportional with the administered waste dose for both residue types (A, B). Nitrogen contribution increases the values by 28% for residue A (A_2) and 25% for residue B (B_4).Soil treatment with residue B without nitrogen supplement generates a higher increase representing 46%, for the highest residue dose This situation can be explained because of the calcium:magnesium ratio in residue A (4 : 1), respectively in residue B (1.4 : 1). The dynamics of magnesium content of plant is similar to that of calcium content for both residue types and alternatives, with or without nitrogen contribution. It comes out that the increase values are higher for the alternatives with nitrogen contribution, representing 37% (A_4) and 52% (B_4).

The influence of residue types and doses on trace elements content of plant is presented in table 4.

Table 4

Influence of residue type and doses on the trace elements content of plant

Experimental alternative		Fe content		Mn content		Zn content		Cu content	
		ppm	%	ppm	%	ppm	%	ppm	%
C_0	R	148.7	100	36.1	100	95.9	100	11.8	100
	R_N	107.4	100	38.5	100	112.7	100	11.5	100
A_1	R	168.1	113	35.9	99	77.5	81	11.2	95
	R_N	101.2	94	36.6	95	91.3	81	11.5	100
A_2	R	132.0	89	35.6	99	87.5	91	10.5	90
	R_N	131.3	122	26.0	68	99.2	88	12.0	104
A_3	R	182.9	123	31.4	87	82.2	86	30.9	261
	R_N	135.7	126	20.0	52	83.1	74	28.3	245
A_4	R	178.4	120	26.6	74	64.6	67	28.2	240
	R_N	130.4	121	18.1	47	68.3	61	35.9	311
B_1	R	129.9	87	30.6	85	83.2	87	25.1	213
	R_N	110.2	103	28.4	74	102.1	91	23.7	205
B_2	R	105.8	71	30.7	85	73.2	76	49.0	348
	R_N	77.0	72	20.5	53	88.6	79	32.7	283
B_3	R	139.7	94	30.6	85	68.6	72	45.9	389
	R_N	126.0	117	24.9	65	94.5	84	63.6	552
B_4	R	166.8	112	29.2	81	72.8	76	54.3	461
	R_N	133.2	124	19.9	52	92.1	82	49.3	427

Analysing the trace elements content in green wheat plants, an increase of the iron content proportional with the administered waste dose was determined. The most important increases were found for higher doses, representing 26% (A_3) and 24% (B_4) - with nitrogen contribution.

The results regarding the manganese content of plant show lower values than that of the control alternative. All the results obtained for the experimental alternatives show that the values of copper content in plant are higher than those determined for the control alternative.Meaningful increases of the copper content were established in all the alternatives treated with residue B, with or without nitrogen addition. The soil treatment with residue A increases significant the copper content only at high doses of residue.

An effect on the increase of zinc content in plant was not established.The determined results are low comparative with the control alternative.

CONCLUSIONS

- Considering the obtained results, the two experimented industrial residues can be used in certain doses as soil fertilizer, with or without nitrogen contribution.
- Because of their composition, containing calcium and magnesium in ratio 4 : 1 (A) and 1.4 : 1 (B) and trace elements like iron, copper, manganese and zinc, the two tested residues (A, B) had an important impact on plant nutrition.
- Soil treatment with the four tested doses of industrial residues (A, B) has a positive influence on plant nutrition and their calcium and magnesium content. An increase of their content in plants was established once with the addition of a nitrogen supplement.
- The presence of trace elements in the residue composition increases the plant content of iron and copper, important in plant nutrition.
- The simultaneous presence of trace and macroelements in soil have an important influence on their absorption in plant.The low element content in plant for manganese and zinc could be explained by the decrease of the absorbtion process for these cations, because of the antagonic effects established between well-known ions couples like Ca^{2+} : Fe^{2+}, Mg^{2+} : Fe^{2+}, Zn^{2+} : Fe^{2+}, Cu^{2+} : Fe^{2+}, Cu^{2+} : Mn^{2+} .

BIBLIOGRAPHY

1. MOCANU R., AVARVAREI I., DAVIDESCU V., GOIAN M., CARAMETE C., RUSU M., *Agrochimie*, Ed. Sitech, Craiova, 1997.
2. RADULESCU HORTENSIA, KISS A. S., TAUBERT LIDIA, PRINCZ ECATERINA, Utilization of an industrial waste as a nutritive elements source for crops, *Proceedings of the 12th Symposium on Analytical and Environmental Problems*, Szeged, Hungary, p. 467-470, 2005.
3. RADULESCU HORTENSIA, TAUBERT LIDIA, KISS A. S., PRINCZ ECATERINA, STEFANOVITS-BANYAI EVA, Effects of an industrial chemical waste on the uptake of cations by green oat, *J. Serb. Chem. Soc.,* 72(6), p. 629-633, 2007.
4. TAUBERT L. M., Utilization of calcium carbonate waste from the magnesium products industry, *12thRomanian International Conference on Chemistry and Chemical Engineering*, Bucharest, Romania, p.201-206, 2001.
5. TAUBERT L. M., Utilization of waste from the magnesium products industry, *Proceedings of the 9th Symposium on Analytical and Environmental Problems*, Szeged, Hungary, p. 41-45, 2002
6. TAUBERT LIDIA, KISS A. S., RADULESCU HORTENSIA, PRINCZ ECATERINA, Study of plant development in presence of industrial waste as soil amendment, *Proceedings of the 13th Symposium on Analytical and Environmental Problems*, Szeged, Hungary, p.261-264, 2006.
7. TAUBERT LIDIA, RADULESCU HORTENSIA, KISS A. S., KASTORI R., PRINCZ ECATERINA, Practical application in agriculture of the magnesium products industry, C*hem. Listy*, *102,* p.482 -486, 2008.
8. TAUBERT LIDIA, RADULESCU HORTENSIA, KISS A. S., STEFANOVITS-BANYAI EVA, PRINCZ ECATERINA, Effects upon the wheat plants developmemt in soils reclaimed by industrial waste, *Proceedings of the 15th Symposium on Analytical and Environmental Problems*, Szeged, Hungary, p.330-333, 2008.