

FORMS OF MAGNESIUM IN SOIL AS INFLUENCED BY ADDED MAGNESIUM SOURCES UNDER SUBMERGED CONDITION

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Abstract: A laboratory incubation study was carried out using two acid rice soils of Kerala under submerged condition for 180 days. The soil samples drawn at regular intervals were analysed for chemical forms of Mg. The insoluble Mg fractions dominated over the soluble ones. Acid soluble Mg and mineral Mg together constituted about 74.03 per cent of the total Mg content. Ammonium acetate extractable Mg of the soils was 19.09 per cent. The content of organic complexed Mg was very low and that of water soluble Mg was practically nil. Total Mg content as well as the content of various Mg fractions was higher in karappadam soil than in the laterite soil. The soluble Mg fractions were higher in samples supplied with magnesium sulphate while the insoluble fractions were higher in samples supplied with carbonate forms of Mg. The difference between the Mg levels tried in this experiment became conspicuous only under conditions of prolonged submergence.

INTRODUCTION

Magnesium is the fifth element in the group of six macronutrients and is the only mineral constituent of the chlorophyll molecule. Because of the differences in weathering and parent materials, forms and availability of Mg in soils vary widely. The Mg in soils is mainly contained in silicate minerals, and smaller amounts are in exchangeable and water soluble forms (Prince *et al.*, 1947; Rice and Kamprath, 1968; and Salmon, 1963).

In the present study using two acid rice soils of Kerala, total soil Mg was fractionated into water soluble, NH_4OAc extractable, organic complexed, acid soluble and mineral Mg forms.

MATERIALS AND METHODS

A laboratory incubation study was carried out using two acid rice soils of Kerala (karappadam and laterite), with three sources of Mg namely, magnesite (MgCO_3), dolomite ($\text{CaMg}(\text{CO}_3)_2$) and magnesium sulphate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) at

two levels of Mg (25 and 50 kg MgO/ha) in a completely randomised design with two replications. These soils were continuously submerged and incubated at room temperature for 180 days. Soil samples were drawn regularly at 30 days interval for chemical analysis. Fractionation of Mg was carried out using the procedure of Mokwunye and Melsted (1972). Flow chart for the fractionation of soil for chemical forms of Mg is given in Fig. 1. A separate soil sample was extracted with water for the estimation of water soluble Mg.

RESULTS AND DISCUSSION

Water soluble Mg

The overall trend of changes in water soluble Mg revealed that its content gradually increased as a consequence of incubation under submergence up to the second month and thereafter declined in a fluctuating pattern to reach a minimum level at the fourth month. Then the level again gradually increased and remained rather stable (Table 1).

