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TRANSFORMATIONS OF APPLIED MAGNESIUM IN SOIL

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Abstract: An incubation study was taken up with two acid soils (laterite and Kuttanad alluvium), three sources of Mg ($MgSO_4.7H_2O$, magnesite and dolomite) and three levels of Mg (1250, 2500 and 3750 MgO kg ha^{-1}) at field capacity. The rate of release of Mg from different sources was in the order of their solubility i.e., $MgSO_4.7H_2O$ > magnesite > dolomite. The retention of available Mg was more in treatments with magnesite. The Mg fractions and pH were found to increase with increased levels of application MgO. Magnesite was superior to other sources in supplying available Mg and exchangeable Mg in both the soils.

Key words: Acid soils, available Mg, exchangeable Mg, magnesium dynamics, magnesium fertilizers.

INTRODUCTION

Various Mg sources are used as Mg fertilizers to correct Mg deficiency. Magnesite and dolomite are cheaper than magnesium sulphate ($MgSO_4.7H_2O$), the principal Mg fertilizer. The study of pattern of release of Mg from these sources in two important acid soil types viz., laterite and Kuttanad alluvium will be useful for a better fertilizer management which includes Mg fertilizers. Hence, the present attempt is made.

MATERIALS AND METHODS

A karappadam soil viz., Kuttanad alluvium (Tropaquept) of Moncompu (Alappuzha district) and a laterite soil (Kandiudult) of Vellanikkara (Trichur district) which represented two important soils of Kerala were used (0-15 cm depth). A laboratory incubation study with three sources of Mg namely magnesium sulphate ($MgSO_4.7H_2O$ having 15.95% MgO), magnesite ($MgCO_3$ having 27.00% MgO) and dolomite ($Ca.Mg\ [CO_3]_2$ having 15.36% MgO) was conducted in a completely randomised design with two replications. The details of the treatments (same for both the soils) are given in Table 1.

Table 1. Details of treatments

Treat. notation	Source	MgO, kg ha^{-1}
T1	No Mg (control)	-
T2	Magnesium sulphate	1250
T3	Magnesium sulphate	2500
T4	Magnesium sulphate	3750
T5	Magnesite	1250
T6	Magnesite	2500
T7	Magnesite	3750
T8	Dolomite	1250
T9	Dolomite	2500
T10	Dolomite	3750

The soils were weighed (800 g) and transferred into plastic containers of 1 kg capacity. The magnesium sources as per the treatments were added and thoroughly mixed with the soil. The field capacity of soils was determined using pressure plate-membrane apparatus and the water content was increased to field capacity accordingly. The soils were maintained at field capacity by periodical weighing on alternate days and adding water to compensate evaporation loss. Incubation was done at room temperature (28-31 °C) for 180 days. Soil samples were drawn regularly at 15 day intervals for the **determination** of available Mg and at 60 day intervals for the determination of exchangeable cations (Mg, Ca, K and Na), pH and specific conductance.

Particle size analysis (piper, 1942), organic carbon, pH, EC, available P, available K, exchangeable Ca, Mg, K and Na, total P, K, Ca and Mg (Jackson, 1958), CEC (Jackson,

Table 2. Soil characteristics as influenced by Mg sources at six months after incubation (mean values)

Soil characteristics	Soil type	Control	Magnesium sulphate	Magnesite	Dolomite
Available Mg, ppm	Karappadam	359.70	708.50	872.00	490.50
	Laterite	228.70	468.70	555.90	76.30
Exchangeable Mg, cmol(+) kg^{-1}	Karappadam	1.02	2.21	3.74	1.67
	Laterite	0.61	2.52	3.13	0.68
Slowly available Mg, ppm	Karappadam	720.30	1041.20	877.80	1262.80
	Laterite	1060.60	1070.90	983.70	1463.40
pH	Karappadam	4.50	4.37	5.72	7.20
	Laterite	5.42	5.37	6.74	7.51
Specific conductance, dS m^{-1}	Karappadam	0.78	0.80	0.79	0.87
	Laterite	1.05	1.89	0.9?	1.14

