EFFECTS REGARDING THE USE OF INDUSTRIAL WASTE FOR SOIL FERTILITY IMPROVEMENT

Hortensia RADULESCU[1], Adina BERBECEA[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 paper presents the effects of soil treatment with industrial mineral waste on some fertility characteristics of acid soils. Two industrial waste were tested by treating luvosoil, a low fertile acid soil, with different doses of waste. These 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 have resulted in the industrial processes of manufacturing magnesium compounds from dolomites as waste products 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 and amendment for acid soils. The experimental alternatives consist of treating luvosoil with four different doses from each waste, without and with adding a nitrogen supplement (ammonium nitrate) to the soil. In order to establish the effects of soil treatment with waste on soil fertility, the available content of soil nutrients and soil reaction were determined. The available nutrient soil content was analysed by using the EDTA extraction method along with atomic absorption spectrophotometry. Soil reaction was determined in watery extracts by means of a pH-meter. The results show that low doses of waste increase by 14-18% the available potassium content. Nitrogen supplement rises the potassium content increase till 26 - 30%. The available calcium content rises proportional with the administered waste doses for both waste types. Nitrogen contribution increases the values by 133% for waste A and 106% for waste B. The dynamics of available magnesium content is similar to that of calcium. The increases represent 65% for waste A and 46% for waste B. Soil acidity was neutralized in all experimental alternatives. The pH values increased proportional with the added waste dose.The originality of this paper consists in the utilization of the waste resulted from the magnesium products industry in agriculture as soil amendment and also as calcium-magnesium fertilizer.The importance of this study lies in the fact that, on the basis of the obtained results, a new technology to improve acid soils fertility can be conceived by specifying the suitable dose, usage manner and application frequency of the tested waste.*

Key words: *amendment, mineral waste, acid soil, available nutrient content, soil reation, soil fertility*

INTRODUCTION

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

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 for acid soils with low fertility (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 fertility characteristics of an acid soil. The paper reports the effects of several waste doses and two waste types on luvosoil, with and without nitrogen contribution. Two types of addings were experimented, one resulted as waste from the industrial process (A) and the second one moulded as crusts deposed on the equipment walls (B).

MATERIALS AND METHODS

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

Table 1.

Composition of the experimented industrial mineral 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

Table 2

Description of the experimental alternatives

Experi-mental 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

The experimental alternatives pursued by this research consist of four different doses for each waste (A_1 - A_4 ; B_1 - B_4) and also a control alternative (C_0) consisting of untreated soil. The description of the experimental alternatives is presented in table 2.

All the experimental alternatives took place in two replicates, one being without nitrogen treatment (R) and the other (R_N) treated with 134 mg N/kg soil as ammonium nitrate. All the pots were sown with thirty wheat grains. The vegetation period pursued was that of green plant representing eight weeks, in order to establish the impact of waste treatment on soil fertility.

In order to establish the effects of soil treatment with waste on soil fertility, the available content of soil nutrients and soil reaction were determined. The available nutrient soil content was analysed by using the EDTA extraction method along with atomic absorbtion spectrophotometry. Soil reaction was determined in watery extracts by means of a pH-meter. The analysed soil nutrients were potassium, calcium, magnesium as essential nutrients and iron, manganese, copper and zinc as trace elements.

RESULTS AND DISCUSSIONS

Results of the impact on soil fertility treatment with waste, in accordance with the experimental alternatives shown in table 2, are presented in table 3.

Table 3

Impact of waste treatment on soil reaction and available macroelements content

Experimental alternative		K content		Ca content		Mg content		Soil reaction	
		ppm	%	ppm	%	ppm	%	pH	Δ
C_0	R	121.7	100	1139	100	30.00	100	6.65	-
	R_N	114.4	100	932.3	100	26.80	100	6.37	-
A_1	R	136.2	112	1007	88	28.65	96	6.71	+0.06
	R_N	147.8	129	1117	120	29.60	110	6.39	+0.02
A_2	R	138.6	114	1030	90	30.55	102	6.90	+0.25
	R_N	149.0	130	1066	114	30.50	114	6.95	+0.58
A_3	R	109.5	90	1312	115	28.05	94	7.25	+0.60
	R_N	113.7	99	1332	143	30.00	112	6.94	+0.57
A_4	R	124.7	102	1869	164	47.25	158	7.97	+1.32
	R_N	113.5	99	2173	233	44.30	165	7.81	+1.44
B_1	R	143.2	118	1221	107	29.10	97	6.94	+0.29
	R_N	143.8	126	1134	122	29.90	112	6.48	+0.11
B_2	R	128.9	106	1176	103	29.75	99	7.11	+0.46
	R_N	134.2	117	1198	128	29.90	112	6.66	+0.29
B_3	R	118.3	97	1161	102	29.70	99	7.31	+0.66
	R_N	97.25	85	1298	139	27.70	103	6.52	+0.15
B_4	R	117.2	96	1915	168	38.55	129	7.45	+0.80
	R_N	93.7	82	1923	206	39.20	146	7.47	+1.10