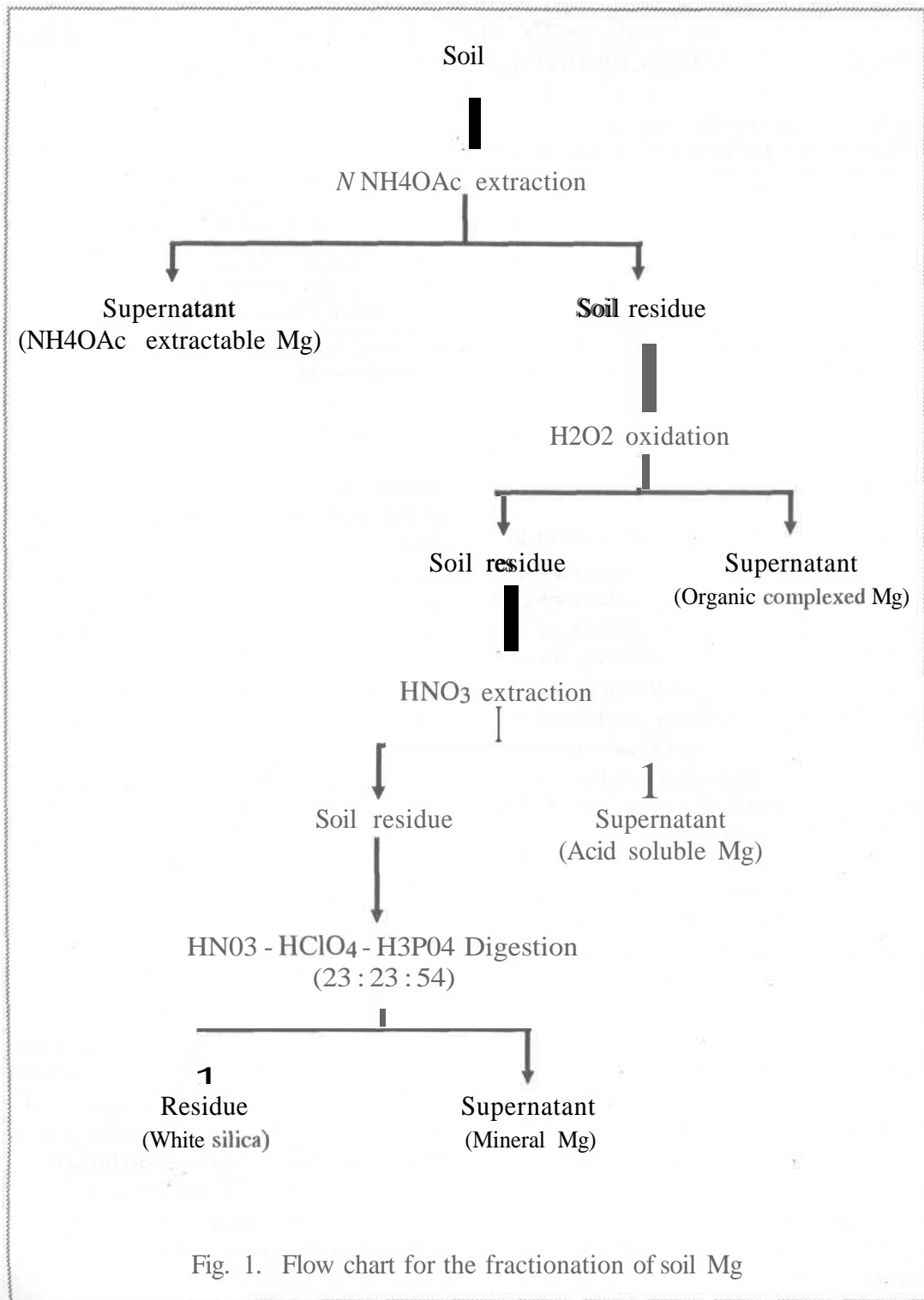


Fig. 1. Flow chart for the fractionation of soil Mg

Table 1. Mean values of Mg fractions in soil as influenced by the period of incubation

Period of incubation months	Mg fractions, ppm				
	Water soluble Mg	NH ₄ OAc extractable Mg	Organic complexed Mg	Acid soluble Mg	Mineral Mg
	1	25.22	181.8	9.33	343.0
2	91.04	187.2	13.52	384.5	343.4
3	64.97	161.28	14.88	368.2	367.8
4	19.07	177.84	12.86	428.6	381.4
5	64.35	167.04	12.10	374.1	386.8
6	58.73	270.0	15.75	363.9	421.1

Magnesium sulphate supplied samples gave the maximum water soluble Mg in both the soils (68.73 and 80.54 ppm) in karappadam and laterite soils respectively. The difference between magnesite and dolomite was inconsistent. The better efficiency of magnesium sulphate when compared to the carbonate forms of Mg may be due to the lesser content of water soluble Mg fraction in magnesite and dolomite. The reported solubility for magnesium sulphate with a dissociation $\log K^0$ of 8.15 reflects a very high solubility for this mineral. The solubility of carbonates decreases in the order of magnesite ($\log K^0 = 10.69$) dolomite ($\log K^0 = 18.46$) (Lindsay, 1979).

Water soluble Mg increased with higher levels of Mg application in both the soils and in the case of all the three sources (Table 3). This can be attributed to the increased release of Mg from Mg sources at the higher levels of application.

Ammonium acetate extractable Mg

In general the NH₄OAc extractable Mg content increased during the initial stages and then changed in a fluctuating manner (Table 1).

Ammonium acetate extractable Mg content was higher in karappadam soil than in the laterite soil in all the stages of sampling and also in the case of all the treatments. This may be due to the high native Mg in the karappadam soil as compared to that of the laterite soil.

