

INTRODUCTION

The nutrient elements contained in fertilizers added to the soil may be washed away by surface run-off, leached out of the soil, lost in a gaseous form, or retained in the soil. Those elements held in the soil may remain soluble and easily available to plants or may become difficultly soluble and only very slowly available. These phenomena have been widely studied in the field and laboratory, with particular emphasis on the major elements nitrogen, phosphorus and potassium.

A survey of the literature was made before commencing this study. Experimental work on the fate of fertilisers added to the soil has been done in various ways, for example with lysimeters in the open under natural or artificial rainfall; using columns of soil in the laboratory; or by studies of the movement and retention of added nutrients in the undisturbed profile, either uncropped or in field fertiliser experiments. Recently radioactive isotopes of phosphorus and calcium have been used to trace the movement of these nutrients in the soil, and also to trace the uptake by plants. Fixation, or the retention of plant nutrients in the soil in a form unavailable to plants, has been particularly studied, especially the fixation of phosphorus and potassium. Loss of nitrogen in a gaseous form - for example as nitrous oxide - has also been studied, and recently with the use of infrared techniques to detect the nitrous oxide.

It does not seem relevant to the present work to recount the detailed results obtained by the very many investigators who have made this type of study, since the detailed results apply only to the particular soil used in the investigation. It is more valuable to note certain generalisations that may be made. Nitrates are liable to be lost rapidly by leaching under heavy rainfalls, but may accumulate in the soil under dry conditions. Ammonium ions are readily adsorbed by soil colloids and rather slowly lost by leaching, but are usually rapidly converted to nitrates and thus soon leached out if under high rainfall. Potassium is adsorbed by soil colloids and only very slowly leached away, and a large part of the absorbed potassium is easily available to plants. Phosphate ions are not readily leached away, but in some soils are particularly liable to be held in the soil in unavailable forms. When ammonium and potassium ions are adsorbed by the soil colloids, considerable quantities of calcium and magnesium may be

displaced and lost by leaching. In the case of ammonium ions, the subsequent nitrification causes adsorbed ammonium ions to be replaced by hydrogen ions thus lowering the pH of the soil. The degree to which the phenomena occur will depend upon the colloidality of the particular soil. For example adsorption of ammonium ions will be greater in the more highly colloidal soils, but the lowering of pH consequent upon displacement of calcium and magnesium ions will be more pronounced on the less highly colloidal and thus less buffered soils.

The present work describes a study of the fate of fertilisers applied to the soil in a long-term field fertiliser experiment on cacao in the wet tropics. The main object is to obtain data which will aid in the interpretation of the behavior of the cacao under the various fertiliser treatments.

The cacao field experiment was planted at River Estate, Trinidad, in 1949. It consists of a 2^5 factorial layout comparing at two levels the five factors nitrogen, phosphorus and potassium fertilisers; overhead shade trees; and the spacing of the cacao trees. The background and layout of the experiment have been described in detail elsewhere (Havord, 1952), and the early yield results have been reported (Havord *et. al.*, 1954, 1955).

The investigation consisted of four main parts:

- (1) A laboratory experiment to study the loss of nutrient elements and the amounts remaining in the soil after prolonged leaching of columns of fertilised soil:
- (2) A field experiment to study the rate of movement of nutrient elements down the natural undisturbed soil profile:
- (3) A field study of the residual quantities of nutrient elements in the soil of the cacao fertiliser experiment after seven years of annual fertiliser applications:
- (4) An incubation experiment to study the effect of added phosphate fertiliser on the nitrification of added ammonium sulphate.