Table 3. Effect of treatments on exchangeable Mg, pH and EC

Treatment	Exch. Mg cmol(+) kg^{-1}			pH			EC, dS m^{-1}		
	Period, months			Periods, months			Periods, months		
	2	4	6	2	4	6	2	4	6
Karappadam									
1	1.22	2.04	1.02	4.44	4.27	4.50	2.44	1.28	0.78
2	4.69	6.53	1.53	4.40	4.20	4.24	2.84	2.66	0.98
3	8.98	8.16	2.55	4.43	4.27	4.36	3.48	3.66	0.95
4	17.34	18.56	2.55	4.46	4.47	4.50	5.00	4.99	0.49
5	5.92	6.12	3.06	5.34	5.44	5.34	2.09	1.80	0.71
6	8.57	8.57	4.08	6.18	6.26	5.91	1.75	1.80	0.74
7	10.00	9.79	4.08	6.36	6.60	5.92	2.22	1.70	0.93
8	3.88	4.49	2.04	6.49	6.62	6.53	2.25	2.15	0.79
9	2.86	3.67	2.55	7.33	7.26	7.33	2.04	2.17	0.91
10	1.22	2.04	0.41	7.61	7.55	7.76	2.34	1.92	0.90
Mean	6.47	7.0	2.39	5.70	5.69	5.64	2.64	2.41	0.82
Laterite									
1	0.61	0.41	0.61	5.09	6.41	5.42	0.64	0.71	1.05
2	1.84	3.06	1.63	4.99	5.10	5.36	1.68	1.39	1.31
3	4.49	6.12	1.63	5.03	5.01	5.38	2.53	2.52	1.92
4	6.73	6.73	4.28	4.97	5.05	5.39	3.23	2.78	2.45
5	3.06	2.86	1.09	6.21	6.20	6.24	0.88	1.01	1.03
6	2.86	4.41	4.08	6.64	6.99	6.94	0.80	0.86	1.03
7	3.67	5.51	4.08	7.14	7.15	7.06	0.74	0.80	0.85
8	0.41	1.22	1.02	7.15	7.26	7.13	0.98	0.70	0.95
9	0.41	0.41	0.61	7.64	7.71	7.62	0.99	0.90	1.13
10	0.20	0.41	0.41	7.81	7.84	7.78	0.97	5.46	1.35
Mean	2.43	3.11	1.95	6.27	6.47	6.43	1.34	1.71	1.31

1969), available N (Subbiah and Asija, 1956) and available Mg (Hesse, 1971) were determined following standard analytical

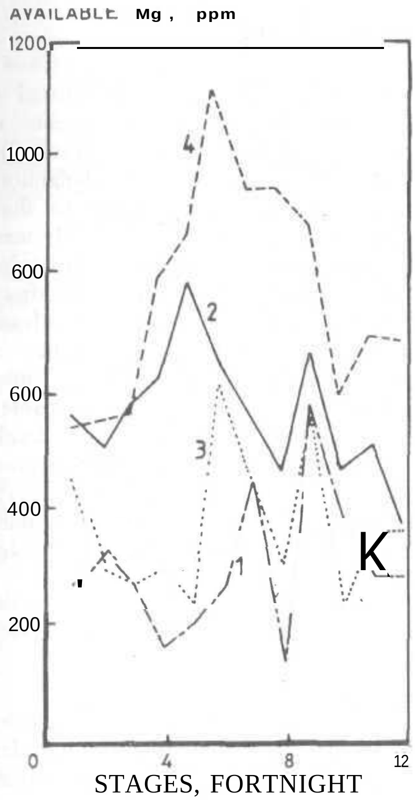

Fig 1. Effect of soil on available magnesium (1) Laterite (Control); (2) Laterite (Mg treated); (3) Karappadam (Control); (4) Karappadam (Mg treated)

procedures. Slowly available Mg was calculated by the difference between total Mg and available Mg extracted by 0.0125 *M* $CaCl_2$.

