Effect of Porous Soil Amendments on Water Retention Characteristics of Soils

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For the past several years porous mineral materials such as vermiculite, pumice and expanded perlite have been used to a large extent as a plant rooting media and in packaging plants for shipment. Within the last year or two, they have been offered for sale as amendments or conditioners to improve the physical properties of soils. A few are advertised extensively and some extravagant claims are made for them. Among the advantages claimed for the use of these inorganic materials as general soil conditioners are that they "lighten" the soil, making tillage easier, improve soil aeration, retain nutrient elements and hold water. They have been shown to be helpful where they are used in very large proportions, as in rooting cuttings. However, it is questionable whether appreciable benefits are obtained when they are introduced in smaller proportions, as would generally be necessary under field conditions. This study deals only with the effect of general soil amendments on the water relations of soil.

Considerable interest has developed in the possibility of using inorganic soil amendments under turf, especially golf-course putting greens. Were it possible to extend appreciably the interval between irrigations on putting greens, the cost of incorporating these materials might be justified easily. Too, the fact that these inorganic materials are relatively inert should afford the advantage of being effective over a long period of time, as compared with organic substances. Inorganic soil amendments have no chemical effect on the soil and probably little influence on the aggregation of soil particles; they merely dilute the soil without altering its inherent structure. Any improvement in the water relations of soils arising from their use will depend directly upon their influence on root growth and water infiltration rates. The effectiveness of a given material will depend upon its specific physical properties, particularly its porosity.

Pumice is a natural glass foam of volcanic origin. Its porous structure was developed by the rapid expansion of entrapped gases when the material was erupted. The pores are often tubular and many are of small diameter; its porosity is about 65 per cent of the apparent volume. Approximately one half of these pores can be filled with water, while the remaining pores are sealed or have dead ends which entrap air, preventing the entrance of water. As yet it is not known whether plant roots could enter the finer pores of this material or whether the rate of de-watering would be sufficiently fast to be of importance to plants.

Scorea is a basic, vesicular lava in which relatively large pores have formed by the expansion of gases before the material hardened. Most of the pores are separated by thick walls and are interconnected.

Expanded perlite is often called synthetic pumice. It is made by a process which expands natural perlite (a variety of obsidian) to produce many enlarged bubbles. The physical properties of perlites depend both on the raw obsidian used and on the processing. Two expanded perlites on the market today are Soil Air and Sponge Rok. Most of the expanded perlite now produced is used for light weight concrete aggregate where it is prized because of its very low moisture and gas absorption. However, it is possible that by suitable processing expanded perlites of quite different characteristics can be produced. Expanded perlites are very fragile and unless great care is exercised in mixing, much of the material is crushed to a fine dust.

Vermiculite has a very unique accordion-like structure with spaces between plates which are penetrated easily by water. It retains more water than the other materials studied; its mechanical strength is low and, if kept wet, it may soon slake down to a pasty mass.

Other products, including slate pellets and haydite, have not as yet been examined.

The usefulness of these numerous materials for water retention in soils is dependent largely upon the nature of their porosity. Total porosity is meaningless. What is needed is a measure of the open and interconnected pores, also information on the size distribution of pores, inasmuch as water will not completely fill very small pores unless air is removed under a high vacuum prior to wetting. A newly developed mercury injection apparatus is being used to determine pore size distribution.

To evaluate the influence of amendments on the water relations of soils, consideration must be given to their effect on field capacity, wilting point and total available soil moisture. Measurements were undertaken of the field capacities and wilting points for two soils mixed with several amendments. Data are now available for only two expanded perlites (Soil Air and Sponge Rok) and for vermiculite, as each reacted with Yolo loamy sand and Yolo clay.

The water retention data suggest tentatively that the coarser particles of Soil Air and Sponge Rok have many blind pores. When mixed with a sandy loam soil even in amounts up to 50 per cent by volume, they do little to alter the field capacity, wilting point or available moisture capacity. Most sandy soils are quite permeable to water and permit deep root growth. Therefore, it would seem that the use of expanded perlites would not extend appreciably the irrigation interval on sandy soils. When added to clay soils, these materials may have little effect on the total available water per unit depth of soil, but they may cause deeper rooting and improve infiltration rates. When added in the amounts now recommended, that is up to 20 per cent volume, it appears that perlites would have little influence on the water relations of plants on many soils. Possible indirect benefits arising from the use of such mineral amendments should be examined.