Magnesium sulphate was a better source of NH₄OAc extractable Mg in both the soils. In karappadam soil, magnesite (99.9 per cent) and dolomite (95.3 per cent) were almost as efficient as magnesium sulphate. Their solubility in laterite soil was such that the magnesite and dolomite were 76.9 and 82.2 per cent as efficient as magnesium sulphate. The higher

Table 2. Mean values of Mg fractions as influenced by Mg sources and soil

Mg fractions	Soil type	Control (No Mg)	Magnesite	Dolomite	MgSO ₄
Water soluble Mg, ppm	Karappadam	27.84	54.06	50.43	68.73
	Laterite	22.19	50.94	60.62	80.54
NH ₄ OAc extractable Mg, cmol(+)kg/ha	Karappadam	2.1	2.54	2.34	2.55
	Laterite	0.55	0.75	0.80	0.98
Organic complexed Mg, ppm	Karappadam	12.05	14.19	15.36	12.88
	Laterite	9.38	14.18	12.98	11.22
Acid soluble Mg, ppm	Karappadam	404.00	442.70	441.40	434.10
	Laterite	317.00	312.60	323.40	324.20
Mineral Mg, ppm	Karappadam	395.20	390.80	386.00	378.20
	Laterite	323.00	355.90	338.60	335.30

efficiency of the carbonate forms in **karappadam** soil may be due to the higher acidic condition prevailing in that soil leading to their increased solubility.

Ammonium acetate extractable Mg content increased with the increased level of Mg application in both the soils and in the case of all the three sources (Table 3). This is due to the increased availability of applied Mg in the soils.

Organic complexed Mg

The organic complexed Mg constituted only 1.31 per cent of the total Mg in the soil. This was in line with the reports of Mokwunye and Melsted (1972) that it formed only 0.05 to 2.8 per cent of the total Mg.

Organic complexed Mg content was higher in karappadam soil than in the laterite soil, which may be attributed to the high organic matter and native organic complexed Mg content of the karappadam soil.

Content of organic complexed Mg was higher in samples supplied with carbonate forms of Mg (Table 2). This is apparently due to the better efficiency of the carbonate forms to raise the pH of the soil; thus creating a more favourable condition for the decomposition of organic matter and release of Mg from the complexed form.

There was a significant increase in the organic complexed Mg of the soils with increase in the levels of applied Mg (Table 3).

Table 3. Mean values of Mg fractions as influenced by levels of Mg application

Mg fractions	Levels of MgO kg ha ⁻¹	Soil		Sources of Mg		
		Karappadam	Laterite	Magnesite	Dolomite	Magnesium sulphate
Water soluble Mg, ppm	25	51.61	58.46	44.35	50.75	70.01
	50	63.87	69.60	60.65	50.30	79.26
NH ₄ OAc extractable Mg, cmol (+)/kg	25	2.326	0.716	1.478	1.426	1.659
	50	2.627	0.971	1.816	1.719	1.864
Organic complexed Mg, ppm	25	13.59	11.73	13.44	14.43	11.12
	50	14.69	13.85	14.94	14.91	12.98
Acid soluble Mg, ppm	25	435.2	322.4	370.6	379.3	386.7
	50	443.6	317.8	384.8	385.5	371.7
Mineral Mg, ppm	25	389.5	345.7	381.7	358.9	362.3
	50	380.4	340.8	365.0	365.7	351.7

Acid soluble Mg

General trend of changes in acid soluble Mg was that its content increased on incubation (Table 1) which may be correlated to the raised pH on submergence.

Acid soluble Mg content of the karappadam soil was significantly higher than that of the laterite soil.

There was significant difference between the sources with respect to their contribution to acid soluble Mg in the soil (Table 2). In karappadam soil, acid soluble

Mg was higher in samples supplied with magnesite and dolomite than in those supplied with magnesium sulphate.

Acid soluble Mg was positively correlated with NH₄OAc extractable Mg ($r = 0.97^{**}$) which was in line with Metson's (1974) finding that this fraction played a vital role in replenishing the levels of exchangeable Mg in soils.

Mineral Mg

Mineral Mg content increased with the advancement of the period of submergence (Table 1). Mineral Mg was

maximum in samples supplied with magnesite followed by dolomite and then magnesium sulphate in both the soils (Table 2). This may be due to the fact that Mg is present in relatively easily soluble form in magnesium sulphate, so the chances of getting converted to mineral form are less. But in carbonate Mg sources Mg is not so easily soluble, so may get fixed to mineral form in course of time.

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