RESULTS AND DISCUSSION

The karappadam soil was sandy loam in texture, non-saline, acidic, high in organic carbon, medium in available P and high in available K. The laterite soil was sandy clay loam in texture, less acidic and contained less soluble salts.

Available Mg

The increased availability of Mg in the soil from the applied sources is evident from Fig 1.

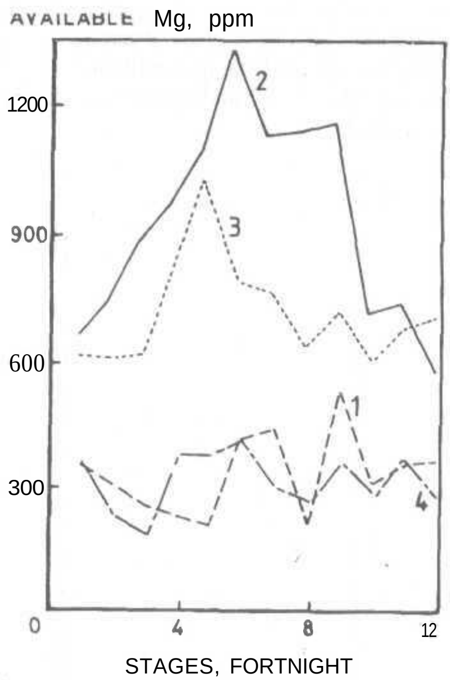

Fig 2, Effect of Mg sources on available Mg in soil. (1) Control; (2) Magnesium sulphate; (3) Magnesite; (4) Dolomite

While comparing the sources, treatments with magnesium sulphate registered highest values of available Mg in all the stages except in the last (Fig 2). The treatments "with magnesite followed a similar trend of variation in available Mg, but the release was at a slower rate. The very low amount of available Mg in treatments with dolomite confirms the least solubility of dolomite among the three sources. The reported solubility sequence of the three sources is in the decreasing order, magnesium sulphate (log K = 8.15) > magnesite (log K^{o} = 10.69) > dolomite (log K = 18.46) (Lindsay, 1979). This explains the behaviour of these three sources in releasing Mg to the soil. The content of Mg in karappadam showed an increase over the same in laterite soil (Table 2). The available Mg content was found to increase with increasing levels of application of MgO (Fig 3), due to the increase in magnitude of release of Mg from the applied sources of Mg at higher levels. The quantity of available Mg in control was lower than that for any of the applied levels of MgO, in all the stages of incubation. Thus the treatments showed their dominance in their effect on type of soil and sources and levels of Mg applied.

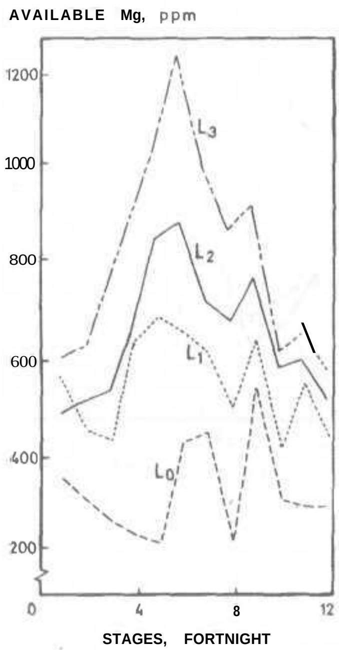

Fig 3. Effect of levels of Mg on available Mg in soil. L_0 = Control; L_1 = MgO 1250 kg ha $^{-1}$; L_2 = MgO 2500 kg ha $^{-1}$; L_3 = MgO 3750 kg ha $^{-1}$

