THE CHEMICAL COMPOSITION OF RUBBER TREES, IN RELATION TO PROBLEMS OF NUTRITION AND MANURING

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In the preceding paper Dyck has presented the results of the chemical analysis of a mature tree of *Hevea brasiliensis,* showing the distribution of the main nutrient elements derived from the soil, among the various parts of that tree.

Dyck's results for the content of nutrient elements in the leaves and leaf-stalks of the tree, if expressed on the acre-basis, assuming a stand of 100 trees per acre, are:—

Nitrogen (N)	420	lb.
Phosphoric acid (P_2O_5)	59	,,
Potash (K_2O)	193	,,
Calcium oxide (CaO)	329	,,
Magnesium oxide (MgO)	119	,,
Manganese dioxide (MnO_2) ...	6	,,
Sodium oxide (Na_2O)	0.4	,,

These represent surprisingly large amounts, especially if stated in terms of the weights of commercial fertilisers to which they correspond. For example, the amounts of nitrogen, phosphoric acid and potash correspond to the following dressings of fertilisers:— sulphate of ammonia, 19½ cwt.; rock phosphate, 1½—2 cwt.; sulphate of potash, 3½ cwt. Dyck has pointed out however, that the leaves, at the time of the annual leaf-fall, may contain much smaller amounts of mineral nutrients than they did in the fresh green condition in which they were collected for his analyses. It is doubtful, however, whether this applies equally to the nitrogen content of the leaves, which may be of the same order when they are shed, as it is when they are green.

The mineral nutrients are not subject to loss into the air in gaseous or volatile form, so that the actual amount of them in the leaf-fall is of secondary importance in its bearing on manuring problems. Provided that ground cover conditions are such that the leaf-fall is retained and not allowed to wash or blow away, the minerals in the leaf-fall will ultimately find their way back into the soil and thus complete without appreciable loss the cycle: absorption from soil by roots → translocation to leaves → fall of leaves to soil.

The position regarding nitrogen is, however, quite different. Even if the fallen leaves became immediately incorporated in the soil, some of their contained nitrogen would probably be lost either into the air or in drainage. Actually, however, most of the leaves decompose on or above the surface of the soil, not in it; under these conditions it is certain that, during their decomposition, much of the nitrogen contained in them will be dissipated into the air and so lost. If, as seems not unlikely, in contrast to what obtains for the mineral elements, much of the nitrogen present in the green leaves remains in the leaves when they are shed, it is clear that there would be a serious leak in the cycle of nitrogen from soil to tree and back. For example, if the leaf-fall contained the amount of nitrogen shown above, and if only one-fifth of this were lost into the air (and in drainage) at the annual leaf-fall, this would correspond to the amount of nitrogen in an annual dressing of about four cwt. of sulphate of ammonia per acre. It is known that the amount of nitrogen removed annually in latex, as a result of tapping, is relatively negligible; it is of no practical account in relation to the nitrogen economy of the mature Hevea tree. These results, however, show that the nitrogen losses associated with the annual leaf-fall, on the other hand, may be quite sufficient to account for the important part which nitrogen-supply has been found to play in the maintenance of healthy stands of Hevea. The further experimental study of this matter is of considerable practical importance in relation to the manuring of Hevea.

In spite of the facts that, in the case of the mineral cycle, there is no serious depletion as a result of removal of latex in tapping nor any reason to expect serious leakage as a result of the leaf-fall, the growth of rubber trees is nevertheless found to be accompanied by marked depletion of mineral element, notably phosphorus, from many Malayan soils. In this connection it is important to remember that, so long as the trees are standing, the soil has been deprived of the whole of the amount of mineral elements which are locked up in the tissues of the trees. Moreover, when these trees are felled, the manner of their disposal may have a marked influence on the mineral economy of the soil. If the burning or rotting of the trees is so managed that the minerals released in the form of ash or otherwise are evenly distributed and find their way back into the soil, the return to the soil of phosphoric acid, potash and lime would, on the basis of Dyck's analyses and assuming a stand of 100 trees per acre, be equivalent in value to about one ton rock phosphate, 3½ tons sulphate of potash and 4½ tons limestone. If, however, the ash is allowed to wash away, or is very unevenly distributed, or if the timber is removed from the land, the loss to the soil may be serious. For example, on the above basis, if the stem and only the main branches are removed as timber, the loss would correspond to about one-half of the above amounts of rock phosphate, of sulphate of potash, and of limestone, *i.e.* ½ ton, 1¾ tons and 2¼ tons per acre respectively. Such factors must be included in any calculation of the economics of the sale of rubber timber as firewood off the estate. Of course, if it is used as fuel for the smoke-house, and if the smoke-house ash is suitably conserved and returned to the land, there will be little serious loss.

The nitrogen contained, per acre, in the tissues of the trees at a stand of 100 per acre, on the above basis, corresponds to that in no less than nearly eight tons of sulphate of ammonia. If the trees are burnt, either on or off the land, all this nitrogen is lost into the atmosphere. A substantial part of it is similarly lost even when the timber and debris are allowed to rot. It is not surprising, therefore, that nitrogen supply, by manuring or otherwise, is of paramount importance in the growth of the rubber tree, and that nitrogenous manuring, and the growth of leguminous covers, are vital factors in replanting programmes on most Malayan soils.

Since the above considerations are based on the analysis of only a single tree, too much weight must not be given to the actual amounts of nutrients, and of corresponding fertilisers, which have been cited. Further information is needed, from the analyses of other trees growing in other soils and situations. Notwithstanding this, it is reasonably certain that the variations in analysis that such further work will reveal, though they will probably be considerable, will not be so great as to invalidate the general conclusions here drawn, and that the amounts of nutrients and fertilisers involved will prove to be of the same order as those given in this note.

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