SOIL ACIDITY AND ITS EFFECTS ON SOIL FERTILITY AND NUTRIENT UPTAKE

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Soil pH signifies the degree of acidity, alkalinity or the neutrality of a soil and is governed by the Hydrogen Ion Concentration in soil solution. It is expressed in a logarithamic form ($pH = -\log_{10} (H^+)$) and is measured using a glass - Calomel combine electrode. The pH scale ranges from 1 to 14 and a pH of 7.0 indicates neutrality. Values below 7 represents acidity and above 7 alkalinity. Thus lower the pH value greater the acidity.

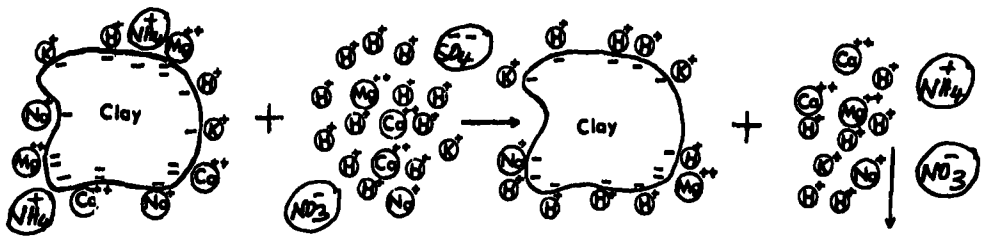
Implications of soil pH

Continuous use of high levels of ammonium fertilizers (ammonium sulphate) over the past few decades has resulted in the tea soils becoming more acidic and certain plantations are recording soil pH values as low as 3.8 and 3.7. Despite the high soil acidity, the nitrifying bacteria in tea soils oxidize the ammonium nitrogen (NH_4^+ - N) to nitrate nitrogen (NO_3^- - N), and the rate of nitrification increases with increase in pH. During this oxidation the ammonium N applied as fertilizer and/or that mineralized by the soil organic matter releases hydrogen ions to the soil.

$$NH_4^+ + 3(0) \xrightarrow[\text{bacteria}]{\text{Ammonium Oxidizing}} NO_2^- + H_2O + 2H^+$$

$$NO_2^- + (0) \xrightarrow[\text{bacteria}]{\text{Nitrite Oxidizing}} NO_3^-$$

The hydrogen ions released enhances the leaching of basic cations (K, Ca, Mg) with the percolating rain-waters making the already acidic soil more acidic. In addition to the nitrification induced soil acidity, in areas of heavy rainfall surface run-off and leaching losses of bases also contribute to soil acidity (due to the lowering of per cent base saturation).



Tropical soils that receive high rainfall (greater than about 20 to 30 inches) usually become acidic because of leaching of Ca, Mg and other bases. In this illustration, hydrogen in the soil solution replaces calcium and magnesium (which leach out) leaving a hydrogen saturated clay which is acidic.

Despite the fact that tea thrives in acid soils (pH 4.0 - 5.0) we have to be cautious when soil pH falls below 4.0 because at a soil pH of 3.9 and below degeneration of the clay minerals occur with the release of oxides of aluminium and silicon. This break down of the clay minerals directly affects the cation exchange capacity with the resultant poor nutrient retention in the soil and also leading further to soil compaction and poor aeration. The high acidity also results in the building up of high concentrations of aluminium, silicon, iron and manganese in the soil solution.

Iron and aluminium so released lead to an increased fixation of phosphorus as insoluble iron and aluminium phosphate. Although tea can tolerate very high concentrations of Al, Fe and Mn, under very acid conditions symptoms of

manganese toxicity have been observed which is rectified by correcting the soil pH by adding dolomite to the soil. At this stage we would like to add a word of caution to highlight the ill effects of high soil pHs. At higher soil pHs greater than 5.0, nitrification and denitrification processes are rapid which makes the applied fertilizers vulnerable to losses *via* denitrification (gaseous N_2O and N_2) and leaching of the resulting nitrate.

In view of the low soil pHs recorded (below pH 4.0) in certain tea plantations, and the consequent adverse effects on soil, the Institute is recommending two times the normal recommended application of dolomite (*ie.* for a four-year pruning cycle, 1000 kg dolomite/ha instead of 500 kg/ha) to such fields, to arrest acidification as an interim remedial measure. This should be followed up by monitoring the soil pHs of such fields until it is increased to about 4.5 and once this is achieved the normal recommended rate of dolomite application to be followed thereafter.

The application of dolomite helps to counteract the soil acidity by increasing the per cent base saturation with a concurrent decrease in per cent hydrogen saturation. In addition it also supplies the Ca and Mg requirement of the crop. It is very likely that the very acid soil pHs (<4.0) that are recorded in certain tea plantations could be due to the application of very high N levels as ammonium fertilizers and the omission or inadequate application of the recommended quantities of dolomite (125 kg/ha/year of the pruning cycle).