THE ROLE OF IRON AND ALUMINUM IN THE RETENTION OF PHOSPHATES
BY SOILS AS INDICATED BY THE SOLUBILITY OF PHOSPHORUS

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The retention of phosphates by soils has for many years been attributed in part, at least, to the effect of iron and aluminum contained in the soil. This fixation has frequently been described, particularly at acid reactions, as being a chemical combination of the phosphate with iron and aluminum to form insoluble iron and aluminum phosphates. Other principles of fixations by which the retention of phosphates by soils may be in part explained have been contributed by studies of colloidal chemistry. Some investigations (1, 6, 7) have yielded data which indicated that fixation may be largely accounted for on the basis of colloidal absorption or anionic replacement on the surface of the colloidal particles. At the same time there have been reported experiments (3, 5) that show that iron or aluminum markedly affects the solubility of phosphates when applied to soils. However, the manner in which the iron and aluminum are effective in holding the phosphorus is an unsolved problem.

It was found from previously reported data (4) that the nature and solubility of the compounds formed by phosphates with iron and aluminum in the soil may be obscured by using extracting acids of two much strength. It seemed likely that data obtained by successive extractions of phosphates beginning with weak acids would throw some light on the manner in which phosphates are held by iron and aluminum.

EXPERIMENTAL PROCEDURE AND METHODS

The experimental method used by Bradfield and Allison (2) for obtaining equilibria in soil-Ca(OH)₂-H₂O-air systems was used. Satisfactory equilibria simulating natural conditions are obtained in a short time by this method. In addition, data can be obtained over a variable pH range with reagents similar to the materials commonly used for field applications.

The soil, the treatments used, and the procedure followed have been described previously (4).

The successive extractions of phosphate with acids of increasing strength, the results of which are reported herein, were made after the samples had been stored in an air-dry condition for a period of 8 to 10 months. The slight reversion of phosphates to less soluble forms, which was observed to occur (4) for a time after treatment, had practically ceased.

In making the successive extractions of phosphates from the soil, the following extracting reagents were used: (a) Distilled H₂O with CO₂ bubbled through the suspension for one hour; (b) 0.002 N H₂SO₄ containing 3.0 grams (NH₄)₂SO₄ per liter; and (c) 0.1 N H₂SO₄. Two-gram samples of soil in 400 ml of extractant were used in every case. The CO₂-saturated water extract was made in Squibb separatory funnels. After filtration the sample and filter paper were returned to the same flasks and shaken for 3 hours. The phosphorus content of the filtrates was determined by the modified Deniges method (9).

EXPERIMENTAL RESULTS

The relation of water-soluble phosphorus to soil reaction are shown in Fig. 1.

These curves show that water-soluble phosphorus was greatly decreased by the added ferric and alumina chloride. The amounts of water-soluble phosphorus in the aluminum series tended to be those of comparable samples of the iron series. It does not seem that this effect could be attributed to differences in degree of acidity since the reactions of the iron series with but a single exception were as low or lower, in pH, than were the reactions of the alumina series.

PHOSPHORUS SOLUBLE IN CO₂-SATURATED H₂O

The amounts of phosphorus dissolved in CO₂-saturated aspirated water are given in Table 1 and their relation to soil reaction are shown in Fig. 2.

The curves showing the relation of the amount of phosphorus dissolved to soil reaction are quite similar for the iron and aluminum series. The pH