Though the order of solubility of the three sources of Mg was magnesium sulphate > magnesite > dolomite, the content of available Mg after six months was highest in samples treated with magnesite (Fig 2). Magnesite gives slow, but prolonged release of available Mg, making it less susceptible to conversion into unavailable forms. The efficiency of magnesite was superior to others in both the soils (49.8% efficiency in karappadam and 36.1% efficiency in laterite soil). The efficiency of magnesium sulphate was 40.5% in karappadam and 30.4% in laterite. Dolomite was the least efficient (27.8% in karappadam and 4.96% in laterite).

Exchangeable Mg

The available Mg content dominated over exchangeable Mg. The treatments were significantly superior to control (Table 3). In general, the trend in the dynamics of exchangeable Mg was similar to that of available Mg. The exchangeable Mg was the highest in treatments with magnesium sulphate followed by magnesite and dolomite after four months of incubation. But with advancing period of incubation, treatments with magnesite retained more Mg in the exchangeable form. The exchangeable Mg content increased with increasing levels of MgO applied in treatments with magnesium sulphate (Table 4). Magnesite was more efficient in contribution of exchangeable Mg compared to magnesium sulphate and dolomite (Table 2).

pH

There was an increase in pH after two months of incubation and thereafter, no considerable variation in pH occurred with advancing period of incubation (Table 3). The application of Mg increased the pH of the soil. The increase in pH was maximum in soils supplied with dolomite in both the soils (Table 2). Dolomite being a source of both Mg and Ca, increases pH appreciably. Efficiency of different sources in correcting soil reaction was in the order dolomite > magnesite > magnesium sulphate. Increasing level of Mg increased the pH.

Specific conductance

In karappadam, the specific conductance increased up to two months. It showed stability up to fourth month and then a decline. Corresponding changes in laterite soil was inconsistent (Table 3). The specific conductance was dependent on the solubility of the material and release of Mg^{++} ions.

Table 4. Soil characteristics as influenced by levels of Mg application at six months after incubation

Soil characteristics	Levels of MgO, kg ha^{-1}	Soil type		Sources of Mg		
		Karappadam	Laterite	Mg sulphate	Magnesite	Dolomite
Available Mg, ppm	1250	588.60	316.10	408.80	621.30	327.00
	2500	763.00	337.90	572.30	768.50	310.70
	3750	719.40	446.90	784.80	752.10	212.60
Exchangeable Mg, cmol(+) kg^{-1}	1250	2.21	1.43	1.58	2.35	1.53
	2500	3.06	2.11	2.09	4.08	1.58
	3750	2.35	2.79	3.42	3.88	0.41
Slowly available Mg, ppm	1250	826.30	886.60	901.10	688.40	982.90
	2500	990.30	1201.80	1072.40	876.40	1339.50
	3750	1365.20	1427.60	1194.70	1227.50	1767.00
pH	1250	5.37	6.24	4.80	5.79	6.83
	2500	5.86	6.64	4.87	6.42	7.47
	3750	6.06	6.74	4.95	6.49	7.77
Specific conductance, dS m^{-1}	1250	0.83	1.10	1.15	0.87	0.87
	2500	0.87	1.37	1.43	0.89	1.02
	3750	0.77	1.55	1.47	0.89	1.12

Table 5. Slowly available Mg as influenced by treatments at six months after incubation, ppm

Treatment No	Slowly available Mg	
	Karappadam	Laterite
1	720	641
2	859	943
3	998	1147
4	1267	1122
5	761	616
6	769	984
7	1104	1351
8	859	1107
9	1205	1474
10	1726	1809
Mean	1027	1120

Slowly available Mg

Magnesium in slowly available form was influenced by the different sources of Mg and the highest amount was seen in samples treated with dolomite and the lowest in magnesite (Table 5). Increasing levels of applied Mg increased the content in the slowly available form.

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