FERTILIZER NITROGEN UTILIZATION BY TEA

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Nitrogen is the most important fertilizer nutrient for tea. In tea, the vegetative portion of the crop harvested for tea manufacture (two leaves and the bud) contains as much as 3 to 4 per cent N. Thus, a substantial quantity of N is removed with each harvest (plucking). Hence, the availability of fertilizer N will markedly affect the tea yields.

It is universally accepted that fertilizers are essential for maintaining high yields of Agricultural crops. At present, 240-300 kg nitrogen ha^{-1} $year^{-1}$ is applied for high yielding tea. Fertilizer recommendations are based on net crop yield, and, for an average production of 200 million kg made tea, approximately 20 million kg nitrogen is applied. Unfortunately, the efficiency of utilization of applied fertilizer nitrogen is generally poor for most crops and, seldom exceeds 50 per cent; for tea, this could be as low as 35 to 40 per cent. This substantial inefficiency of use of N cannot be ignored, especially because of the high cost of nitrogenous fertilizers.

With the global energy crisis the cost of urea and ammonium sulphate fertilizers have increased by about 300 per cent and today we have to pay Rs 4.65 per kg N as Urea and Rs 15.95 per kg N as ammonium sulphate. The total cost on nitrogen alone amounts to Rs 93 million as urea and Rs 319 million as ammonium sulphate.

It has, therefore, become important to investigate the manner in which nitrogen is lost so that steps could be taken to minimize this and increase the efficiency of N utilization.

In Sri Lanka, tea is cultivated on hilly lands and the major tea growing areas in the country vary in elevation from about 300 m to 2200 m A.M.S.L. Most areas receive high rainfall (200-350 cm) during the south-west and north-east monsoons. Soils are mulched period-

ically (leaf matter from prunings) and the soil organic carbon in the 0-30 cm layer ranges from about 1 to 4 per cent depending on elevation and atmospheric temperature. Soils are acidic with pH ranging from 3.5 to 4.5 and are predominantly Kaolinitic with clay contents ranging from 45 to 55 per cent. Most soils are heavily leached and are poor in soil fertility. In addition, insufficient attention to soil conservation has led to many tea soils being highly eroded.

Nitrogen is applied to the soil almost exclusively as urea and ammonium sulphate. The urease present in the soil hydrolyses the urea to ammonium (NH_4^+). In spite of the high soil acidity, part of the NH_4^+ ions are rapidly oxidised to Nitrate (NO_3^-) by nitrifying bacteria present in tea soils. The conversion of NH_4^+ to NO_3^- (nitrification) is very rapid in tea soils and appreciable quantities of nitrate could be observed after about 7 to 10 days following fertilizer application. A tea soil would then contain N as both Ammonium and Nitrate ions.

The major causes of loss of added fertilizer N are:

1. Surface run-off
2. Leaching
3. Ammonia volatilization
4. Microbial immobilization
5. Denitrification

1. Surface run-off:

A serious loss, but could be prevented completely by proper management practices.

(a) Timing fertilizer application in relation to rainfall and avoiding heavy rains;
(b) Maintaining a good cover of tea and mulch on the soil surface so that raindrops do not directly beat the soil leading to soil erosion and surface run-off;
(c) Efficient drainage system to carry the excess water from the field with minimum soil erosion.

2. Leaching:

Most tea soils contain Kaolinite as the main clay mineral and have low cation exchange capacities *ie.* only a few sites are available for the exchange of positive ions such as H^+, NH_4^+, K^+, Ca^{++}, Mg^{++}, Al^{+3}, and Fe^{+3}. Therefore with the addition of ammonium fertilizers, the NH_4^+ ions are exchanged with the other cations such as K^{+4}, H^+, Mg^{++} and Ca^{++} at these exchange sites and retained. Thus, the chances of leaching of NH_4^+ ions beyond the root zone (0-40 cm) are rare. However, the nitrifying bacteria in these soils rapidly transform the NH_4^+ to NO_3^- and the nitrate thus formed is vulnerable to leaching and also denitrification. Leaching and denitrification are undesirable processes, because they cause loss of nitrogen, otherwise available for plant growth.

3. Ammonia volatilization:

Gaseous NH_3 losses from applied urea fertilizers could be completely controlled by ensuring uniform distribution of fertilizer, avoiding any lumps and timing fertilizer applications with rainfall.

4. Microbiology of soil nitrogen:

The numerous nitrogen transformation processes occurring in soil could be categorised into:

Ammonification
Immobilization
Nitrification
Denitrification

4.1 Ammonification (Mineralization of Organic - N)

Most of the nitrogen in plants and animals is contained in the proteins. After death these are decomposed by micro-organisms to yield amino acids which on further decomposition lead to the formation of some ammonium nitrogen. This process is called Ammonification and many types of organisms including Fungi take part.

4.2 Immobilization

The decomposition of organic matter in most instances releases very little ammonium which is inadequate to satisfy the needs of the micro-organisms. Then extra N is needed to ensure complete decomposition of the organic matter and the inorganic nitrogen in the soil or fertilizer nitrogen is used, thus immobilizing temporarily the nitrogen available to the plant.

4.3 Nitrification

The process of oxidation of NH_4^+ to NO_3^- in soil is referred to as nitrification. This oxidation is a two stage process brought about by two groups of bacteria known as nitrifiers. One group oxidising ammonium to nitrate, and the second group oxidising the nitrite to nitrate. Generally both types of nitrifiers are present in soil and so nitrite rarely accumulates.

5. Denitrification:

A process during which denitrifying bacteria under O_2 stress (anaerobiosis in the soil) reduces the NO_3^- nitrogen in the soil to gaseous N_2O and N_2 which is lost to the atmosphere thus making the NO_3^- unavailable to the plant. Denitrification is therefore an undesirable process in agriculture and should be controlled and prevented wherever possible by proper fertilizer and soil management practices. The fact that only nitrate ions are subjected to denitrification, but not the ammonium ions, should be taken into consideration in formulating fertilizer recommendations. Hence with the exclusive use of ammonium fertilizers, urea and sulphate of ammonia, denitrification losses can be controlled to a large extent because the added NH_4^+ fertilizers have to be first transformed to the nitrate, by the nitrifying bacteria, which usually takes a minimum of 10 to 12 days, before any denitrification can occur.

Furthermore we have also observed that denitrification losses in tea soils are confined to the surface soil (0-15 cm depth) and losses are negligible in the sub soil (30 cm and below). Therefore the Institute's recommendation of ammonium-N (urea and ammonium sulphate)

instead of Nitrate-N (Calcium ammonium nitrate) for tea plantations is well founded.