Plant Nutrition and the Hydrogen Ion: VI. Calcium Carbonate, a Disturbing Fertility Factor in Soils

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The extent to which the exchangeable cations on the colloidal exchange complex within the humid soils of the eastern United States have been replaced by hydrogen ions has been used as a criterion of the high degree of soil development there. It has likewise represented the magnitude of the fertility problems associated with the acid soils. Conversely, then, the accumulation of calcium carbonate in the soils of the arid west to the extent that the adsorbed cations consist mainly of calcium should similarly serve as a criterion of their low degree of soil development. It should likewise represent the complexity of the fertility problems associated with crop production on these soils.

With the concentration of agriculture on the humid soils and the numerous fertility problems associated with them, especially the need to apply calcium carbonate, it may seem somewhat of an exaggeration to venture the statement that soils with excessive calcium carbonate present more complex fertility problems than those with excessive acidity. However, the arid soils of the West are demonstrating this truth. The fertility problems of these arid soils include not only those associated with irrigation practices, but also that of coping with the tremendous influence which free calcium carbonate exerts upon the availability of phosphorus, iron, manganese, and boron, and upon the colloidal exchange complex to bring about ultimately an ionic monopoly of it by calcium.

Soil development in the light of the transformation of parent materials into soil by their weathering into new minerals and into solution indicates that soils exist in all degrees of development. They range from these calcareous soils insufficiently developed for crop production and still in the earlier stages to those acid soils excessively developed for this purpose and in the later stages of these transformations. Therefore, the soils within the regions of low rainfall and high evaporation rates, respectively 8 and 95 inches annually in southern New Mexico, exist in the earlier stages of the soil development processes. As a result, there has been little chance for a breakdown of the calcium carbonate regime. The colloidal clay complex has become saturated by calcium to as much as 80 to 90% as is the case of the Gila clay series located in the Rio Grande River Valley of southern New Mexico and used in the studies reported herewith.

It is our belief that this free calcium carbonate in solution so dominated by calcium as to give the colloidal complex approaching saturation by it alone. This is analogous, therefore, to the hydrogen-saturated soils which give an ionic monopoly of the colloidal complex by other cations than calcium.

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