

**THE SOIL SOLUTION:
THE NUTRIENT MEDIUM
FOR PLANT GROWTH**

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FRANK K. CAMERON

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The Soil Solution

The Nutrient Medium for Plant Growth

By

FRANK K. CAMERON

In Charge, Physical and Chemical Investigations, Bureau of Soils,
U. S. Department of Agriculture

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Preface.

It has long been the custom to regard soil chemistry from one of two diametrically opposed points of view. Either, it has been considered extremely simple, or complex and hopelessly difficult. In either case the impression has generally prevailed that practical work in soil chemistry consists in treating the soil with some solvent or other and analyzing the resulting solution for "available" plant food elements; in other words, that the chemist's role in soil studies is merely that of an analyst.

Soil chemistry is complex, but not by any means hopelessly so. Unfortunately, the complexity of most of the problems presented has deterred the student of pure chemistry from attacking them, and because they do not offer any material pecuniary rewards, they have not appealed strongly to the investigator in applied chemistry. Investigations in soil chemistry, for their own sake, or for the sole purpose of increasing the sum total of human knowledge concerning the phenomena taking place in the soil, have been comparatively rare. The subject has generally been regarded from the analytical point of view and as incidental to agronomic studies.

One purpose of this little book is to show the investigator in chemistry who is not limited by the condition that his work must bring some personal financial return, that the soil and its problems offer a field for his efforts quite worthy of ranking alongside the most interesting branches of pure chemistry, as well as being of the very highest importance to the development of the welfare of the human race. Another purpose is to point out the line of attack upon the problems of soil chemistry which at this time offers the largest opportunity for results. In how far the details of the story in the following pages are correct, time with its further investigations will tell. In a sense, the correctness of the details is of secondary importance. It is of the first importance, however, that there should be a general recognition that soil phenomena are essentially dynamic in character, and that the investigation of the properties of the soil solution and its relation to crop production is a procedure certain to yield results of positive value.

Again, it is a purpose of this book to make available for students of agriculture, a systematic outline of the work so far accomplished in this particular field. It is to the students of to-day from whom are to come the investigations of the near future that the book is particularly addressed. Some of the details presented in the following pages are matters on which opposed opinions are now held strongly by different authorities, and to the unbiased minds of the coming investigators must be left the decision as to how closely the truth has been approximated in what is written to-day. The field of effort covered by this book is one in which there is an increasing activity, and new facts and deductions will inevitably bring modifications to present opinions. To encourage this further acquisition of knowledge is the main purpose of the book.

The material brought together in this book has been presented to the faculties and students of several of our Agricultural Colleges, in the form of a short course of lectures. In large part, moreover, it has been published in Volume XIV of the *Journal of Physical Chemistry*. To make it accessible to and more easily read by one familiar with the progress of technical soil investigations, it has been recast in its present form.

It has been assumed that the reader will have a fair working knowledge of the concepts of modern chemistry. Nevertheless, an effort has been made to avoid technical terms so far as this can be done without undue sacrifice of lucidity of expression. Free references have been made to the bulletins of the Bureau of Soils, U. S. Department of Agriculture, because they are generally accessible to the American student, and because in them will be found detailed discussions and bibliographical material pertinent to the subjects outlined here. To his coworkers, the author is indebted for many criticisms and suggestions; and more especially in the making of the book is he indebted to Mr. S. C. Stuntz.

Washington, D. C.

1911.

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AN INTRODUCTION TO THE STUDY OF THE SOIL SOLUTION.

Chapter I.

THE SOIL.

The soil, or that part of the land surface of the earth adapted to the growth and support of crops, is a heterogeneous mixture composed of solids, gases and a liquid, and containing living organisms. There are present: mineral debris from rock degradation and decomposition; organic matter from the degradation and decomposition of former plant and animal tissues; the soil atmosphere, always richer in carbon dioxide and water vapor and possibly other gases than the atmosphere above the soil; living organisms, such as various kinds of bacteria and fungi, with the products of their activities, notably the "nitrogen carriers" and the enzymes; and finally the soil moisture, a solution of products yielded by the above components and in equilibrium or approaching equilibrium with the solids and gases with which it is in contact.

In its relation to crop plants,¹ that part of the soil of immediate importance is the soil moisture. From this solution the plants, through their roots, draw all the material involved in their growth, except the carbon dioxide absorbed through their leaves. The soil solution is the natural nutrient medium from which the plants absorb the mineral constituents which have been shown to be absolutely essential to their continued existence and development. And from this solution plants sometimes absorb dissolved organic substances, but such absorptions are probably adventitious and incidental to the growth of the plant in a particular environment. While it appears certain

¹ By crop plants are meant the ordinary green plants employed in agriculture. As is well-known, the fungi as well as certain parasitic and saprophytic non-green seed plants obtain their nutriment in a very different way from ordinary green crop plants.