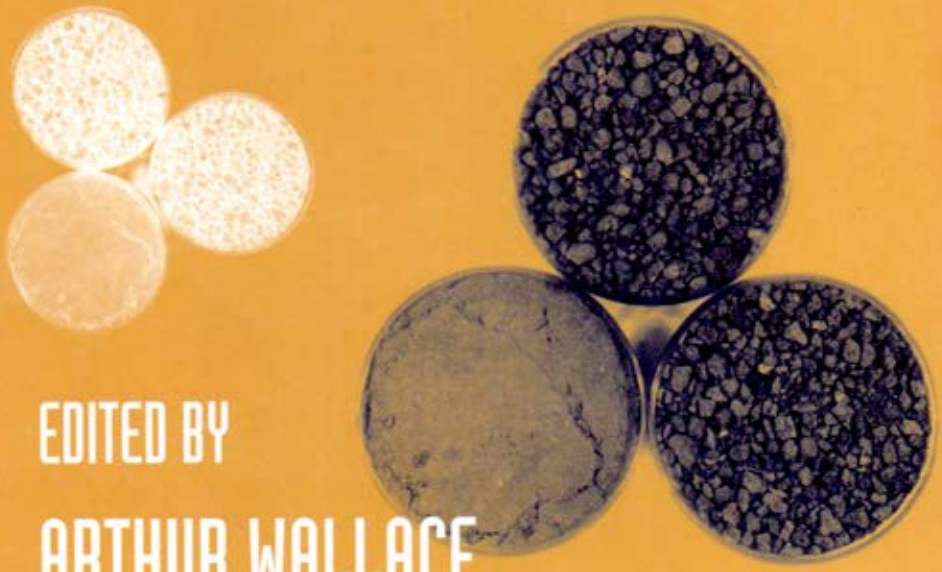
Handbook of Soil Conditioners

Substances That Enhance the Physical Properties of Soil



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Marcel Dekker, Inc. New York · Basel · Hong Kong

ISBN 0-8247-0117-8

MARCEL DEKKER, INC.
270 Madison Avenue, New York, New York 10016
http://www.dekker.com

Current printing (last digit):
10 9 8 7 6 5 4 3 2 1

PRINTED IN THE UNITED STATES OF AMERICA

Preface

Many books, reviews, and symposia have covered the various materials used in the past to improve the physical properties of soil. Gypsum, lime, compost, biosolids (sewage sludge), and polymers have been the subject of various reports. This volume, however, is the first to integrate several uses and functions of mineral conditioners, organic conditioners, and synthetic conditioners. Its scope is unique. This handbook outlines the usage of many products that can be considered as soil conditioners, and also emphasizes how many of these products interact in beneficial ways.

We define a soil conditioner as a substance—natural or manufactured—that has the ability to improve the physical properties of soil, with emphasis on the soil's ability to grow plants. Soil conditioners enhance the quality of soil for many of its functions.

The definition of soil conditioners presented here is not universally used. Nevertheless, it is important to consolidate the many products that give somewhat similar results when used on soil. Some materials that we classify as soil conditioners also do other things to soil besides changing or improving its physical properties. Appropriate products, then, can also be considered as nutrient sources, as suppliers of organics and microorganisms, as well as soil conditioners.

Any substance added to soil, to benefit either the soil or the crop, is called a soil amendment. Soil conditioners, therefore, are also soil amendments. Technically, fertilizers are also soil amendments, but they are not usually discussed with soil amendments (or conditioners) used to improve aeration, increase water infiltration, decrease erosion, and enhance tilth.

A soil amendment is any material applied to the soil to improve it or the crop it supports. There are three general types of amendments:

1. Fertilizers: Any nutrient or combination of nutrients, consistent with legal requirements, that are applied to the soil
2. Soil conditioners: Any material applied to soil to improve one or more of its physical properties
3. Biological/physiologically active substances: Mostly microorganisms, food for microorganisms, and plant hormones or regulators

The boundaries between these three groups are not strictly defined; there nearly always is overlap. Many materials possess two and sometimes all three of these functions. For example, manure has fertilizer properties; it conditions soil, and it provides microbes, organic carbon, vitamins, and regulators. It is, therefore, an amendment that participates in each of the three subgroups.

Each of the three types of amendments may be subdivided. For purposes of this book, soil conditioners may be classed generally as 1) mined or mineral, 2) organic, 3) synthetic, and 4) waste or by-products. Other classifications are sometimes used.

The major purpose of this book is to discuss the various products added to the soil that improve its physical properties. Some of the products have more value than others, especially for specific intended usages. Some will have more value for particular soils or crops than for others. Precision, extensive soil analysis, and a holistic approach to soil management can help get the most from tools classed as soil conditioners.

Very often, a soil conditioner gives little or no response when it theoretically should. In those cases, there must be reasons. With adequate analysis and a holistic approach, the reasons may be identified so that satisfactory results are ultimately possible. Too often, symptoms of problems are treated without looking for the underlying causes.

