THE EFFECT OF PHOSPHATE WITHDRAWAL BY PLANT AND BY AN ANION-EXCHANGE RESIN ON THE PHOSPHATE POTENTIAL OF A SOIL

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SUMMARY

Varying degrees of phosphate depletion by plants and AER were brought about in two acid soils. After depletion, the monocalcium phosphate potential was determined in soil suspended in dilute CaCl₂ solution.

The results showed that phosphate depletion either by plants or AER did not change the phosphate potential of a soil. It seemed that some of the labile phosphate removed by plants was replaced by a mobilization of non-labile soil phosphate fraction in the soil.

The constancy of the phosphate potential indicated that the concentration of phosphate in the soil solution was controlled by the solubility of sparingly soluble soil phosphates. The data implied that it was the solubility of hydroxyapatite which determined the phosphate potential of both soils.

INTRODUCTION

The removal of phosphate from soil by plants or by an anion exchange resin (AER) involves the following processes:

\[
P \text{ (solid)} \xrightarrow{\text{Labile P}} P \text{ (solution)} \rightarrow P \text{ (plant or resin)}
\]

Non-labile P Labile P

Due to the minute concentration of phosphate in the soil solution the bulk of the phosphate taken up by the plant must come from phosphates adsorbed to soil particles and by dissolution of sparingly soluble phosphate salts in the soil. These are the two possible

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mechanisms which are responsible for replenishing the soil solution with phosphate. The desorption process must, by necessity decrease the chemical potential while the dissolution process will not if one crystalline phase is controlling the chemical potential throughout the period of plant growth.

In the present study an attempt was made to test the above assumption.

MATERIALS AND METHODS

Two acid sandy loam soils were used. Some of their properties are given in Table 1.

Varying degrees of phosphate depletion of the soils by plants were brought about by varying the amount of soil in the cylindrical containers used for growing a ryegrass crop. The containers were 40 cm tall and had a cross section of 500 cm², i.e. a volume of 20 liters. The soil was placed on the top of quartz sand. The depth of the soil varied from 5 to 30 cm and the amount of sand was adjusted to give a total column height of 35 cm. Ryegrass seeds were sown on the soil surface and covered with a 1-cm sand layer. The water content was kept at field capacity during the growing period. A solution of ammonium nitrate was added before sowing and after each cut in order to ensure an adequate supply of nitrogen. No other nutrient salts were added.

A total of five cuts was taken and dry matter and phosphorus content of each cut were determined. After the last cut, samples of the soil were taken.

The monocalcium phosphate potential (0.5 pCa + pH₂PO₄) was determined in soil after each level of P removal by plants. Ten grams soil was suspended in 50 ml 0.001 M CaCl₂. A few drops of chloroform were added to the suspension in order to inhibit microbial activity. The soil suspension was shaken for one week, which period had previously been found to be adequate for attainment of apparent phosphate equilibrium in the system. After shaking, pH was measured in the suspension, and the phosphate concentration in the filtrate was determined by the method of Murphy and Riley.

TABLE 1

<table>
<thead>
<tr>
<th>Soil</th>
<th>Mechanical analysis</th>
<th>pH*</th>
<th>OM %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sand</td>
<td>Silt</td>
<td>Clay</td>
</tr>
<tr>
<td>1</td>
<td>70.0</td>
<td>14.3</td>
<td>13.1</td>
</tr>
<tr>
<td>2</td>
<td>65.1</td>
<td>16.8</td>
<td>16.0</td>
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</tbody>
</table>

* measured in 0.01 M CaCl₂ solution.