WASTE MANAGEMENT AS A FERTILIZATION SOURCE IN AGRICULTURE

Hortensia RĂDULESCU

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

Abstract: *This paper presents the effects of magnesium supplementation by two industrial waste types on the development and nutrition of oat plants. Both waste types tested resulted from the magnesium products industry, namely as waste-product and as crusts deposited on the industrial equipment. These two residual magnesium sources also include precipitated calcium carbonate together with low contents of solid impurities, like iron, copper, manganese, zinc and nickel. An important difference between the two mineral sources mentioned consists in their double magnesium content, one compared to the other. The effects of an acid soil amendment by four different waste doses and magnesium contents, with and without nitrogen contribution were studied on oat plants using the two mentioned waste types. From the results obtained, higher contents of residual magnesium improves the size of the oat plants, which were taller. Nitrogen addition increase some physiological characteristics of oat plants. A higher magnesium contribution increased the phosphorus and potassium plant content and their calcium and magnesium content, too. The calcium and magnesium plant content was visibly improved by nitrogen addition. Most of the trace element uptake is positively influenced by a higher magnesium support; their content in the oat plants also increased due to the additional nitrogen. Green oat plants grew taller once with the increase of the waste dose. Adding nitrogen, an obvious increase of the plant size was established. The nitrogen supplement makes the plants more vigorous having a higher fresh weight and dry weight for all the experimental alternatives. The altering of dry matter was increasing for the alternatives without nitrogen treatment and decreasing for those with nitrogen addition. Soil treatment with different doses of the two industrial waste types generally had a positive influence on plant development and nutrition, increasing their essential and trace elements content. Nitrogen addition improved the uptake process of nutritive elements, raising their level in the oat plants. The originality of this paper consists in the use of waste as fertilizer in agriculture. The importance lies in the fact that a new fertilizing technology can be conceived on the basis of the obtained results. The usefulness of this study is represented by the possibility of using large amounts of industrial waste, obtained from the magnesium products industry, as nutritive elements source.*

Key words: *residual magnesium products, fertilizing doses, nutritive elements content, oat plant vegetation characteristics*

INTRODUCTION

The manufacture processes of magnesium carbonates and oxide from dolomites by carbon dioxide leaching generate important amounts of waste. Because of the waste composition, which contains calcium, magnesium, as well as several trace elements, this material can be valuated in agriculture for soil fertilization. This waste includes a considerable part of the raw material, containing therefore an important amount of calcium and magnesium, two very important mineral elements for plant nutrition (TAUBERT, 2001, 2002). In fact, this industrial waste includes precipitated calcium carbonate together with appreciable amounts of precipitated magnesium carbonate (in ratio of 3:1, till 4:1) and besides that, low contents of solid impurities like copper, iron, manganese, zinc and nickel (TAUBERT et al., 2006). There are two types of waste resulted from the magnesium products industry, namely a waste product and crusts deposited on the industrial equipment. The difference between the two mineral sources mentioned above, consists in a double magnesium content of the waste product compared to the magnesium content of the crusts. The main objective of this study is to present the influence of the two waste types, administered to soil, on plant development and nutrition.

Magnesium has a catalytic role in plant nutrition taking part at the photosynthesis process and facilitating the circulation of some major nutritional elements. Calcium is a nutritive element used by all 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). Trace elements play an important role in plant nutrition, although their demands lie only between $10^{-3}$and 10^{-5} %. They fulfill a catalytic function in enzymatic processes, participating at several biochemical reactions in plants (KISS et al., 2006).

The paper reports the effect of the two waste types mentioned above, applied on luvosoil, in different doses, in pots sown with oats grains. The research shows also the impact of growing magnesium doses, with or without nitrogen addition, on the essential and trace elements content of the oat plants.

MATERIAL AND METHODS

Luvosoil, having a pH of 5,8 and a rather low soil fertility was collected, air-dried, crushed, mixed thoroughly and put into pots, each containing 1 kg soil. The soil was treated before sowing with two types of mineral supplements, both resulted from the magnesium products industry, namely waste A and crusts B.

