IMPACT OF WASTE REVALUATION AS FERTILIZER ON THE NUTRITIVE ELEMENTS CONTENT OF WHEAT PLANTS

Hortensia RADULESCU[1], Isidora RADULOV[1], Lidia TAUBERT

[1] Banat's University of Agricultural Sciences and Veterinary Medicine Timisoara
Faculty of Agriculture - Department of Ecology and Environment,
Calea Aradului 119, 300645-Timisoara, Romania
E-mail: hortensiaradulescu@yahoo.com.

Abstract: *The study shows the impact of soil treatment with industrial waste on the nutrient content of wheat plants. Two industrial waste were tested as fertilizer, by treating luvosoil with different doses of waste. 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. Both waste 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 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 fertilizer, mainly on acid soils. The experimental alternatives consist of four different doses from each waste, added to soil without or with nitrogen supplement (ammonium nitrate). In order to establish the impact of soil treatment with waste 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 waste as fertilizer on plant content differs depending on the pursuit nutrient element. The potassium content in green wheat plants shows an increase by 17% comparative with the control alternative only for A_2,, both with or without nitrogen supplement. The calcium content in plant rises proportional with the administered waste dose for both waste types. Nitrogen contribution increases the values by 33% for waste A and 22% for waste 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(63%)-without nitrogen contribution and B_4 (73%)- with nitrogen contribution. Analysing the trace elements content in plant, an increase of iron content proportional with the administered waste dose was determined. The increase of 14% was established for the experimental alternative with the highest waste doses for both waste types. The originality of this paper consists in the utilization of these waste, resulted from the magnesium products industry, in agriculture as a calcium-magnesium 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 waste, usage manner and application frequency.*

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

INTRODUCTION

The huge amounts of waste proceeded by human activities are increasingly 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 carbonate and oxide 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 waste (TAUBERT, 2001). The composition of these waste 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 waste, 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 waste 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 waste type and doses on the nutrient plant content. The paper reports the effects of several waste doses and two waste types added to luvosoil, with or without nitrogen contribution and their potential role as fertilizer.

MATERIALS 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 waste (A, B) in different amounts, each having the compositions presented in table 1.

Table 1

Composition of the tested industrial waste

Specification	Waste 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 waste (A_1 - A_4 ; B_1 - B_4) and also a control alternative (C_0) - represented by untreated soil. 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.

All the pots were sown with thirty wheat grains. The vegetation period pursued was that of green plant during 8 weeks, in order to establish the impact of waste treatment on soil fertility.

In order to establish the impact of soil treatment with waste 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. Soil reaction was determined in watery extracts by means of a pH-meter. 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.

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

RESULTS AND DISCUSSIONS

The impact of waste revaluation as fertilizer on green wheat plants was studied by analysing the influence of waste type and doses on the nutrient plant content. Because of the two waste types 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.

The impact 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 waste A, for both situations with or without nitrogen contribution. The highest increase represents 17% for A_2. The calcium content in plant rises proportional with the administered waste dose for both waste types (A, B). Nitrogen contribution increases the values by 33% for waste A (A_4) and 22% for waste B (B_3). This situation can be explained because of the calcium:magnesium ratio in waste A (4 : 1), respectively in waste B (1.4 : 1).

The dynamics of magnesium content of plant is similar to that of calcium content for both waste types and alternatives, with or without nitrogen contribution. It comes out that the

increase values are higher for the alternatives with nitrogen contribution, representing 53% (A_4) and 73% (B_4).

Table 3

Impact of waste treatment on macroelements total content of plant

Experimental alternative		K content		Ca content		Mg content	
		% K_2O	%	% CaO	%	% MgO	%
C_0	R	0.42	100	0.30	100	0.16	100
	R_N	0.41	100	0.27	100	0.15	100
A_1	R	0.45	107	0.29	97	0.17	106
	R_N	0.43	105	0.31	115	0.16	107
A_2	R	0.49	117	0.28	93	0.19	119
	R_N	0.48	117	0.28	104	0.18	120
A_3	R	0.39	93	0.31	103	0.20	125
	R_N	0.38	93	0.31	115	0.21	140
A_4	R	0.38	90	0.36	120	0.26	163
	R_N	0.37	90	0.36	133	0.23	153
B_1	R	0.42	100	0.32	107	0.21	131
	R_N	0.42	102	0.29	107	0.20	133
B_2	R	0.40	95	0.31	103	0.22	138
	R_N	0.40	98	0.30	111	0.23	153
B_3	R	0.36	86	0.31	103	0.22	138
	R_N	0.35	85	0.33	122	0.20	133
B_4	R	0.38	90	0.27	90	0.25	156
	R_N	0.34	83	0.27	100	0.26	173

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

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 the highest waste dose, representing 14% (A_4) - with nitrogen contribution and 15% (B_4) - without nitrogen contribution.

The results regarding the manganese content of plant show lower values than that of the control alternative, excepting alternative A_2 with an increase of 18% at nitrogen contribution.

Because of the low available copper content in soil for all the experimental alternatives, the values of copper content in plant are lower than those determined for the control alternative.

An effect on the increase of zinc content in plant was established only for soil

treatment with waste B, but the determined increases are low comparative with the control alternative.

Table 4

Influence of waste type and doses on the trace elements total content of plant

Experimental alternative		Fe content		Mn content		Cu content		Zn content	
		ppm	%	ppm	%	ppm	%	ppm	%
C_0	R	58.5	100	0.11	100	1.51	100	4.88	100
	R_N	58.0	100	0.11	100	1.51	100	5.01	100
A_1	R	62.0	106	0.09	82	0.54	36	4.48	92
	R_N	62.0	107	0.08	73	0.85	56	4.66	93
A_2	R	65.5	112	0.12	109	1.12	74	4.11	84
	R_N	65.0	112	0.13	118	0.96	64	4.26	85
A_3	R	60.0	103	0.09	82	1.26	83	4.65	95
	R_N	61.0	105	0.08	73	1.26	83	4.55	91
A_4	R	64.0	109	0..09	82	1.35	89	5.02	103
	R_N	66.0	114	0.10	91	1.35	89	4.95	99
B_1	R	60.0	103	0.10	91	1.46	97	5.08	104
	R_N	59.0	102	0.09	82	1.38	91	5.12	102
B_2	R	63.5	109	0.08	73	1.38	91	4.93	101
	R_N	60.0	103	0.09	82	1.35	89	5.00	100
B_3	R	63.5	109	0.09	82	1.33	88	4.78	98
	R_N	64.0	110	0.10	91	1.46	97	5.12	102
B_4	R	67.5	115	0.11	100	1.33	88	4.97	102
	R_N	66.0	114	0.11	100	1.33	88	4.88	97

CONCLUSIONS

- Considering the obtained results, the two experimented industrial waste can be used in certain doses as soil amendment for low fertile acid soils or as calcium-magnesium 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, as well as due their alkaline reaction, the two tested waste (A, B) had an important impact on plant nutrition.
- Soil treatment with the four tested doses of industrial waste (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 waste composition and their alkaline reaction increases the available content of iron and zinc, important in plant nutrition.

- The simultaneous presence of metal trace and macroelements in soil and the soil reaction have an important influence on their absorption in plant.
- The low metal element content in plant for manganese, copper 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+}.

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