https://doi.org/10.29321/MAJ.10.A02770

Madras agric. J 69. (10 : 667-671. October 1982

Interrelationship between forms of Magnesium in the Nilgiris soils

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Interrelationships among the various fractions of magnesium and their relationship with total magnesium were observed. As the total magnesium increased, its component fractions also correspondingly increased. The relationship between total Mg and both organo-complexed Mg and reserve (acid-soluble) Mg was linear. The relationship between reserve Mg and both organic-complexed Mg and mineral Mg was significantly positive and quadratic.

Magnesium is known to occur in several forms which are in equilibrium. Acid-soluble fraction plays a vital role in replenishing levels of exchangeable magnesium in soils (Metson, 1974). The acid-soluble magnesium is considered as a measure of the reserve of potentially available non-exchangeable magnesium in the soils (Metson and Brooks 1975). Since "organic-complexed" magnesium comprised only an insignificant proportion (Metson and Gibson, 1977), work on this fraction was very meagre. With maturity, it was reported by Mokwunye and Melsted 1972 that the bulk of the magnesium was associated with the more resistant primary minerals as a part of their basic crystal structure. Work on the inter relationship between the various fractions was very much limited. Work on this nature was practically nil on Indian soils Hence a detailed investigation on magnesium fractions was undertaken in the Nilgiris soil profiles to establish their relationship between each other.

MATERIAL AND METHODS

A total of 147 samples covering 31 representative soil profiles of the Nilgiris were collected. The Nilgiris is a hilly tract and its average elevation is 1981-2m above mean sea leval. The soils are laterite in character derived from charnokite as parent rock, the kind of clay being kaolin. The district receives an annual average rainfall of 1891 mm. Soils were analysed for the different fractions of magnesium namely, total magnesium, exchangeable magnesium, acid-soluble magnesium, organic-complexed magnesium and mineral magnesium by the fractionation procedure suggested by Mokwunye and Melsted (1972). Simple correlation coefficients and quadratic equations were worked out according to Snedecor and Cochran, 1967.

RESULTS AND DISCUSSION

Data of the surface soils are furnished in Table 1. The values for 147 samples are explained as means and ranges. The correlation coefficients

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among the different forms of magnesium are furnished in Table 2.

Total magnesium ranged between 2.5 to 13.3 me/100g soil with a mean of 6.7 me/100 g. This was positively correlated with the exchangeable Mg ($r = 0.657^{*}$), organic complexed Mg ($r = 0.234^{**}$), mineral Mg ($r = 0.525^{**}$), while a negative correlation with Ca/Mg ratio ($r = -0.342^{**}$) was observed A positive correlation existed with exchangeable Mg expressed as percentage of the cation exchange capacity ($r = 0.478^{**}$) and with elevation ($r = 0.211^{**}$).

Total Mg values estimaed according to Metson (1956) ranged between 2.0 and 12.7 me/100 g soil with a mean value of 6.7 me/100 g. Positive correlation with organic-complexed Mg ($r = 0.220^{**}$), acid-soluble Mg ($r = 0.485^{**}$), mineral Mg($r = 0.607^{**}$), Mg ($r = 0.470^{**}$) and elevation ($r = 0.240^{**}$) was observed, while with Ca/Mg ($r = -0.304^{**}$) and pH ($r = -0.263^{**}$), the correlation was negative.

Mineral Mg

The values varied from 0.3 to 4.4 me/100g soil with a mean of 2.2 me/100 g soil. The relationship between mineral Mg and both acid-soluble Mg and total Mg of the soils studied was best described by second order equations (Table 2) Mineral Mg was negatively correlated with the base saturation percentage ($r = -0.231^{*}$), pH ($r = -0.163^{*}$) and Mg ($r = -0.166^{*}$) while positive correlation with H/Mg ratio ($r = 0.226^{**}$), elevation ($r = 0.310^{**}$) and rainfall ($r = 0.220^{**}$) was observed.

Mineral Mg expressed as percentage of the total Mg ranged from 8.1 to 60.5 per cent with a mean value of 33.5 per cent. When this fraction was epxressed as percentage of the total inorganic Mg content of the soil, the values ranged from 16.3 to 81.6 per cent with a mean value of 45.8 per cent.

Acid-soluble Mg

The range of variation for this fraction was between 0.2 to 4.6 me/100 g soil with a mean of 1.5 me/100 g. This constituted 22.2 per cent of the total Mg content on an average, the values ranging from 2.7 to 56.1 per cent. This formed 29.4 per cent of the total inorganic Mg, the values ranging from 6.5 to 62.7 per cent.

Acid-soluble Mg, negatively correlated with the organic-complexed Mg ($r = 0.192^{*}$), but the best fit was a quadratic function ($R^2 = 0.249^{**}$), with the second order equation, $Y = 1.18 + 0.69X - 0.25X^2$. This fraction correlated positvely with both elevation ($r = 0.281^{**}$) and rainfall ($r = 0.202^{**}$). The relationship between this fraction and total Mg was quadratic in nature ($R^2 = 0.528^{**}$).

Exchangeable Mg

The values for this fraction range between 0.2 and 7.9 me/100 g soil with a mean value of 1.4 me/100 g soil. This fraction consistuted 2.3 to 63.2 per cent of the total Mg with a

mean of 18.6 per cent. Further, this formed 24.9 per cent of the total inorganic Mg content, the range of values being 3.8 and 72.0 per cent.