Their compositions are:

A: Ca 28%, Mg 7%, Fe 1850 mg/kg , Mn 136 mg/kg , Zn 2,6 mg/kg , Cu 1,9 mg/kg;
B: Ca 19%, Mg 14%, Fe 880 mg/kg , Mn 51 mg/kg , Zn 50 mg/kg , Cu 51 mg/kg ,Ni 2,6 mg/kg;

Table 1

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	Ni µg/kg
Waste A									
V1	179	-	50	13	0,33	24,3	0,47	0,34	-
V1+ N	179	134	50	13	0,33	24,3	0,47	0,34	-
V2	357	-	100	25	0,66	48,7	0,93	0,68	-
V2 + N	357	134	100	25	0,66	48,7	0,93	0,68	-
V3	714	-	200	50	1,32	97,4	1,86	1,36	-
V3 + N	714	134	200	50	1,32	97,4	1,86	1,36	-
V4	1429	-	400	100	2,64	194,7	3,72	2,72	-
V4 + N	1429	134	400	100	2,64	197,4	3,72	2,72	-
Waste B									
V5	263	-	50	37	0,23	13,4	13,2	13,4	6,8
V5 + N	263	134	50	37	0,23	13,4	13,2	13,4	6,8
V6	526	-	100	74	0,46	26,8	26,4	26,8	13,6
V6 + N	526	134	100	74	0,46	26,8	26,4	26,8	13,6
V7	1053	-	200	147	0,93	53,6	52,6	53,7	27,3
V7 + N	1053	134	200	147	0,93	53,6	52,6	53,7	27,3
V8	2105	-	400	295	1,85	107,3	105,2	107,4	54,7
V8 + N	2105	134	400	295	1,85	107,3	105,2	107,4	54,7

The experimental alternatives pursued by the research consist of 4 different doses for each mineral supplement, namely waste A (V1, V2, V3, V4) and crusts B (V5, V6, V7, V8); the untreated soil was the control alternative (V0). All the experimental alternatives took place in 3 replicates (R1, R2, R3), with the mention that a nitrogen contribution (134 mg/ kg) was added to the replicates R2 and R3 in each pot. The description of the experimental alternatives is shown in table 1. The experiments took place at laboratory scale. All the pots were sown with 30 oat grains and the pursued vegetation period was that of green plant. The pots were placed near the window and watered every second day by 100 ml water.

In order to establish the effects of the waste treatment on the development and nutrition of green oat plants, several vegetation characteristics such as number of risen plants, size of green plants, fresh weight, dry weight, dry matter as well as the content of essential and trace elements in green oat plants were analyzed. 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 effects of soil treatment using different doses of waste A or B, with or without nitrogen addition, on the nutrition and development of green oat plants are shown in table 2.

Table 2

Influence of the waste type, doses and nitrogen contribution on some vegetation characteristics of green oat

Experimental alternative	Risen plants number / %			Size of green plants cm / %			Fresh weight mg/piece / %			Dry weight mg/piece / %			Dry matter %
V0R	21	70		51	100		362	100		162	100		44,8
V0RN	24	80		62	122		533	147		242	149		45,2
V1R	22	73		54	106		327	90		159	98		48,1
V1RN	23	77		73	143		591	163		248	153		41,9
V2R	27	90		53	104		352	97		167	103		46,9
V2RN	22	73		72	141		623	172		255	157		41,0
V3R	28	93		56	109		332	92		161	99		47,9
V3RN	22	73		75	147		650	180		255	157		39,2
V4R	23	77		59	116		387	107		183	113		47,3
V4RN	19	63		77	151		737	204		300	185		41,0
V5R	22	73		53	104		300	83		155	96		51,3
V5RN	27	90		70	137		537	148		233	144		43,0
V6R	24	80		60	118		350	97		158	98		45,6
V6RN	22	73		78	153		600	166		273	169		46,0
V7R	25	83		52	102		404	112		184	114		46,5
V7RN	28	93		70	137		464	128		200	123		43,4
V8R	30	100		53	104		370	102		150	93		40,8
V8RN	22	73		58	114		582	161		250	154		42,9

R – replicate without nitrogen treatment;

RN – average of replicates R2 and R3, treated with 134 mg N/ kg soil in each pot;

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 oat plants. Adding nitrogen to soil the number of risen plants remained lower than that of the control alternative. The effects are similar for soil treatment with waste B, except for V5 and V7 where the nitrogen contribution increases the number of risen plants by 10% respectively 13%. The highest number of risen plants was established for V8, 30 representing 100% of the sown oat grains. The increase of the magnesium doses had a beneficial effect on the grain germination, which becomes of 100% for the highest administered magnesium dose. In case of nitrogen addition no improve can be seen.

Green oat plants grew taller once with the increase of the waste dose in both cases (waste A and B). Adding nitrogen an obvious increase of the plant size was established; for the control alternative this was of 22%. The tallest plants were found for the alternatives V4 (highest waste A dose + nitrogen contribution) 77 cm and V6 (second waste B dose + nitrogen contribution) 78 cm. Rising the magnesium dose generates taller oat plants. Their size shows an important growth once with the nitrogen addition.

