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MAGNESIUM STATUS OF SOILS

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Abstract: The magnesium status of the soils of Kerala was studied. In general, they were deficient in total Mg reserves (61 per cent of the soils studied). Altogether, 17 per cent of the soils were deficient in available Mg and 25 per cent deficient in exchangeable Mg. Black soils were rather rich in total Mg, available Mg and exchangeable Mg. The most deficient were the sandy loam soils of coastal alluvium. The laterite group was in between. The inter-relationships among total, available and exchangeable Mg were found to be significant and positive. Exchangeable Mg correlated positively with other exchangeable cations. About 24 per cent of the total Mg reserve in the soils under study is considered available and 11 per cent exchangeable. The total Mg reserves in Kerala soils are found to be poor and Mg can be considered as a critical element in these acid soils.

Key words: Available magnesium, exchangeable magnesium, magnesium status

INTRODUCTION

The content of Mg in acid soils of India is low, varying from 0.1 to 1 per cent. A major portion of Kerala comprises of acid soils except a small patch of neutral to alkaline soils of Chittoor taluk of Palghat district. The availability of Mg has become very critical in the acid soils of Kerala, as Mg deficiency has been reported in many crops in this state. Limited information is available on the status of Mg in these soils except for the work of Venugopal and Koshy (1976). The present study was undertaken to assess the Mg status of different soils of Kerala.

MATERIALS AND METHODS

One hundred and fifty composite surface soil samples (0-15 cm) were collected from all over the state of Kerala, covering different districts for assuring wide variation in the content of available Mg and physico-chemical characteristics of the soil. The soil samples were grouped into three, based on the type of soil, to facilitate statistical analysis and interpretation. Group 1 included the red, laterite and brown hydromorphic soils. Group 2 consisted of coastal alluvium, riverine alluvium, Onattukara alluvium and acid-saline riverine alluvium of Kuttanad. The black soils formed group 3. Group 1 included 101 soil samples (red, laterite and brown hydromorphic soils). Group 2 (alluvium) contained 44 samples and Group 3 (black soils) contained 5 samples. The soils were analysed for organic carbon, pH, EC, CEC, total Mg, available Mg (0.0125 *M* $CaCl_2$), exchangeable Mg, exchangeable Ca, exchangeable K and exchangeable Na, making use of standard analytical procedures.

RESULTS AND DISCUSSION

Ranges of values of properties relating to the behaviour of Mg in soil groups selected for determination of Mg status are furnished in Table 1 and the mean values of these properties of the different groups are presented in Table 2. The soils were medium in their organic carbon content. Most of the soils were acidic, except the black soils which were alkaline. With the exception of black soils, all the soils exhibited low CEC and were poor in exchangeable bases.

A wide variation of 100 ppm to 10880 ppm in the content of total Mg was recorded in the soils selected for the study. The overall mean was 963.7 ppm. The total Mg content (mean) was maximum in black soils (5452 ppm) and minimum in alluvial soils (669.1 ppm).

In general, the soils of Kerala can be considered to be deficient in total Mg reserves. The mean content of total Mg of soils selected for the study was only 963.7 ppm which is less than even the lower limit of the normal range of total Mg in soil (1000 ppm) as suggested by Tisdale *et al.* (1985). Of the 150

Table 1. Range of values relating to the behaviour of Mg in different soil groups

Soil characteristics	Soil group		
	Red, laterite and brown hydro-morphic	Alluvium	Black
Organic C, %	0.03-2.52	0.03-4.23	0.27-1.35
PH	4.25-8.16	2.93-7.73	7.83-8.56
EC, dS m^{-1}	0.039-1.0	0.04-20.6	0.05-0.42
CEC, cmol(+) kg^{-1}	1.54-24.1	1.54-23.5	6.1-25.6
Total Mg, %	0.01-0.4	0.01-0.2	0.15-1.08
Av. Mg, ppm	26.1-758	13-1203	340-915
Exchangeable, cmol[+]kg^{-1}			
Ca	0.41-14.8	0.20-12.2	0.23-19.1
K	0.02-0.50	0.01-0.50	0.10-0.32
Na	0.01-0.31	0.01-0.29	0.12-0.25
Mg	0.08-3.26	0.08-8.16	2.85-9.39

soils selected, 61 per cent were found to be deficient with regard to the total Mg content in soil. This could be attributed to the following reasons: (1) Magnesium in soil originates from the decomposition of rocks containing primary minerals such as biotite, dolomite. hornblende, olivine, serpentine etc. The Mg released by the disintegration of these rocks is lost by leaching under humid tropical conditions. (2) Magnesium salts like epsotnite ($MgSO_4.7H_2O$), magnesium sulphate hexahydrate ($MgSO_4.6H_2O$), bloedite ($Na_2Mg[SO_4]_3.4H_2O$) are never stable under acid leaching situations and therefore are seldom met with in the acid soils of Kerala. (3) The soils of Kerala are predominantly kaolinitic in nature and therefore are deficient in Mg containing clay minerals like chlorite, illite, montmorillonite and vermiculite.