The relationship between exchangeable Mg and total Mg was quadratic (R^2 = 0.756**). The linear relationship between total Mg (estimated) and exchangeable Mg was also significant at 1 per cent (r = 0.603**). This fraction was negatively correlated with Ca/Mg ratio (r = -.484**). K/Mg ratio (r = -0.160**) H/Mg ratio (r = -0.350**), elevation (r = -0.198*) and rainfall (r = -0.213**), while a positive correlation with Mg expressed as percentage of the cation exchange capacity (r = 0.779**) was obtained

Organic-complexed Mg

In the present study the soil samples contained, on an average, 1.6 me/100g of organic-complexed Mg the values ranging from 0.2 to 4.3 me/100g of soil. This fraction constituted, on an average, 25.3 per cent of the total Mg with the values ranging between 5.9 and 67.6 per cent. This was positively correlated with elevation (r = 0.307**), while the relation was negative with acid-soluble Mg (r=-0.192**).

The authors wish to express their thanks to the Tamil Nadu Agricultural University for the facilities offered to carry out this investigation as part of the Ph.D. thesis of the first author.

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TABLE 1. Distribution Of Magnesium fractions In The Surface Soil Samples (me/100 g - moisture free basis)

Pro— file No.	Location	Maineral Mg	Acid soluble Mg	Exchan— geable Mg	Organic comple- xed Mg	Total Mg Sum- matic	Total Mg estimated	Ca/Mg
Bembatty		2 5	2.7	2.4	2.8	10 4	106	3.6
Emarald		1.7	2.4	1.2	2.6	7.9	7.9	4.4
Yedakad		1.2	1.0	2.8	2 4	7.4	7.6	2 7
Mulligur		1.9	1 1	1.6	2.3	6.9	6.2	3.3
Malkundha		2.2	1.2	0.4	2.7	6.5	6.2	6.5
Titukkal		1.4	1.4	0.7	1.2	4.7	4.3	29.0
Kavaratty		1.6	0 9	2.8	1.3	6.6	6.8	3.3
Wardigate		2.2	1.5	1.6	1 6	6.9	6.3	4 1
Kadanad		2.6	2.0	2.2	1.3	8.1	8.8	2 3
Maragal		2.5	1 9	7.1	1.8	13.3	12.2	1.6
Ebbanad		2.7	0.7	2.8	3.2	7.4	7.6	3.1
Thuneri		2.6	0.8	2.0	2.1	7 5	7 5	2.7
Doddabetta	(top)	2.4	2.8	1.0	1.7	7.5	7.6	6.5
Doddabetta	(middle)	3.2	1.6	1.2	2.3	8 3	8.3	2.2
Doddabetta	(Bottom)	3.4	2.3	2.4	2 5	10.6	10.1	1.9
Kambatty		5.3	3.0	2.6	2.1	13.0	10.9	2.9
Thummanatty		2.0	2.6	2.6	2 1	13.0	10.9	2.9
Balacola		2.6	1.6	0.4	1 7	6.3	6.9	13.3
Melur		1.9	0.8	0.7	2.4	5 8	6.0	9.7
Hulikkal		1.4	1.1	1.2	2.3	6.0	5.5	2.2
Ketty		3.2	1 7	0.5	2.2	7.6	7.0	7.2
Kengarai		1.5	1.9	0.8	0.5	4.7	4.8	2.5
Nedugula		2.0	1.3	0 4	0.6	4.3	4 8	6.5
Kodanad		1.8	3.3	0.8	1.1	7.0	6.8	2.5
Kotagiri		1.4	3.0	2.4	1.1	7.9	6.7	2.2
Kodanad		1.8	3.3	0 8	1 1	7 0	6.8	2.5
Kotagiri		1.4	3.0	2.4	1.1	7.9	6.7	2.2
Sholur		1.7	1.1	1.0	1.2	5.0	6 2	2 9
Gudalur		1.6	1.3	2.4	0.9	6,2	6.3	2.2
Naduvattam		2.7	2.4	5 1	0.8	11.0	11 5	1.5
Nanjanad		2.2	1 5	2.4	0.7	6 8	7.6	4.1
Kadaithanal		0.9	0.6	0.2	0.3	2.0	2.9	19.5
Yercaud		1.1	0 7	2.8	0.3	4.9	4.8	1.4

Table 2. Relationship between various Fractions of soil Magnesium (linear and quadratic)

Relationships between X	Y	"r"	Regression equation	Number of pairs of value
Total Mg (summation) (me/100 g)	Exchangeable Mg (me/100 g)	0.657**	Y=0.45 x —1.633	147
Total Mg (summation) (me/100 g)	Organic-complexed Mg (me/100 g)	0.234**	Y=1.019 +0.09 x	147
Total Mg (summation) (me/100 g)	Acid soluble Mg (me/100 g)	0.525**	Y=0.017 +0.22 x	147
Total Mg (summation) (me/100 g)	Mineral Mg (me/100 g)	0.549**	Y=0.594 +0.24 x	147
Total Mg (summation) (me/100 g)	Ca/Mg (exchangeable)	—0.342**	Y=11.616 — 0.846 x	147
Total Mg (summation) (mc/100 g)	Mg ex as percentage of CEC	0.478**	Y 2.048 +3.319 x	147
Total Mg (estimation) (me/100 g)	Exchangeable Mg (me/100 g)	0.603**	Y=0.423 x — 1.491	147
Total Mg (estimation) (me/100 g)	Organic-complexed Mg (me/100 g)	0.220**	X=1.047 +0.085 x	147
Total Mg (estimation) (me/100 g)	Acid-soluble Mg (md/100 g)	0 485**	Y=0.065 +0.210 x	147
Total Mg (estimation) (me/100 g)	Mineral Mg (me/100 g)	0.607**	Y=0.316 +0.278 x	147
Total Mg (estimation) (me/100 g)	Total Mg (summation) (me/100 g)	0.973**	Y=1.001 x — 0.0097	147
Total Mg (estimation) (me/100 g)	Mg ex as percentage of CEC (me/100 g)	0.470**	Y=2.074 x — 3.679	147