At harvest time, the green oat plants for all the alternatives were thinner, having a reduced fresh weight in comparison with the control alternative, for those without nitrogen contribution. The nitrogen supplement makes the plants more vigorous having a higher fresh weight and dry weight for all the experimental alternatives. The fresh weight increase was more evident for soil treatment with waste A; for the highest waste dose (V4), the increase was of 104% in comparison with the control alternative. Similar to the fresh weight increase, took place the dry weight increase. The most evident results were established for the alternatives treated with waste A. The increase of the dry weight was the highest, 85%, for the alternative V4.

The altering of dry matter was increasing for all the alternatives without nitrogen treatment and decreasing for those with nitrogen contribution. The highest dry matter value was 51,3% for V5 (lowest waste B dose) and the lowest value was 39,2% for V3 (waste A+ nitrogen contribution). Crop yields characteristics such as fresh weight, dry weight and dry matter indicate an important improve once with the increase of the magnesium dose and supplementary addition of nitrogen.

Table 3

Impact of the magnesium doses and nitrogen supplementation on the essential nutrients content in oat plants

Experimental alternative	P		K		Ca		Mg	
	mg/g	%	mg/g	%	mg/g	%	mg/g	%
V0	0,78	100	14,38	100	2,44	100	1,58	100
V1	1,00	128	16,73	116	2,14	88	1,29	82
V1 + N	0,82	105	13,81	96	3,03	124	1,80	114
V2	0,87	112	13,24	92	2,44	100	1,50	95
V2 + N	0,62	79	11,69	81	3,25	133	1,79	113
V3	0,93	119	13,43	93	2,44	100	1,48	94
V3 + N	0,91	117	12,84	89	3,78	155	2,18	138
V4	1,09	140	16,89	117	2,41	99	1,61	102
V4 + N	0,81	104	12,39	86	3,58	147	2,07	131
V5	1,05	135	17,11	119	2,36	97	1,49	94
V5 + N	0,78	100	14,41	100	3,40	139	1,91	121
V6	1,10	141	14,49	101	2,50	102	1,67	106
V6 + N	0,86	110	13,97	97	3,46	142	2,07	131
V7	1,10	141	19,57	136	2,41	99	1,48	94
V7 + N	0,89	114	14,20	99	3,68	151	2,34	148
V8	1,30	167	19,84	138	2,52	103	1,65	104
V8 + N	0,98	126	17,49	122	3,98	163	2,69	170

Once with the increase of the magnesium doses supplied by the 2 waste types (waste A and crusts B) a proportional growth of the phosphorus (P) content in oat plants was established. A nitrogen supplement causes a lower phosphorus content in oat plants than that reported for the alternatives without nitrogen (table 3). Rising the magnesium doses administered to soil, the potassium (K) content in oat plants increases too. Nitrogen addition had improved the plant potassium content only for the highest magnesium dose administered, comparative to the control alternative (V0). The calcium (Ca) content in oat plants is not influenced by the increase of the magnesium doses. Its value remains close to that of the control alternative (V0). Nitrogen addition generates a substantial improve of the calcium content proportional with the magnesium doses. The increase of the administered magnesium doses can not be find again in the plant magnesium (Mg) content. The established values are generally lower than that of the control alternative. Nitrogen addition shows an important increase of the plant magnesium content once with the growth of the magnesium doses.

Table 4

Effects of magnesium supplementation and nitrogen contribution on the trace elements content in oat plants

Experimental alternatives	Fe		Mn		Zn		Cu	
	µg/g	%	µg/g	%	µg/g	%	µg/g	%
V0	45,79	100	35,81	100	35,63	100	4,80	100
V1	36,82	80	18,23	51	18,10	51	3,96	83
V1 + N	56,01	122	36,50	102	42,90	120	5,64	118
V2	59,08	129	24,48	68	17,74	50	2,62	55
V2 + N	56,06	122	23,89	67	45,39	127	4,30	90
V3	47,26	103	20,79	58	18,44	52	2,46	51
V3 + N	74,09	162	26,70	75	50,95	143	4,97	104
V4	42,17	92	21,13	59	18,11	51	1,95	41
V4 + N	51,70	113	22,51	63	32,37	91	4,67	97
V5	59,31	130	27,20	76	20,24	57	4,91	102
V5 + N	62,93	137	40,87	114	31,77	89	6,95	145
V6	49,19	107	27,30	76	20,16	57	5,64	118
V6 + N	71,43	156	35,90	100	35,94	101	7,36	153
V7	47,81	104	19,69	55	20,15	57	4,66	97
V7 + N	63,02	138	29,15	81	41,05	115	7,93	165
V8	55,37	121	16,62	46	18,00	51	5,64	118
V8 + N	65,21	142	26,31	73	36,34	102	7,68	160