Only the black soils which are present in a small tract of Palghat district of the state are relatively rich in total Mg with the mean value of 5452 ppm. The soils of Kerala except the black soils are in general deficient in total Mg considering a threshold value of 0.1 per cent (1000 ppm).

The available Mg content of the soils selected for the study varied from 13.08 to 1203 ppm. The average content of available Mg in these soils was 231.9 ppm. The black soils contained the highest amount of available Mg (638.3 ppm) and alluvial soils showed the least (184.6 ppm). The laterite group was in between (231.9 ppm). When all the soils are considered, available Mg constituted 24% of the total Mg.

The relationship between available Mg and exchangeable Mg in the present study showed that in general, the content of available Mg is almost double the quantity of exchangeable Mg and therefore, a value of 50 ppm of available Mg can be considered as the critical value "for the humid tropical soils of Kerala. Accordingly it may be suggested that soils containing less than 50 ppm available Mg are considered deficient and those containing 50 to 100 ppm as marginal and more than 100 ppm as sufficient. A soil with more than 500 ppm available Mg can be taken as high or rich in available Mg. Adopting these criteria, 10 per cent of the soils in Group 1 and 34 per cent of the soils in Group 2 were deficient in available Mg. They together constituted 17 per cent of the total soils. In Group 1 soils, 14 per cent and in Group 2 soils, 16 per cent were marginal containing only 50 to 100 ppm of available Mg. All the black soils were sufficient in available Mg registering values higher than 100 ppm. More number of soils which are deficient in Mg were under Group 2 which mainly consisted of sandy loam soils of coastal alluvium with very little organic matter.

It was seen that soils selected for the study especially Group 1 and Group 2 were in general deficient in Mg reserves. But examination of the status of available Mg in soil shows that Mg deficiency in terms of available Mg values is not that much extensive. This is because, though these soils are poor in total Mg reserves, whatever Mg is present in soil becomes easily available due to its high solubility under acidic soil conditions.

The black soils are relatively rich in available Mg (340.1 to 915.6 ppm) because they contain

Table 2. Mean values of the properties relating to behaviour of Mg in different soil groups

Soil characteristics	Soil group			
	Red, laterite and brown hydro-morphic	Alluvium	Black	Over all mean
Organic C, %	1.012	0.705	0.690	0.911
pH	5.49	5.75	8.16	5.66
EC, dS m^{-1}	0..179	0.791	0.283	0.362
CEC, cmol(+)kg^{-1}	9.335	7.949	16.51	9.168
Total Mg, ppm	869.8	669.1	5452	963.7
Av. Mg, ppm	231.9	184.6	638.3	231.6
Exchangeable, cmol(+) kg^{-1}				
Ca	2.305	1.707	5.977	2.252
K	0.203	0.116	0.244	0.179
Na	0.031	0.036	0.165	0.037
Mg	0.785	0.716	4.896	0.902

higher amounts of total Mg. The dominant clay minerals in this type of soil are of 2:1 type which are rich in Mg, while the soils of Group 1 and 2 contain kaolinite as the most important clay mineral. Moreover, the neutral to alkaline reaction of black soils facilitates the formation and retention of Mg containing minerals.

The selected soil samples showed wide variation in exchangeable Mg from 0.082 to 9.383 cmol(+) kg^{-1}. The alluvial soils showed the lowest average exchangeable Mg content (0.716 cmol[+] kg^{-1}). The black soils showed the maximum content (4.896 cmol[+] kg^{-1}). The laterite group came in between. Soils of Group 1 and 2 in the present study manifested very low values of exchangeable Mg as coarse textured soils of humid regions are usually deficient in Mg due to excessive leaching. For such soils, Tisdale *et al.* (1985) coasidered a Mg level of less than 25 ppm as deficient. Assuming this threshold value of 25 ppm, 25 per cent of the total soils selected for the study were deficient in exchangeable Mg and another 25 per cent was marginal being within the range of 25 to 50 ppm. The remaining 50 per cent can be considered as sufficient in exchangeable Mg.

Exchangeable Mg formed the major portion of the available Mg pool of the soil. In general, exchangeable Mg constituted almost half of the available Mg content. The exchangeable Mg represented approximately 11 per cent of the total Mg when all the soils were considered. The inter-relationships among total, available and exchangeable Mg were found significant and positive. Exchangeable Mg was found positively correlated with other exchangeable cations.

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