CONSIDERATIONS UPON SOIL TREATMENT WITH WASTE PRODUCTS ON SOIL FEATURES AND PLANT DEVELOPMENT

Hortensia RĂDULESCU

Banat's University of Agricultural Science and Veterinary Medicine ,Faculty of Agriculture, Calea Aradului 119, Timişoara, email:hortensiaradulescu@yahoo.com

Abstract: *The paper presents the influence of several nutritive elements available in the composition of two industrial waste products (A,B), on the soil features and plant development . The nutritive supplementation was achieved by treating the soil with different doses of waste products (A,B). These two mineral sources (A,B) comprise in their composition significant contents of calcium and magnesium as well as low contents of iron, copper, manganese and zinc. The experimental alternatives consist of four different doses from each waste product, administered to soil with or without nitrogen supplement. The main objective of this study is to present the influence of waste type and doses on the fertility features of an acid soil and on plant development by pursuing some physiological characteristics of wheat green plants (Triticum). The higher additional magnesium contribution, administered to soil by waste product B, generates some important alterations in soil and plant characteristics. The pH values rise, soil reaction turns from low acid to low alkaline. The magnesium content increase by 2-16 %, in soil tilled with wheat, while in presence of nitrogen, the magnesium content of soil was improved by 11-25%. The soil calcium content increases by 2-5%, while nitrogen addition improves the calcium content in soil by 5-19%. A beneficial effect on grain germination was established, improving the number of risen plants; the nitrogen addition increases this number by 100% for green wheat plants. At harvest time, a significant increase of plant size was established, while nitrogen addition increases supplementary their size by 35%. The fresh weight of plants show a considerable increase (79%).The dry matter values are decreasing, once with the rise of the waste doses, while nitrogen addition decreases the dry matter values by 19%. The originality of this paper consists in the use of waste products resulted from the magnesium products industry in agriculture as soil amendment and fertilizer. The importance of this study lies in the fact that, on the basis of the obtained results, a new technology to improve soil quality can be conceived by specifying the suitable dose, usage manner and application frequency of the tested waste products. The usefulness of the study is represented by the utilization of large amounts of waste, obtained from the magnesium compounds industry, as fertilizer and amendment for low fertile soils.*

Key words: *waste products, waste doses, soil amendment, soil features, plant characteristics*

INTRODUCTION

The industrial processes of manufacturing magnesium compounds, oxide and carbonates, mainly from dolomites by carbon dioxide leaching, generate important amounts of waste (TAUBERT, 2001, 2002). The composition of this waste includes calcium carbonate and precipitated magnesium carbonates (in ratio of 3:1 till 4:1) together with other impurities, present in the row material such as iron, manganese, copper and zinc compounds (RĂDULESCU ET AL., 2005, TAUBERT et al., 2006).

The alkaline reaction and the important mineral content of these wastes can be valuated in agriculture as soil amendment and fertilizer for acid soils with low fertility (RĂDULESCU et al.,2007, TAUBERT et al., 2008).

The main objective of this study is to present the influence of waste type and doses on the fertility characteristics of an acid soil. The improve of the soil fertility was established by studying some vegetation characteristics of green wheat plants. The paper reports the effects of several waste doses and types on luvosoil , with and without nitrogen contribution. Two types of additions were experimented, one from the industrial process (A) and the second one resulted as crusts deposed on the equipment walls (B).

MATERIAL AND METHODS

Luvosoil having a pH of 6,85 and a rather low fertility was collected, air dried, crushed, mixed and put into pots, each containing 1kg soil. The soil was treated with 2 waste types (A, B) in different amounts, having the composition presented in table 1.

Table 1

Composition of the experimented waste types

Specification	Waste A	Waste B
Calcium , (%)	28	19
Magnesium, (%)	7	14
Iron, (mg/kg)	1850	880
Copper, (mg/kg)	1,9	51
Manganese, (mg/kg)	136	51
Zinc, (mg/kg)	2,6	50

The experimental alternatives pursued by this research consist of four different doses for each waste type (A1- A4, B1- B4) and a control alternative (C0) representing untreated soil.

Table 2

Description of the experimental alternatives

Experimental alternative	Waste dose (mg/kg)	Nitrogen addition (mg/kg)	Ca mg/kg	Mg mg/kg	Fe mg/kg	Mn µg/kg	Zn µg/kg	Cu µg/kg
Waste A								
A1R	179	-	50	13	0,33	24,3	0,47	0,34
A1RN	179	134	50	13	0,33	24,3	0,47	0,34
A2R	357	-	100	25	0,66	48,7	0,93	0,68
A2RN	357	134	100	25	0,66	48,7	0,93	0,68
A3R	714	-	200	50	1,32	97,4	1,86	1,36
A3RN	714	134	200	50	1,32	97,4	1,86	1,36
A4R	1429	-	400	100	2,64	194,7	3,72	2,72
A4RN	1429	134	400	100	2,64	197,4	3,72	2,72
Waste B								
B1R	263	-	50	37	0,23	13,4	13,2	13,4
B1RN	263	134	50	37	0,23	13,4	13,2	13,4
B2R	526	-	100	74	0,46	26,8	26,4	26,8
B2RN	526	134	100	74	0,46	26,8	26,4	26,8
B3R	1053	-	200	147	0,93	53,6	52,6	53,6
B3RN	1053	134	200	147	0,93	53,6	52,6	53,6
B4R	2105	-	400	295	1,85	107,3	105,2	107,3
B4RN	2105	134	400	295	1,85	107,3	105,2	107,3

All the experimental alternatives took place in two replicates, one being without nitrogen treatment (R) and the other (RN) treated with 134 mg N / kg soil as ammonium nitrate (table 2).

