POTASSIUM FIXATION IN SOILS IN REPLACEABLE AND NONREPLACEABLE FORMS IN RELATION TO CHEMICAL REACTIONS IN THE SOIL

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In previous articles (4, 5), two of the authors have reported results of long-time cropping experiments on the availability of potassium to growing plants with special reference to evidence on replaceable, nonreplaceable, and soil solution potassium. Emphasis was given to the view that some soils have the power to fix relatively large amounts of potassium in nonreplaceable form, but that some forms of nonreplaceable potassium may be capable of long-continued ability to supply potassium absorbable by the roots. A group of California soils was studied which presented markedly different potassium-supplying power. Some of them gave evidence from field experiments of deficiencies in this power. Those studies have been continued as opportunity offered by controlled cropping experiments and by chemical procedures applied to the soils in the laboratory. The present report is chiefly concerned with the chemical reactions observed in the laboratory when potassium salts were applied to the soil. A later report will discuss further the effects of cropping and addition of organic matter on potassium availability.

No adequate theory for the mechanisms involved in potassium fixation can be proposed at the present time, but certain of the data to be presented will require explanation in any theories that may be ultimately formulated. The data also have interest in that results on semi-arid soils are presented, while most of the data now available are largely based on soils from humid regions.

EQUIVALENT DISPLACEMENT OF OTHER CATIONS DURING FIXATION OF POTASSIUM IN REPLACEABLE AND NONREPLACEABLE FORMS

In the extensive literature consulted on potassium fixation by soils, detailed quantitative data on the displacement of other cations during the processes are lacking. It seems essential to learn, however, to what extent potassium fixation (in both replaceable and nonreplaceable form) is accompanied by equivalent displacement of other cations. The determination of water-soluble cations, replaceable cations were estimated by subtracting water-soluble cations from the ammonium acetate-soluble cations. The following general technique was utilized.

Two soils, Vina clay loam (soil No. 77) and Mono loam (soil No. 95), of quite different characteristics but each known to be capable of fixing potassium in nonreplaceable form, were utilized for a preliminary experiment in which the ammonium acetate extracts of the soils with and without potassium treatment were analyzed. The values obtained are shown in Table 1. There is a close quantitative agreement in the total amounts of Ca, Na extracted by the ammonium acetate reagent from the treated and from the untreated soils on the basis of these data it has been assumed, that calculations of adsorbed cations (replaceable by NH₄⁺) may be made by subtraction of those found in the equilibrium water extracts from those established with ammonium acetate.

The two soils referred to above were subjected to a series of treatments with different amounts of KCl and the resulting partition of the water-soluble and the replaceable cations determined. The potassium fixed in nonreplaceable cations in each instance is the sum of the ammonium extractable potassium in the untreated soil and the added potassium less that found in the ammonium acetate extract of the treated soil. The values obtained are shown in Table 2 and in Figs. 1 and 3.

Considering first soil No. 95, a soil of quite low colloid content but of high capacity to fix potassium in nonreplaceable form, Fig. 3 shows...