In contrast, the use of vermiculite in sandy soils would appear to offer a means for enlarging the available water capacity and lengthening the periods between irrigations. Its use in clay soils for this purpose would be less effective. In such soils, its value would probably depend largely upon its influence on rooting depth and infiltration rates. Unfortunately, when kept moist, vermiculite may slake down into a pasty material, causing poor-drainage problems in high vermiculite-soil mixtures. This property would seem to restrict its usefulness for improving the water relations of turf soils.

It is hoped that these findings may be helpful in interpreting results of plot

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work. Some plots have been established in Los Angeles by Stoutemyer and Gallagher using pumice, scorea, expanded perlite and vermiculite. Additional plots are planned. Anderson, in Missoula, Mont., has plots with vermiculite. The plots are essential for investigating such things as the resistance of these amendments to crushing under service conditions, their effect on rooting depth and their influence on the growth and general appearance of the grass.

The other materials now available, especially pumice, will be studied. A better understanding of the pore structure of these products should aid in the selection of the most promising materials for field tests. In the last analysis, the usefulness of these materials will have to be verified under typical field conditions before their value can be ascertained.

Contribution of the Division of Irrigation, University of California, Davis, Cal. This paper was presented by Dr. Hagan at the American Society of Agronomy meetings, Turf Section, held in August, 1951, at State College, Pa. In the accompanying letter Dr. Hagan writes about the project at Davis, supported in part by a research grant from the USGA Green Section: "Plots of Merion bluegrass have been established to study irrigation practices required for the maintenance of acceptable turf. There are three irrigation treatments, wet (when 1/3 of total available water used), medium (when 2/3 of total available water used) and dry (when approximately all the available water has been used and grass just begins to show wilting). These irrigation treatments will be carried out under two heights of clipping (1/2 and 1 1/2 inches) and under two or three levels of nitrogen fertilization. Observations or data will be obtained on the influence of these irrigation treatments (at the two clipping heights and fertility levels) on the general appearance of the turf, growth, summer dormancy of bluegrass, turf density, weed encroachment, disease incidence (particularly brownpatch), root distribution and water requirements. Another study is in progress to determine the depth of rooting, the water requirements and the relative drought resistance of Alta vs. K-31 fescue, Merion vs. Kentucky bluegrass, Illahee vs. F-74 fescue and chewings (Penn State) fescue, U-3 vs. common bermuda, and Z-52 vs. Zoysia matrella. We may include Poa annua in this study."

EXCERPTS FROM TYPICAL ADVISORY SERVICE REPORTS

In the USGA JOURNAL, June 1950, an announcement was made concerning the enlarged scope of Green Section activities through Advisory Service visits to our USGA Member Clubs and Green Section Service Subscribers. The value of such visits is considerably enhanced by an official report which accompanies each inspection tour. These reports have proven valuable to superintendents and club officials in evaluating their programs and in formulating plans for further turf improvement. The cost of an Advisory Service visit to our members is $50 a day of service, plus traveling and living expenses. Non-members may obtain this service at a cost of $100 a day plus traveling and living expenses. Many of our member clubs avail themselves of this service during one trip of a Green Section representative, and thus pro-rate traveling and living expenses. Where two or more clubs are visited in one day, the Advisory Fee is $25 to each club.

The following excerpts taken from our report files are typical examples of this service. These recommendations may or may not pertain to your conditions.

Tees

"Most of the tees are much too small. The smaller ones could be enlarged to about three times their present size. It is suggested that the enlargement of these tees be done in such a way that there will be no steep slopes or abrupt changes in grade. Long, easy slopes can be maintained with power equipment whereas steep slopes require expensive hand maintenance . . . "

"Tees in general need aerifying more than anything else. This will allow water to penetrate and it will help in obtaining penetration of fertilizer down into the root zone, which will produce a more firm, deeper-rooted turf . . . "

"The plan for the sunny one-shot tees is to resod half of these tees at a time with U-3 Bermuda. The procedure will be to strip the U-3 sod as thin as possible. Thin sod always lays better, knits quicker, and, of course, the nursery area recovers much faster . . . "