All the pots were sown with 30 wheat grains and the vegetation period pursued was that of green plant. Along the vegetation period, some morphological parameters, like number of risen plants, plant size, fresh and dry plant weight were established. At harvest time, soil samples were collected in order to establish the impact of waste treatment on soil fertility. Soil characteristics like pH, essential and trace elements content were analyzed. Soil pH was determined in watery solution by a pH-meter. The total nutrient content in plant was analyzed by using the dry ash method along with atomic absorption spectrophotometer (AAS-ICP method).

RESULTS AND DISCUSSIONS

The influence of the waste treatment on soil reaction and calcium/ magnesium content is shown in table 3.

Table 3

Influence of waste treatment on soil reaction and essential elements content

Experimental alternative	Soil reaction		Calcium content		Magnesium content	
	pH	Δ	g/kg	%	g/kg	%
C0R	6,85	-	2,248	100	0,308	100
C0RN	6,39	-	2,544	100	0,299	100
A1R	6,71	-0,14	2,345	104	0,329	107
A1RN	6,39	0	2,208	87	0,301	100
A2R	6,90	0,05	2,511	112	0,340	110
A2RN	6,95	0,56	2,419	95	0,345	115
A3R	7,25	0,40	2,546	113	0,376	122
A3RN	6,94	0,55	2,535	100	0,373	125
A4R	7,97	1,12	2,767	123	0,417	135
A4RN	7,81	1,42	2,769	109	0,426	143
B1R	6,94	0,09	2,333	104	0,336	109
B1RN	6,48	0,09	2,347	92	0,330	110
B2R	7,11	0,26	2,639	117	0,394	128
B2RN	6,66	0,27	2,436	96	0,357	119
B3R	7,31	0,46	2,623	117	0,348	125
B3RN	6,52	0,13	2,767	109	0,425	142
B4R	7,45	0,60	2,807	125	0,464	151
B4RN	7,40	1,01	3,336	131	0,582	195

Soil reaction was analyzed using the analytical method in watery extract. The soil reaction turned from low acid to low alkaline, proportional with the increase of the waste dose. The increase of the pH values took place slowly by adding waste A and suddenly in case of waste B which contains more magnesium than waste A. The highest pH values were established for A4R (7,97) and B4R (7,45). The nitrogen contribution, decreases the pH values because of the ammonium nitrate acid reaction.

Analyzing the soil calcium (Ca) content, a proportional increase was established once with the growth of the waste dose. The increase of the calcium content took place along with the waste dose for both types of waste. A sudden growth was established only for the highest B dose with nitrogen contribution (3,336 g/kg). A growth of the magnesium (Mg) soil content was established once with the increase of the waste dose. Higher values were determinate for the alternatives with crusts B. The nitrogen contribution generates an important magnesium increase in soil content.

Because of the waste trace element content, the soil treatment with waste A and crusts B generates in soil a different trace element level in comparison to the control alternative, presented in table 4.

Table 4

Impact of waste type and doses on soil trace elements content

Experimental alternative	Iron content		Manganese content		Zinc content		Copper content	
	µg/g	%	µg/g	%	µg/g	%	µg/g	%
C0R	325	100	100,2	100	3,45	100	0,379	100
C0RN	306	100	84,8	100	3,57	100	0,367	100
A1R	311	96	91,7	92	4,50	130	0,346	91
A1RN	313	102	90,1	106	3,46	97	0,481	131
A2R	303	93	87,1	87	7,51	218	0,462	122
A2RN	315	103	100,3	118	4,60	129	0,264	72
A3R	320	99	91,8	92	3,24	94	0,348	92
A3RN	316	103	89,3	105	4,27	120	0,363	99
A4R	316	97	99,8	99	4,43	128	0,437	115
A4RN	304	99	88,3	104	5,55	156	0,436	119
B1R	299	92	92,8	93	3,43	99	0,364	96
B1RN	296	97	89,9	106	4,61	129	0,381	104
B2R	305	94	85,6	85	3,28	95	0,489	129
B2RN	294	96	95,8	113	4,68	131	0,474	129
B3R	308	95	88,4	88	3,00	87	0,433	114
B3RN	286	94	91,4	108	6,38	179	0,451	123
B4R	300	92	87,3	87	4,13	120	0,529	140
B4RN	295	96	102,5	121	4,91	138	0,360	98

Analyzing the iron (Fe) content of the experimental alternatives it was established that unimportant increases of iron content took place once with the growth of the waste doses. The manganese (Mn) content in soil has lower values for all the experimental alternatives without nitrogen contribution than that of the control alternative. The nitrogen contribution generates an increase of the manganese soil content for all the alternatives treated with waste (A, B). The zinc (Zn) content in soil generally decreases once with the increase of the waste dose. The highest zinc values were established for waste A alternatives without nitrogen contribution. The copper (Cu) content in soil increases slowly once with the growth of the waste doses. For waste A, the highest established values are 0,481 µg/g for A1(increase of 31%) with nitrogen contribution and 0,462 µg/g for A2 without nitrogen contribution. The highest copper soil content was determinate for B4, experimental alternative with the highest dose of waste B without nitrogen contribution, representing 0,529 µg/g .

