CHEMISTRY AND TRANSFORMATIONS OF CALCIUM AND MAGNESIUM IN TROPICAL ACID SOILS OF KERALA

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ABSTRACT OF THE THESIS

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ABSTRACT

Calcium and magnesium are indispensible as secondary nutrients for plant growth. Availability of these nutrients to plants depends on the form and quantity present in soil. Soils of the tropics normally pose the problem of acidity due to high rainfall and leaching of bases causing widespread deficiency of these nutrients. The study aims at characterization of soil samples from 23 agro ecological units of Kerala with respect to supplying power, chemistry, dynamics, transformations and availability indices of calcium and magnesium and also to optimize the level of calcium and magnesium for rice nutrition in lateritic soils.

Sixty four representative soil samples from 23 agro ecological units under five agro ecological zones of the state were collected and characterised for physico-chemical properties. Among these soils, ninety two per cent were acidic in reaction, of which sixty three per cent were strongly to very strongly acidic (4.5-5.5). Lowlands of Kuttanad, Pokkali and Kaipad were extremely to ultra acidic. Twenty seven per cent of samples were deficient (< 300 mg kg\(^{-1}\)) in available calcium, while sixty seven per cent samples were deficient in available magnesium (< 120 mg kg\(^{-1}\)). Deficiency was negligible in soils from Attapady hills (AEU 18 and 19), Palakkad central and eastern plains (AEU 22 and 23) and the lowlands of Kuttanad, Pokkali, and Kaipad (AEU 4, 5 and 7). The availability of calcium and magnesium increased with pH, cation exchange capacity and decreased with increase in exchangeable aluminium. Forty one soil samples from different agro ecological units were subjected to sequential fractionation. The mean per cent contribution of different fractions to total calcium was in the order exchangeable > mineral > acid soluble > water soluble > organic complexed, whereas in the case of magnesium, it was observed as mineral > acid soluble > exchangeable > water soluble > organic-complexed. Exchangeable calcium and water soluble magnesium were the sole forms contributing directly to the available pool.

The quantity-intensity relationship of calcium and magnesium in twenty-three soils belonging to different AEU\s of Kerala were studied at 25°C and 40°C.
Potential buffering capacity or the supplying power of soil had significant positive correlation with CEC and exchangeable cations in soil. The adsorption data of both calcium and magnesium at 25°C and 40°C were best explained by Tempkin adsorption isotherm indicating that the affinity for adsorption decreases linearly with degree of saturation. The change in free energy of adsorption for calcium and magnesium was negative in all the soils studied signifying the spontaneous nature of adsorption. The change in enthalpy (ΔH°) was negative in most of the soils indicating the process to be exothermic. The close correlation of enthalpy change with change in entropy proved that as the enthalpy change becomes more negative, stronger is the bond and more orderly is the adsorption.

The incubation experiment conducted to study the effect of organic matter on the adsorption of calcium and magnesium revealed a positive influence of organic matter on availability of calcium and magnesium. The addition of organic matter improved the supplying power with respect to calcium and magnesium either through mineralization or formation of stable soluble complexes especially at higher pH.

Two field experiments to optimize the level of calcium and magnesium nutrition for rice in low land of north central laterites (Pattambi) revealed the clear role of calcium and magnesium in improving the yield and yield attributing characters of the crop. Application of dolomite as per ΔpH was found to be effective in increasing the yield and maintaining optimum level of calcium as well as magnesium in soil. Application of lime was not found to influence the in situ soil pH. The response of crop to magnesium showed yield improvement to the tune of 1.18 t ha⁻¹ by application of magnesium sulphate @ 120 kg ha⁻¹. Residual effect of dolomite had significant influence on the yield of rice whereas no residual effect of applied magnesium sulphate was evident. The correlation studies and path analysis clearly indicated that plant absorption of calcium mainly takes place from exchangeable fraction and that of magnesium from water soluble fraction.