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Release of Magnesium from Soil During Incubation with Different Organic Materials

Beeinflussung der Mg-Freisetzung im Boden nach Inkubation mit verschiedenen organischen Materialien

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1. Introduction

Plants take up Mg from exchangeable and water soluble forms which represent only a small amount of total Mg content of soils. So, studying the release of Mg from non-exchangeable forms to satisfy the requirements of plants and the factors effecting this process and its rate seems promising (Harrod, 1971).
Among the chief factors that may affect the alteration of Mg forms in soil, Daragon (1971) indicated to soil organic matter, living organisms and their efficient activities in soils. Stevenson and Arkadani (1967) reported that organic substances play a significant role in increasing the availability of Mg by solution and transport of Mg ions to plants as a chelated organo-Mg complex. Daragon (1971) and Chanem (1975) concluded that the most important agents of mineral decomposition may be mineral and organic acids of biogenic origin, biogenic alkalies and microbial slimes capable forming complex compounds with elements contained in the crystal latlices of minerals.
However, little is known about the role of the different forms of organic substances on the release of Mg from Egyptian soils. So, this work was conducted to study the effect of glucose, clover straw and cotton stalks on the release of Mg from different soils during incubation.

2. Materials and Methods

Four surface (0–30 cm) soil samples were collected from different Egyptian localities. The samples were air dried, ground and sieved to pass 1 mm sieve and

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then their chemical and physical characteristics were determined using the conventional methods (Black, 1965). Sources and characteristics of soils used are presented in Table 1.

The effect of organic matter on the release of the nonexchangeable Mg were studied by using three types of organic materials, glucose, clover straw and cotton stalks. Clover straw, and cotton stalks were obtained from college farm, oven dried and powdered to pass through a 60 mesh screen. The C/N ratio were 85 and 28.9 for the cotton and clover respectively. Pure glucose were also used as a free nitrogen carbonaceous material.

A 25 g portion of each soil were placed in 250 ml Erlenmyer flasks and mixed throughly with 0, 1, 2, 3 and 4% of the powdered material. Water was added to bring the moisture content to 60% of saturation percentage. The flasks were covered with parafilm.

The mixtures were incubated at room temperature (25 ± 3 C) for 1, 2, 3 and 4 weeks. Four applicates were made of each treatment.

On the 7th, 14th, 21th, and 28th days of incubation, samples from these mixtures were taken and extracted for exchangeable-Mg using the method of Balba et al. (1975).

Exchangeable Mg:

Exchangeable Mg was extracted by shaking 1 g. of soil sample with 20 ml 1N neutral NH_4 OAC for 50 minutes followed by centrifuging for 10 min. at 4000 rpm and the supernatant was decanted. Additional 20 ml aliquots of NH_4 OAC were used with 10 min. shaking periods followed by centrifuging until a total of 100 ml of the supernatent solution was collected (Mokwunye and Melsted, 1972). Calcareous soil samples were treated with 0.1 N Na_2Co_3 and Na_2 So_4 as cited by Balba et al. 1975.

Mg was determined by means of Atomic absorption Model Unicom 1900 Sp.

3. Results and Discussion

As shown in Table 2, addition of glucose, clover straw, and cotton stalks to soil samples used, increased the amount of released magnesium during incubation, over the check treatments. The highest amounts of Mg were obtained upon dressing soils with clover. Although glucose caused higher release during the first two weeks than clover, but the total released-Mg was higher with clover at the end of incubation by 150% more than glucose (Table 2). On the other hand with cotton stalks treatments, soils released little steady increment with slight fuctuation during the first three weeks of incubation. No detectable increases in the released Mg with the different concentrations of cotton straw used.

