RELEASE OF P ADSORBED BY SOME SOILS OF SEMI-ARID REGIONS IN THE SARAGOSSA PROVINCE (SPAIN)

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Abstract
This is a brief study about the P adsorbed by 5 soils of Saragossa province according to the amount of this nutrient released through a desorption process which was produced by using a laboratory procedure consisting of fourteen water extractions or by the acting of 0.01 N calcium chloride solution. The soils examined showed a different behaviour with respect to P-desorption ranging from 55 to 84% (water extraction). These properties have to be considered when P-fertilizers are applied under irrigation conditions.

Introduction
Nutrient uptake by plants depends on the requirement of each species as well as on the nutrient concentration in the soil solution. In the case of phosphorus, it is well known that the concentration of this nutrient ranges from 0.7 to 4 x 10^-6 M in virgin and agricultural soils [BARBER et al., 1963; FRIED-BEOHARD, 1967]. For that reason many of them do not offer the necessary conditions and requirements to satisfy the P-demand of crops.

Phosphorus, added to a soil, reacts outright with soil constituents in a way which can be described in the following scheme proposed by TALIBUDEEN (1972).

There are two types of reactions, one quick and another slow, the former being described by the Langmuir isotherm indicating that the nature of it can be an adsorption process. In soils of Saragossa province, a variation of this P adsorption has been proved, and the existence of a close ratio between the P value and the clay and lime contents of these soils established [HANATIAUX and ELEIZALDE, 1977].

Before the maximum P adsorption is reached, a second, very slow reaction starts, in which a portion of P adsorbed can be transformed to some fixed forms. This process is regulated by the principles of solubility.

When a plant is growing, it uptakes phosphorus from the soil solution and lowers the level of its P-concentration. As a consequence, the aforesaid equilibrium is shifted to the left side. That means that phosphorus adsorbed by the soil constituents must be transferred to the soil solution.

Following the ideas of some soil scientists [FOXKAMPRATH, 1970; KHASAWNETH-COPELAND, 1973; SYERS et al., 1970] about the desorption of P from the adsorption complex, it has been found that some soils of the semi-arid region of Saragossa province can be characterized by specific differences in their P-dynamics related to P-adsorption as well as capacity of P-release.

Taking into account these characteristics which well define the P-behaviour of soils related to their fertility, we attempted in a brief study to show this varied release of adsorbed P by some soils of the Saragossa province.

Material and methods

The arable layers of five different soil groups of Saragossa province were used, the properties of which have been described in detail in a former publication [ELEIZALDE, 1976].

2.5 g of soil, sieved through 1 mm, was brought into a centrifuge tube [100 ml] and 50 ml of 0.01 M calcium chloride solution containing 8 ppm P as Ca-diphosphate was added.

This soil suspension was shaken for 24 hours and then centrifuged at 4000 rpm for one hour. The liquid was discharged and the soil remaining in the tube was subjected to fourteen subsequent extractions, one set with water and the other one with 0.01 M CaCl₂-solution. After each centrifuging the liquid phase was collected separately and analyzed for P according to the molybdate chloride procedure.

Results and discussion

In Figure 1 [a–d] the values of P released from these soils through the extraction by water or 0.01 M calcium chloride solution are presented. They show the differences in shape of the P-release curves. It
Figure 1a: Release of P adsorbed. Gypsum Serosem

Figure 1b: Brown soil

Figure 1c: Release of P adsorbed. Soils from Gallego river

Figure 1d: Releasing of P adsorbed from Marl Serosem

can be said that the three calcareous soils [Terrace, Alluvial meadow and Marl Serosem] exhibit two sites for P releasing, while in Gypsum Serosem and Brown soil only a simple solution process of the surface adsorbed P-ions takes place following a steadily declining desorption curve. The different behaviour of all 5 soils in their physico-chemical properties, with regard to the one or two-reaction process, has been explained by BLANCHERT et al. (1964) and also by SHAPIRO and FRIED (1959).

Both Serosem soils behave in different ways; while the Gypsum follows a steady desorption curve, the Marl Serosem is characterized by a 2-reaction mechanism as its dominant process. Table 1 shows the % of P released by the action of water or 0.01 M calcium chloride solution.

Both extracting procedures demonstrate approximately the same sequence in the % of P release, which is inversely proportional to the quantity of this nutrient adsorbed. An exceptional case is presented by the Terrace soil which seems similar to Brown soil.

Table 1: Phosphorus release (as % of P adsorbed) by action of water or 0.01 M CaCl₂ solution

<table>
<thead>
<tr>
<th>Soils</th>
<th>P adsorbed ppm</th>
<th>% Release Water</th>
<th>% Release 0.01 M CaCl₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum serosem</td>
<td>145</td>
<td>60</td>
<td>34</td>
</tr>
<tr>
<td>Marl serosem</td>
<td>124</td>
<td>55</td>
<td>32</td>
</tr>
<tr>
<td>Terrace</td>
<td>123</td>
<td>71</td>
<td>45</td>
</tr>
<tr>
<td>Alluvial meadow Gallego</td>
<td>155</td>
<td>55</td>
<td>32</td>
</tr>
<tr>
<td>Brown soil</td>
<td>68</td>
<td>84</td>
<td>46</td>
</tr>
</tbody>
</table>
In all soils studied, the values of % P releasing obtained with water are higher than those with calcium chloride solutions. This fact agrees with the literature (RAJAN and FOX, 1972). Some researchers recommend the 0.01 M CaCl₂ solution because it seems to reflect the natural soil conditions better than a water extraction.

Referring to Table 1, from the three calcareous soils the % of P released is the same in Marl Serosem and Alluvial meadow. In contrast to these soils, the Terrace soil-type shows a higher % of P desorbed which is related more to that attained for the Brown soil, that means an easier transfer of P to the soil solution.

These findings are of special importance for P-fertilizer application adjusted to the needs of the cropping system in irrigation conditions.

References