The results show that low doses of both waste (A_1, A_2 ; B_1, B_2) increase by 14-18% the available potassium content in soil. Nitrogen supplementation rises the potassium content increase till 26-30%. The available calcium content rises proportional with the administered waste dose for both waste types. Nitrogen contribution increases the values by 133% for waste A and 106% for waste B. The dynamics of available magnesium content is similar to that of calcium. The increases represent 65% for waste A and 46% for waste B, for the alternatives with nitrogen supplement. The highest experimented waste dose (A_4, B_4) improves significant the available calcium and magnesium content. The registered increases lie by 64% (A_4); 68% (B_4) for calcium and 58% (A_4); 29% (B_4) for magnesium. Soil acidity was neutralized in all experimental alternatives. The pH values have increased proportional with the added waste dose. Treating soil with the highest waste A dose (A_4), the pH value becomes 7.97. For waste B (B_4), the pH value registered was 7.45. Nitrogen supplementation by ammonium nitrate lowers the pH values because of its acid reaction.

The presence and dose of waste in soil and their trace elements content affects the available trace elements soil content. The results presenting the influence of waste type and doses on available trace elements soil content are shown in table 4.

Table 4

Influence of waste type and doses on available trace elements soil content

Experimental alternative		Fe content		Mn content		Cu content		Zn content	
		ppm	%	ppm	%	ppm	%	ppm	%
C_0	R	233.3	100	50.78	100	11.75	100	29.58	100
	R_N	198.0	100	55.00	100	11.50	100	27.05	100
A_1	R	210.9	90	42.35	85	4.82	41	19.25	65
	R_N	223.5	113	40.35	73	5.00	43	20.75	77
A_2	R	228.4	98	40.35	79	10.18	87	21.03	71
	R_N	220.3	111	43.85	80	12.00	104	20.75	77
A_3	R	186.9	80	39.83	78	11.75	100	24.83	84
	R_N	169.3	86	40.85	74	12.50	109	25.20	93
A_4	R	192.6	83	42.93	85	11.00	85	25.28	85
	R_N	219.8	111	37.60	68	10.00	87	24.85	92
B_1	R	211.6	91	60.80	120	10.75	91	20.35	69
	R_N	198.0	100	62.30	113	10.00	87	21.90	81
B_2	R	207.0	89	29.74	59	8.75	74	34.60	117
	R_N	208.3	105	28.60	52	9.00	78	42.50	157
B_3	R	200.4	86	35.48	70	9.25	79	15.18	51
	R_N	220.0	111	38.50	70	10.50	91	17.80	66
B_4	R	167.6	72	37.25	73	6.60	56	33.03	112
	R_N	179.8	91	39.20	71	7.00	61	34.50	128

An increase of iron content was established only for the alternatives with nitrogen supplement representing maximum 13% (A_1) for waste A and 11% (B_3) by treatment with waste B. Most of the manganese and copper content values are lower than that of the control alternative. Increases of the available zinc content were determined only for the alternatives treated with waste B. The registered increases were 17% (B_2); 12% (B_4) without nitrogen supplement and 57% (B_2); 28% (B_4) with nitrogen supplement.

CONCLUSIONS

1. Considering the obtained results, the two experimented industrial waste can be used in certain doses, with or without nitrogen supplementation, as soil amendment for acid soils and as calcium – magnesium fertilizer.
2. The presence of magnesium and calcium in the waste composition induces an alkaline reaction of both types of waste. Therefor, the acid soil reaction can be neutralized by treating soil with the suitable waste dose.
3. Because of their composition, both waste types can be used as fertilizer containing calcium and magnesium. The enhance of the available essential nutrient soil content by treating soil with the suitable waste dose mantains its role as fertilizer.
4. The increase of the available iron content in presence of nitrogen apport, conditioned by a suitable waste dose, completes its fertilizer role.

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