Several concerns require increased improvement in the physical properties of soils. Much progress has been made in the past 100 years in enhancing plant nutrition. There is an equal need now to enhance the physical properties of soil. Full response to the high levels of nutrients (fertilizers) applied will seldom be achieved without simultaneous improvement in the physical properties of the soil. Soil conditioners can do this when properly used. As more food will be necessary in the coming decades, because of world population growth, soil improvement will become increasingly important.

We claim that the best management practices are the best management practices only when used with other best management practices. Positive interactions that have been documented among some soil conditioners emphasize this fact. When various inputs are used simultaneously, effects on crops are often greater than the sum of the individual responses. Gypsum, various organics, and water-soluble polymers can interact favorably.

As much as $25 billion is spent in the United States per year for soil care. Worldwide, the value is much larger. The fraction used to improve the physical properties of soil, however, is too small, and much more can be done.

Losses of all kinds caused by soil erosion are reported at $40 billion each year in the United States, and ten times that figure for the whole world. Among techniques for erosion control, in addition to cropping systems and farm layout, are various uses of most of the major soil conditioners including organics, gypsum, lime and water-soluble polymers, especially polyacrylamide. One reason for so much soil erosion, however, is that the techniques for control are not thoroughly known and/or are greatly underutilized.

World population is increasing so rapidly that many people worry that soon the need for food and other resources will not be met. An urgent concern is that the land and production systems are not sustainable. This means that they cannot last indefinitely, especially with current use procedures. Soil conditioners certainly can help. Degraded soils can and must be vastly improved to achieve sustainability and needed production. Levels of soil organic matter can be increased even though most are decreasing throughout the world. Many advantages will result as soil organic levels are increased: scarce water supplies can be used more efficiently, there will be less erosion, and crop yields can be dramatically increased. The simultaneous use of multiple soil conditioners can often make a huge difference in these matters.

In past decades and centuries, lime, manure, gypsum, green manure, and cover crops have been the major conditioners. More recently, a myriad of waste products have also been used as soil conditioners. Most composts are derived from waste products. In recent decades, synthetic polymers have been added as conditioners. Zeolites, pozzolans, and other mined products are also being added. At this time, the scientific basis for most of the newer materials has not yet advanced as much as it has for the older materials. This is reflected in the various chapters of this book.

Water-soluble polymer soil conditioners are relatively new and have much promise for improving physical properties of soils. They are probably most effective when combined with other soil conditioners, especially with organic matter and gypsum. Water-soluble polymers can improve soil aeration and water infiltration, prevent crusting, and protect against compaction. Some results are: less erosion, greater water-use efficiency, higher yields, few soil-borne diseases, and earlier crop maturity.

Much progress has been made in the past ten years in the use of polymer soil conditioners to solve various problems. The products used in the 1990s are far superior to those used in the 1950s.

We firmly believe that even more potent products will become available for future use. Moreover, there is yet much to be gained from further discovery and implementation of beneficial interactions in soil that are possible with polymers and other materials.

The landfill crisis and other environmental concerns have resulted in a surge in recycling, including composting. In the near future, some 50 million megagrams (more than 55 million tons) of compost in the United States will be available for land use. Use of compost on soil is increasing, but for full use of the 50 million MG, much more must be used on farms. In order for this to happen, value-added procedures in which one or more soil conditioners are combined will probably be necessary.

Some new conclusions emerge from this overview of compost soil conditioners. Compost should not be considered to be in competition with other soil conditioners (amendments), but rather as a valuable companion/aid to go with at least some of the others. There are separate benefits for each, and also benefits that are enhanced by interactions with one another. Maximum benefits from a given soil conditioner are obtained under conditions obtained from use in conjunction with other soil conditioners (amendments) that result in synergy or near synergy. Most likely, the only way for compost to achieve its rightful level of use is in combination with other conditioners (amendments). Also, its possible value in plant disease suppression is as yet mostly unexplored.

Soil improvement is important for many reasons. We have to assume that good land must last forever. As soils are used, however, they tend to degrade. Effort and new inputs can reverse this tendency. Not only must soils be protected from misuse and degradation, but they must be so cared for in order for future generations to produce more food on less land. Further, the public also expects environmental benefits from the land. Specifically, it expects soil to be a means for using and detoxifying wastes, as well as a means for recycling substances necessary for life.

Use of soil conditioners is largely in the realm of technology. This book presents a blend of scientific and technological information. Some of the citations used are from trade journals. These sources tend to fine-tune technologies. Many of the relevant findings are reported, often first and exclusively, in those sources.

We have designed this book to address the need of a wide range of concerned groups. It is hoped that the professionals in soil and plant sciences as well as those with practical concerns, will find much of value.

Arthur Wallace
Richard E. Terry

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