The effects of soil treatment with waste A and B show an important influence on the development and nutrition of green wheat plants (table 5). The enhance of the waste A amounts in soil treatment had a beneficial effect on the grain germination praised by a higher number of risen plants. Adding nitrogen to soil, the number of risen plants remained generally low. The effects are similar for soil treatment with crusts B. Green wheat plants grew taller once with the increasing of the waste doses for both waste types. Adding nitrogen an increase of the plant size was established. At harvest time, green wheat plants have a higher fresh weight value in comparison with the control alternative, for those without nitrogen contribution. The nitrogen supplement makes the plants more vigorous having a higher fresh and dry weight for all the experimental alternatives. The altering of dry matter was generally increasing for all the alternatives without nitrogen treatment and decreasing for those with nitrogen treatment.

Table 5

Effects of waste and nitrogen contribution on vegetation characteristics of green wheat plants

Experimental alternative	Risen plants number	Risen plants %	Size green plants cm	Size green plants %	Fresh weight mg/piece	Fresh weight %	Dry weight mg/piece	Dry weight %	Dry matter %
C0R	30	100	28	100	140	100	33,7	100	24,1
C0RN	29	97	26	100	120	100	43,6	100	36,3
A1R	30	100	30	107	170	121	40,5	120	23,8
A1RN	29	97	30	115	240	200	41,8	96	17,4
A2R	27	90	28	100	200	143	35,6	106	17,8
A2RN	27	90	28	108	130	108	49,1	113	37,8
A3R	29	97	32	114	270	193	39,7	118	14,7
A3RN	30	100	35	135	350	292	51,1	117	14,6
A4R	25	83	33	118	310	221	44,0	131	14,2
A4RN	26	87	34	131	270	225	59,7	137	22,1
B1R	28	93	35	125	270	193	41,0	122	15,2
B1RN	25	83	32	123	270	225	51,3	118	19,0
B2R	28	93	30	107	170	121	37,9	113	22,3
B2RN	30	100	37	142	310	258	44,6	102	14,4
B3R	28	93	36	129	190	136	39,1	116	20,6
B3RN	26	87	35	135	280	233	40,3	92	14,4
B4R	27	90	36	129	270	193	46,4	138	17,2
B4RN	27	90	36	139	320	267	49,9	114	15,6

CONCLUSIONS

Considering the obtained results, the two experimented industrial wastes can be used in certain doses as soil amendment for low fertile acid soils and fertilizer for plant nutrition.

Treating luvosoil with different doses of industrial waste (A, B), the pH values rise from low acid to low alkaline.

The presence of magnesium and calcium in the wastes composition increases the soil content proportional with the growth of the waste dose. The enhance of the trace elements in soil is representative for manganese (with nitrogen contribution), copper and zinc (without nitrogen contribution).

At harvest time, the size of green wheat plants for all experimental alternatives was taller comparative with the control alternative. Nitrogen addition increase their size. The fresh weight of the plants show a decrease proportional with the increase of the waste dose, for all the alternatives without nitrogen addition. The nitrogen contribution decreases the dry matter values.

BIBLIOGRAPHY

1. RĂDULESCU H., KISS A.S., TAUBERT L., PRINCZ E., Utilization of an industrial waste as a nutritive element source for crops. Proceedings of the 12 th Symposium on Analytical and Environmental Problems, Szeged, Hungary, p. 467-470, 2005.

2. RĂDULESCU H., TAUBERT L., KISS A.S., PRINCY E., STEFANOVITS-BANYAI E., Effect of an industrial chemical waste on the uptake of cations by green oat. Journal Serb. Chem. Soc. 72(6), p.629-633, 2007.
3. TAUBERT L., Utilization of calcium carbonate wastes from the magnesium products industry, Proceedings of the 12th Romanian International Conference on Chemistry and Chemical Engineering, Bucharest, Romania, p.201-206, 2001.
4. TAUBERT L., Utilization of waste from the magnesium products industry, Proceedings of the 9th Symposium on Analytical and Environmental Problems, Szeged, Hungary, p.41-45, 2002.
5. TAUBERT L., KISS A. S., RĂDULESCU H., PRINCZ E., Study of plants 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.
6. TAUBERT L., RĂDULESCU H., KISS A.S., KASTORY R., PRINCZ E., STEFANOVITS-BANYAI E., Practical application in agriculture of the magnesium products industry waste. J. Chemical Listy, 102, p.482-486, 2008.