Variations obtained with the different organic material used on releasing soil Mg could be attributed to their chemical structure, C/N ratio and legnin content (Alecandrer, 1977 and Gomah, 1969). The simplicity of glucose structure led to its rapid biological oxidation, consequently more Mg was released during a short time. On the other hand, clover straw, the nitrogenous material, is of complex nature relatively than glucose, so more time was needed for decomposition. How-

Table 1. Physical and chemical characteristics of the studied soils

Soil characteristics		Soils from Giza	El-Mansoura	Baltim	Mariut
Texture		Silty clay loam	Clay loam	Silty clay loam	Silty loam
MgO %		4.48	5.80	7.43	7.94
E.C., mmhos/cm		2.0	4.4	61.3	5.8
Soluble cations	Ca^{++}	0.15	5.0	89.2	28.2
(meq/L)	Mg^{++}	4.0	2.7	160.7	18.2
	Na^{+}	11.5	29.7	312.2	9.1
	K^{+}	0.1	0.9	9.2	0.1
Soluble anions	Cl^{-}	18.5	21.1	545.7	31.2
(meq/L)	$SO_4^{=}$	4.9	14.3	93.1	23.1
	HCO_3^{-}	2.4	6.6	4.9	3.3
$CaCO_3$ %		1.09	2.82	1.84	23.2
Organic matter %		1.43	1.59	1.84	2.19
CEC (meq/100 g)		41.6	61.1	41.6	21.2
Exchangeable cations	Ca^{2+}	21.6	27.3	10.4	11.2
(meq/100 g)	Mg^{2+}	13.3	17.1	14.8	7.3
	Na^{+}	6.1	17.1	17.3	2.5
	K^{+}	0.3	0.74	0.3	0.2

Table 2. Effect of adding organic materials on the release of non-exchangeable magnesium. (The data in mg/100 g soil)

Added organic materials		Gyza Soil				Mansoura Soil				Baltim Soil				Mariut Soil			
		Incubation periode															
	%	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28
Glucose	1	6.7	9.6	9.7	9.6	8.1	13.2	13.1	13.1	14.1	25.6	25.9	26.0	5.1	7.4	7.3	7.4
Glucose	2	8.2	11.4	11.3	11.5	9.9	15.3	16.2	15.9	18.1	32.8	32.7	33.1	6.3	9.3	10.1	10.2
Glucose	3	9.3	14.3	16.7	16.7	12.2	17.2	18.3	18.1	21.4	40.3	42.1	42.7	8.4	11.2	12.6	12.7
Glucose	4	9.7	18.1	20.2	20.1	14.1	23.7	25.5	25.9	24.9	46.5	49.2	50.8	9.3	14.1	17.3	17.9
Clover	1	4.0	9.8	16.3	24.3	5.3	11.9	18.9	26.6	11.2	24.3	44.6	46.2	3.4	7.2	17.7	24.4
Clover	2	5.9	11.3	21.6	31.1	7.1	14.8	25.4	30.9	13.4	30.2	52.8	58.1	4.6	8.5	23.6	29.8
Clover	3	6.2	13.4	34.6	42.4	7.9	17.4	32.6	43.1	17.6	37.1	63.5	78.4	5.5	13.4	28.7	36.4
Clover	4	6.9	15.6	39.1	48.9	9.5	22.9	40.7	52.3	20.8	44.2	74.2	85.4	6.4	14.9	35.6	41.3
Cotton	1	1.5	1.5	1.5	2.2	1.4	1.3	1.5	2.2	2.9	2.8	2.9	5.1	1.3	1.4	1.5	2.6
Cotton	2	1.6	1.5	1.5	2.3	1.5	1.5	1.6	2.8	2.9	2.8	2.9	5.2	1.4	1.3	1.4	2.8
Cotton	3	1.3	1.4	1.5	2.4	1.6	1.6	1.6	2.9	2.8	2.7	2.8	5.9	1.4	1.4	1.5	2.7
Cotton	4	1.5	1.6	1.5	2.5	1.6	1.7	1.7	3.4	2.6	2.7	2.8	5.8	1.4	1.4	1.5	2.9
Control		2.2	2.1	2.3	2.4	2.1	2.1	2.4	2.4	2.9	3.0	3.4	3.5	1.7	1.8	1.8	2.1

ever, due its narrow C/N ratio, which leads to more biological activity and consequently more Mg was released. Lower amounts of Mg were released from soils treated with cotton stalks due its higher legnin content and wide C/N ratio which retard its decompisition (Table 2). These results are in line with those obtained by Ghanem, 1971 and Puttaswamy-gowde and Pratl, 1973. Data presented in Table 2 and Figs 1–4 show that the amount of Mg released was related to the added amount of organic substances.

