A LABORATORY METHOD FOR THE EVALUATION OF NUTRIENT RESIDUES IN SOILS

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Nutrient uptake by crops removes preferentially the more readily labile nutrient from a soil, which leaves the soil in a 'meta-stable equilibrium' if the very labile pool is depleted more rapidly than nutrient is transferred to it from the labile or non-labile fractions. After standing long enough, a moist depleted soil re-establishes a stable equilibrium between the labile and non-labile parts of the soil nutrient. These can be measured (e.g. the fraction $P_{\text{rapid}}$, $P_{\text{slow}}$ and $P_{\text{non-exchangeable}}$ for phosphate ions), by analysing the rate of isotopic exchange of the nutrient ion in soil into its different rate components. The rate at which a new stable equilibrium is attained depends on the water content of the soil, its temperature, the diffusion path-length between adsorption sites and, finally and possibly most significantly, the nature of the originally non-labile nutrient reserves. Such reserves, including those in organic compounds, release nutrients by dissolving slowly and so enabling the soil to move towards a stable equilibrium during cropping. The breakdown of organic reserves is by soil enzymes and bacteria and of inorganic reserves in part by contact with added acidic fertilisers. The new stable equilibrium of the cropped soil will differ significantly from that of the original soil only if more than a critical amount of nutrient is removed from the soil by 'cropping'. The nutrient status of a soil is in 'stable equilibrium' when the ratio labile/non-labile nutrient fractions does not change with time.

The experiment below illustrates this process and suggests a simple laboratory procedure for measuring the extent to which non-

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labile nutrient reserves in a soil can restore a given loss of the labile nutrient, the rate at which they can do so, and the maximum amount of nutrient that can be removed from the soil without lowering its equilibrium nutrient status.

MATERIALS AND METHODS

Materials

The two soils used were from a long-term fertiliser experiment on arable land at the Coffee Research Station, Mysore State, South India in the Western Ghats region, 3000 feet above sea-level. The soils are heavy (45% clay) and their surface is covered with rotting organic litter; the organic matter content to 6 inches deep was about 3%, at the time of sampling (1960). Arabica coffee is grown continuously; half-yearly dressings applied to the manured plots (Soil D) were of bone meal between 1939-1950 and of ground mineral phosphate from 1951 onwards. Soil E is unmanured.

Procedure

The soils were extracted for 1 and 4 days using an anion exchange resin (Amberlite IRA 400, chloride form (AER)) with and without a cation exchange resin (Zeokarb 225 (CER)) by a modification of a procedure described elsewhere. The resins were packed loosely in a fine-mesh nylon cloth bag to minimise both abrasive degradation of resin by soil and contamination of the soil by the resin and then shaken for different times with soil suspensions at 25 ± 1°C. The extracted soils were air-dried and passed through a 40 mesh sieve. The soils were also cropped with Italian ryegrass in pots, and 2 cuts were taken in 2 months. The resin-extracted soils, together with the original soils, were incubated at 25°C ± 1°C and 25% water content aerobically for 8 weeks. Periodically, the isotopically exchangeable phosphate \( P_e \) and the phosphate concentrations in the equilibrium solution \( P_{soln} \) of the incubated soils were measured in sub-samples suspended in 0.02M KCl.

RESULTS AND DISCUSSION

Compared with many tropical soils, both these soils are rich in phosphate; Soil D has large residues from mineral phosphate and bone meal dressings. The \( P_e \)-values of the unextracted soils on incubating for various periods up to 8 weeks decreased (more sharply in the unmanured Soil E) showing that they were not in equilibrium; to allow for this, correction factors \( K_t \) were calculated for each period of incubation from \( K_t = (P_e)_0/(P_e)_t \) (suffixes signify time of incubation). ‘Corrected’ \( P_e \)-values of the resin-