FACTORS INFLUENCING THE AVAILABILITY OF PHOSPHATE IN ALKALINE SOILS.

By

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CONTENTS

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LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Phosphorus performs functions in plant metabolism, structure and reproduction that cannot be performed by any other element. The importance of phosphate chemistry in calcareous alkaline soils involves largely the nature and reactions of slightly soluble calcium phosphate naturally present in the soil and of the calcium phosphates resulting from the reactions between the soil and the applied phosphatic fertilizers.

Considerable data have been accumulated concerning soil factors affecting the availability of phosphorus to plants and the reactions of the fertilizer with the soil. However, the reactions occurring between calcium carbonate and calcium phosphate including soluble phosphate fertilizers, which is considered to be the most important factor in our soils, need more informations. Moreover, it is known that salts of different cations and anions affect the solubility of soil phosphate in different ways. Such effect can be considered of major importance in arid regions - like ours - because of the greater abundance of soluble minerals and salts. The results of experiments with phosphate compounds of low solubility have suggested that solubility is increased by some cations and reduced by others. This problem is important in view of the high rate of fixation of phosphate applied to cultivated soils and consequent low recovery in crops. In addition, the factor of soil moisture plays a good part in the availability of native and applied phosphate.

Therefore, this work was carried out to clarify the type of reactions occurring between the applied phosphate and the solid phase - $Ca CO_3$. A trial was conducted to find a tracer method to differentiate between adsorbed and fixed phosphate. Moreover, as some attemps have been made to use saline water to irrigate food plants because of the shortage of irrigation water. Therefore, the effect of salts that are assumed to be used as fertilizer or to be likely present in the soil or irrigation water on the availability of native and applied phosphorus was studied. In addition, the effect of soil moisture levels on the availability of native and applied phosphate is also incorporated.

REVIEW OF LITERATURE

Fixation of plant nutrients in soils may be defined as the process whereby readily soluble plant nutrients are changed to less-soluble forms by reaction with inorganic or organic components of the soil, with the result that the nutrients become restricted in their mobility in the soil and suffer a decrease in their availability to the plant. Phosphorus can be considered the major nutrient which is greatly affected by fixation. The types of reactions by which phosphorus becomes fixed include: adsorption, isomorphous replacement, precipitation and double decomposition (Kardos 1964).

Adsorption reactions may be classified, generally, into two types: chemical adsorption and physical adsorption. Both types may be characterized by the Freundlich adsorption isotherm or by the Langmuir adsorption equation. Low and Black (1950) found through applying Freundlich adsorption equation that the degree of adsorption was increased by increasing temperature, and hence, concluded that this reaction is a type of chemical adsorption involving primary valence bonds, rather than a physical adsorption. Since Freundlich equation can represent exchange reactions when applied to ions, it was suggested that this adsorption reaction is an exchange reaction between phosphate and hydroxyl ions on the surface of the soil particle. This exchange adsorption reaction results in the phosphate ions becoming attached to exchangeable iron, aluminum, and calcium ions of the clay and hydrous oxides, or the same ions held in the outer edges of the lattice (Low & Black 1950, Dean & Rubins 1947 and Haseman et al 1950). They concluded that although the short-time reaction at low concentrations may be an adsorption reaction, other reactions dominate at higher concentrations and after more prolonged contact. Applying Langmuir isotherm to phosphate adsorption from dilute solutions has several advantages (Olsen and Watanabe 1957). The main one is that it provides a method to describe the behaviour of the adsorbed phosphorus. Agreement of the phosphorus adsorption data with the Langmuir isotherm has been considdred a strongevidence for a monolayer of adsorbed phosphorus on a surface. Evidence from phosphate adsorption on Ca CO_3 indicates, that in the range of equilibrium concentrations where the Langmuir equation applies, essentially all of phosphate adsorbed is exchangeable with P^{32} (Cole et al. 1953). Olsen (1953) found, that all P - adsorbed by calcareous soils from dilute solutions was exchangeable with P^{32}. As the phosphorus concentration in solution increases, less of the adsorbed phosphorus is exchangeable with P^{32}. Similar data were found by Fried and Dean (1955) for phosphorus adsorbed on a ferrated IRC -50 cation-exchange resin. They stated that the nature of the adsorbed phosphate, or surface phosphate is unique compared to other phosphate compounds, since it includes the fraction of all phosphate compounds present in the soil which will readily equilibrated with P^{32}. Thus, the adsorbed phosphate could be present in varying proportions of Ca , Fe and Al - phosphates, or mixtures of these, but each form would have a certain fraction of the total phosphate as surface phosphate. The latter is common to all other forms present and closely related to plant response (Olsen 1953, Olsen & Watanabe 1957, Baker 1964 and Dunbar & Baker 1965). Chu and Chang (1966) mentioned that the surface activity of soil phosphates was found to be as much as, or even more, than that of their solubility in determining the availability of these phosphates to the plants. Hence, the nature and properties of surface phosphates should be more thoroughly studied.