Expressing the relationship between the applied amounts of organic matter and released amount of non-exchangeable-Mg by the equation, $Y = a + b\,x$, where Y is the amount of Mg released, X, the time of incubation, a, the intercept and b, a constant represents the slope of the curve. The values of a and b were calculated by the least square method for each organic treatment while the data obtained for cotton straw connot be lineared. The "X^2" test showed that the calculated and experimental values of Y for each treatment, were of the same population, indicating that the equations represents the experimental data of each treatment.

However, the test soils differed in their released Mg upon adding certain organic matter at certain ratio (Table 2). The lacustrine (Baltim) soil sample have the highest amount of Mg released in comparison with other soils, and thus may be due to its mineralogical composition. On the other hand, the calcareous soil sample from Mariut, which have the highest amount of non-exchangeable Mg, have relatively the lowest released amount of Mg and thus may be due to the neutralizing effect of $CaCo_3$ which reduces the effect of the biogenic acids in releasing Mg. These results are in agreement with data obtained by Reda (1975), who found that the amount of Mg released from the calcareous soil sample during microbial activity was less than the amount of Mg released from alluvial soil sample.

4. Abstract

The effect of glucose, clover straw and cotton stalks on the release of non-exchangeable Mg from 4 different soils during incubation was conducted. Clover straw was the most effective material in releasing Mg while cotton stalks was the lowest. Baltim, the lacustrine soil sample had the highest released Mg amounts but the calcareous soil sample from Mariut had the lowest amount. In general, the released Mg was related to the added organic matter form and amount as well as soil type.

Zusammenfassung

Es wurde der Einfluß auf die Mg-Freisetzung in Boden nach Inkubation von Glukose, Kleestroh, Baumwollstengeln, an vier Bodenarten untersucht. Kleestroh hatte die höchste Wirksamkeit auf die Mg-Freisetzung im Boden, während die niedrigste bei Baumwollstengeln lag. Im Baltim- und Lacustrineböden wurden höhere Mg-Mengen freigesetzt als im kalkhaltigen Boden vom Mariut. Allgemein bestand eine gute Korrelation zwischen den freigesetzten Mg-Mengen einerseits und Form und Menge des organischen Materials sowie den Bodenarten anderseits.