Iron (Fe) is found in the composition of both supplements, namely 1850 mg/kg in waste A and 880 mg/kg in crusts B. In all the experimental alternatives, the iron content in plant is higher than that of the control alternative. The highest iron concentration was registered for V2 (59,08 µg/g) with waste A supplementation and for V5 (59,31 µg/g) with crusts B treatment. The addition of nitrogen leads to an increase of the iron content for all the experimental alternatives, representing 13-62% (waste A) and 37-56% (crusts B), as it can be seen in table 4. The presence of small magnesium doses acts positive on the iron absorption of the green oat plants. Increasing the magnesium dose simultaneous with the nitrogen addition improves substantial the iron content in plant (table 4).

The manganese (Mn) concentration in waste A represents 136 mg/kg and 51 mg/kg in crusts B. The content of manganese in the green oat plants is generally lower for all the experimental alternatives in comparison with the control alternative. An exception is the V5 + N alternative, where the manganese concentration is 40,87 µg/g, representing an increase of 14% related to the control alternative (table 4). The growth of the magnesium doses by adding waste to soil does not improve the plant absorption of manganese because of the antagonist effects between the two ions. Even nitrogen addition do not improve the manganese content in plant.

The composition of waste A indicates the presence of 2,6 mg/kg zinc (Zn)and 50mg/kg in crusts B. The zinc concentration in plant exceeds the value registered for the control alternative only for the alternatives with nitrogen addition. The zinc content increases are obvious only for the alternatives with waste A, which unfold proportional with the administered dose, being of 20-43%. The presence of magnesium in low doses simultaneously with nitrogen addition increases the zinc content in green oat plants (table 4).

Increases of the copper (Cu)content comparative to the control alternative were found prevalent only for the experimental alternatives V5-V8. The treatment with crusts B and nitrogen addition had a benefic influence on the copper content in plant, established by 45-65% related to the control. The increases took place proportional to the given doses (table 4).

CONCLUSIONS

Considering the obtained results, the two experimented industrial waste can be used in certain doses as fertilizer for low fertile soils with or without nitrogen addition.

The experimental waste doses (waste A and B) had a beneficial effect on grain germination improving the number of risen oat plants by 23% (waste A) till 30% (waste B). At harvest time, the size of green oat plants was taller by 8 cm (waste A) and 9 cm for crusts B comparative to the control alternative with untreated soil. Nitrogen addition increased their size by 51% (waste A) till 53% (crusts B). The fresh weight of the plants shows a decrease proportional with the increase of the waste doses only for the alternatives without nitrogen addition. The dry matter values are increasing once with the enhance of the waste dose for both waste in all alternatives without nitrogen contribution. The addition of nitrogen decreases the dry matter value at harvest time for all the alternatives comparative to the control alternative. Grain germination becomes of 100% for the highest magnesium dose (V8R) administered. The plant sizes show an important growth once with the increase of the magnesium dose and nitrogen addition. Crop yields characteristics indicate an improve once with the increase of the magnesium dose and supplementary nitrogen addition.

The increase of the magnesium doses generates a proportional growth of the phosphorus and potassium content in plant. Nitrogen addition generates a substantial improve of the calcium and magnesium content in plant.

Trace elements absorption by oat plants is visible improved for iron, zinc and copper once with the increase of the magnesium dose and nitrogen addition. Soil treatment with different doses of industrial waste has generally a positive influence on plant nutrition and their nutrient elements content. Because of the waste composition, the accessible fraction for plant nutrition increases. The simultaneous presence of trace and essential elements in soil has an important influence on their absorption in plant. The low metal element content in plant for manganese and zinc could be explained by the decrease of the absorption process for this ions, because of the antagonist effects established between the 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. AVARVAREI I., DAVIDESCU V., MOCANU R., GOIAN M., CARAMETE C., RUSU M., Agrochimie, Ed. Sitech, Craiova, 1997.
2. KISS A. S., RĂDULESCU H., STEFANOVICS-BANYAI E., TAUBERT L., PRINCZ E., Trace elements study of oat plants in presence of an industrial waste admixture, Proceedings Trace Elements in Food Chain, Budapest, Hungary, 2006.
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, 2001.
4. TAUBERT L., Utilization of waste from the magnesium products industry, Proceedings of the 9th Symposium on Analytical and Environmental Problems, Szeged, Hungary, 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, 2006.