A TALK GIVEN TO THE MORAWAK KORALE PLANTERS' ASSOCIATION ON 31st JULY, 1954

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In my talk on manuring at the last Conference I compared manuring to the process of paying into a current account at the bank. I made the point that payments into the account should be deposited at regular intervals and that they should be sufficient in amount to cover the maximum probable withdrawals.

During periods of vigorous growth i.e. rushes of crop, the available nutrients must be present in sufficient amounts to allow the bushes to make the most of the favourable periods of growth. There is no certainty that the soil bank will allow an overdraft.

It must be realised that manuring does not force crop. It only allows the bush to continue growing at the maximum possible rate when sunshine, warmth and moisture conditions are forcing. Growth must be active before nutrients can be taken up from the soil—the egg comes before the chicken. You can only *limit* the crop—by withholding nutrients, or by over-plucking ; that is to say, by removing too many leaves which are the lungs of the plant. Ninety per cent. of the crop is manufactured from carbon dioxide and water and no amount of manuring can compensate for over-plucking.

Another fallacy of which I must dispose is that phosphate makes root, potash wood and nitrogen leaf, and that you can increase wood or root growth by changing manurial mixtures. This is nonsense : you can only *upset* growth by supplying unbalanced manures.

The purpose of manuring is, therefore, simple and clear, and is to ensure that there is always enough nitrogen, phosphate, potash and other minor and trace elements to support the demand when growth is most rapid. There must always be a healthy balance in the nutrient bank.

So far I have done little more than summarise my remarks at the Conference. Today I propose to say more about the banking system for nutrients. Sulphate of ammonia and potash do not merely lie in the soil until they are wanted, nor do they wash out with the first shower of rain. Soil is far more complicated than a mere mixture of mineral particles of various sizes. It is to all intents and purposes a living thing—it breathes, feeds, excretes and one might almost say reproduces.

Clay and organic matter both possess a property known as base exchange capacity. As soon as highly soluble salts such as sulphate of ammonia and potash are dissolved by rain or soil moisture and come into contact with particles of clay and organic matter, the ammonia and potash are firmly held and the sulphate and muriate (chloride) pass on in the drainage water. The capacity for holding ammonia, potash, magnesium, lime, etc. is a characteristic of a soil and can be measured.

Once these nutrients have come through the base exchange process they are very resistant to leaching but are available to the plant when required. There is, therefore, no need to worry unduly about loss of manure by leaching even in a district where rainfall is heavy. The phosphate in saphosphosphate is of course insoluble in water. It is slowly dissolved by the soil acids and possibly by acids excreted by plant roots. The phosphate dissolved by the soil is held by the clay to some extent, probably in association with iron and aluminium, but I don't want to become too technical. I can assure you that if you supply the nutrients the soil is well able to look after them so long as it is in good condition. It is important, however, that there should be at least light rain after manuring and that the manure should be scuffled in so that the nutrients get down below the surface subject to alternate wetting and drying. The stored potash and phosphate are liable to undergo changes which spoil their nutrient value if the soil is dried out.

The phosphate and potash stored in the soil are ready for use when required by the plant, but the ammonia has to undergo further changes. Recent work at the Tea Research Institute indicates that tea cannot use ammonium ions directly in the way some plants, for instance paddy, can. Ammonium ions held by the clay and organic matter have to be oxidised by bacteria first to nitrite and then almost immediately to nitrate. Nitrate is not held by the soil and washes out very easily, and this is why we recommend the application of nitrogen in the form of sulphate of ammonia rather than as nitrate.

It is important, therefore, that the stores of ammonium ions should be adequate so that a steady supply of nitrate is made available by bacterial action. It is probable that the rate of nitrification is highest when the stocks of ammonium ions are high. This is the case in most soils, and we expect it will prove to be the case in tea soils. We are at present engaged in studies of the rate of nitrification. At the high soil temperatures usual in the low-country the rate of nitrification appears to be plenty high enough, but in some up-country areas, where the soil temperatures are much lower, there are some indications that the rate of nitrification may be too slow. We are, in fact, exploring possible means for increasing the rate of nitrification where it is very low.

Apart from warmth, nitrifying bacteria require a good supply of calcium, phosphates and proper balance of the trace elements iron, copper and zinc. There is an abundance of iron and manganese in all our soils. We have also investigated the copper and zinc status of Ceylon soils and it appears to be adequate. In fact we are indebted to Mr. Fernando for carrying out some experiments with zinc sprays on Enselwatte Estate. The calcium status of our Ceylon soils is, however, low and the calcium phosphate of saphosphosphate is, for this reason, undoubtedly an important constituent of TRI-500. It is, therefore, necessary, when formulating a manure mixture, to take into account factors other than the simple requirements of nitrogen, phosphate and potash, for they are by no means the only minerals which may be needed by the plant or the soil. Recent analyses of leaf from our manurial experiments indicate that tea has a marked requirement for calcium. Although tea will not grow in calcareous soils, (soils rich in lime), the element is undoubtedly essential for growth. Tea leaf contains as much, sometimes more, calcium than phosphate, and the composition of the minerals in the leaf; from plots receiving a wide range of different manurial treatments, reflects the amount of calcium added as calcium phosphate. Calcium and magnesium requirements are closely linked with potash requirements and may to a limited extent act as substitutes for potash or, perhaps it would be better to say, as potash economisers.

One of the difficulties of research on the mineral needs of plants is that they may take up more of the easily available minerals then they need. Unlike animals, plants lack the power of excretion and may accumulate considerable quantities of minerals in their tissues. The total amount of any particular mineral is, therefore, not necessarily a measure of its importance. Generally speaking, plants require comparatively large amounts of nitrogen, phosphate, potash, calcium, magnesium, iron, manganese, aluminium, sulphur and other similar elements. The general practice is to refer to these elements apart from nitrogen, phosphate and potash (abbreviated NPK) as minor elements. The most minute quantities of other elements such as boron and molybdenum may, however, be equally essential, and growth will fail without them. As a parallel illustration I give the example of the amount of platinum in your car. It is very small by comparison of the amount of iron, aluminium, (and perhaps chromium in the form of plating), but unless there is sufficient platinum on the contact breakers and plug points, the car will not work. Such elements are generally referred to as trace elements, and include copper and zinc, which are present in Ceylon tea in unusually large amounts compared to other plants. Copper is known to be essential for proper fermentation of tea.

Saphosphosphate and muriate of potash recommended in TRI-500 are quite important sources of minor and trace elements. Saphosphosphate, for example, contains 48 per cent. of lime, 0.85 per cent. of magnesium, 0.2 per cent of zinc and 0.013 per cent. of copper. Muriate of potash contains up to 0.8 per cent. of magnesium. Both saphosphosphate and muriate of potash contain a wide variety of trace elements. So far as we are aware, therefore, TRI-500 contains all the mineral nutrients required by tea. The proportions of nitrogen, phosphate and potash, and the amounts recommended for application at different crop levels are based on 25 years' of field experiments. It is possible that in future we may recommend variations for different districts and elevations, but at the present moment TRI-500 is the best informed guess we can make at the correct mixture for tea, and I frankly doubt whether anyone, who has not studied the subject in such great detail as we have at the Tea Research Institute, can do any better.