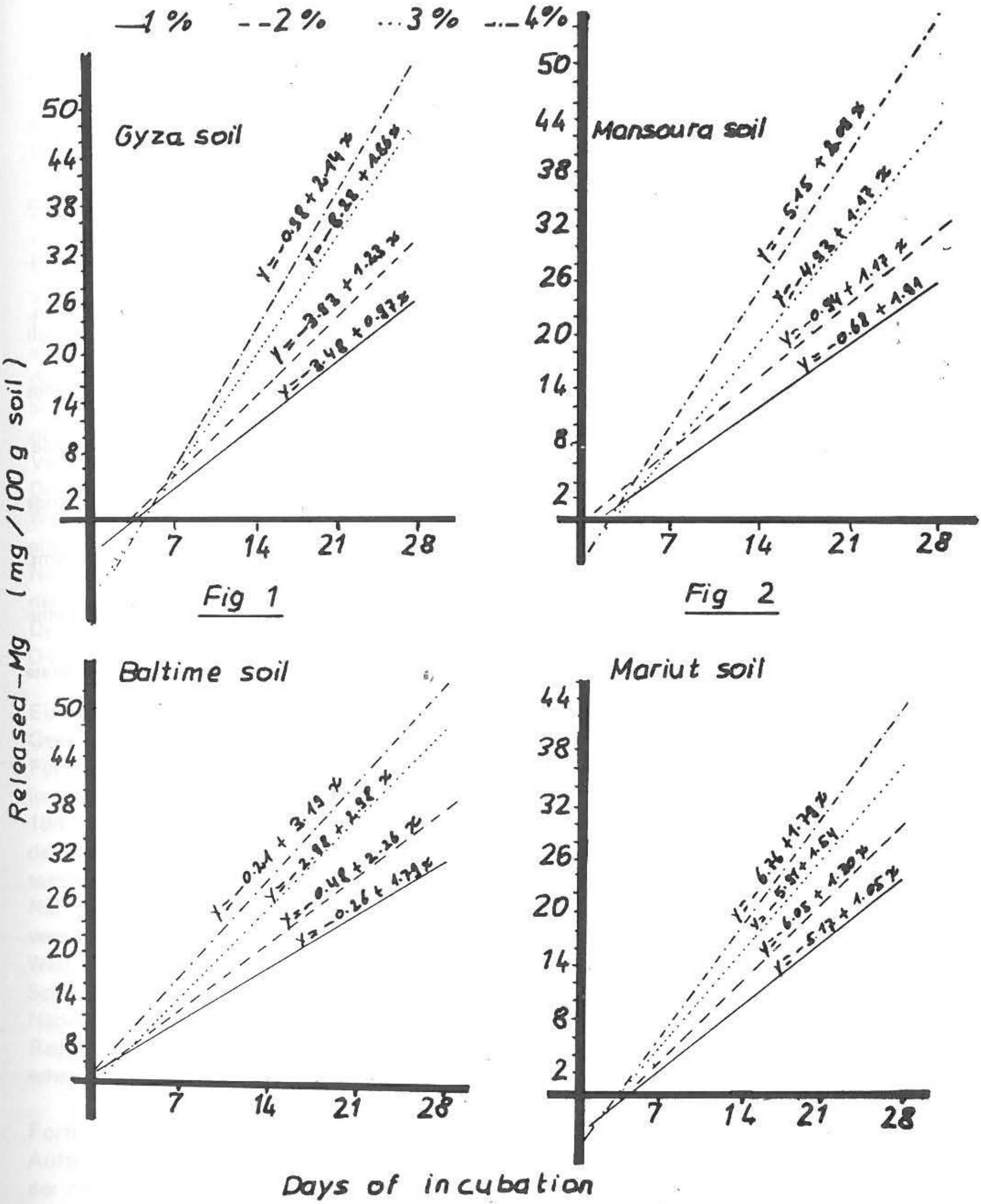

Fig 3 Fig 4

Effect of the additions of different percentages of clover straw on the release of non-exchangeable Mg.

References

1. ALEXANDER, M., 1977: Introduction to soil Microbiology. 2nd Ed. John Wiley & Sons, Inc. New York and London.
2. BALBA, A.A.; KISHK, F.M.; SHENAWY, M., 1975: The loss of in alkalinity as a new method for determination of CEC and exchangeable Ca^{2+} and Mg^{2+} in calcareous soils. Jour. of Agric. Res. Tanta Univ., 1, 138–150.
3. BLACK, C.A. (ed. in Chief), 1965: Methods of soil analysis. Part II. (Agronomy series No. 9). Amer. Soc. Agron., Inc. Publisher, Wisconsin, U.S.A.
4. DARAGON, A.Y., 1971: Decompostion of minerals containing iron by soil organisms. Sov. Soil Sci. 3, 367–372.
5. GHANEM, I.; HASSAN, M.N.; KHADER, M.; TADROS, V., 1971: Studies on Mn in soils. II-Effect of adding organic materials on the transformation of native Mn. U.A.R. J. Soil Sci. 11, 125–134.
6. GOMAH, A.M., 1969: Studies on decomposition of plant residue in sandy, calcareous and clay loam soils. Ph.D. Thesis, Fac. Agric. Alex. Univ.
7. HARROD, M.F., 1971: Residual value of Mn. Ministry of Agric. Fisheries and Food, Technical Bull. Iodon 2, 270–277. (In Soils and Fert. 35, 1972).
8. PUTTASWAOMY-GOWDA, B.S.; PRATT, P.E., 1973: Effects of straw; calcium chloride and submergence on sodic soil. Soil Sci. Soc. Amer. Proc. 37, 208–212.
9. REDA, R.S., 1975: The release of cations from clay minerals affected by microorganisms. M. Sc. Thesis, Fac. Agric. Cairo. Univ.
10. STEVEN, F.J.; ARKADANI, M.S., 1967: Organic matter reactions involving micronutrients in soils. Soil Sci. Soc. Amer. Proc. 31, 79–114.
11. MOKWUNYE, A.U.; MELSTED, S.W., 1972: Magnesium forms in relected temperate and tropical soils. Soil Sci. Soc. Amer. Proc. 36:762–764