SOIL PORE-SPACE

by

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That the soil is a three phase system has long been recognized by many authorities. The solid phase has been divided into the mineral and organic, with special emphasis being placed during the last few years on the colloidal fraction. The liquid phase, commonly called soil moisture, which is in fact a dilute solution, in the majority of cases has usually been expressed either in terms of per cent based on the oven-dry weight of the soil or on the volume basis where the total volume occupied by all three phases is taken as one hundred, and sometimes expressed in terms of inches per foot of soil.

As far as the percentage expression of soil moisture is concerned, there is confusion, especially in the mind of the layman, and for this reason the writer proposed (3) the expression “moisture ratio” to indicate the grams of water present in the soil compared to 100 parts of the soil dried to constant weight at a temperature of 100-110°C. The expression percentage by weight or volume have been used for a long period, and will no doubt be used in the majority of instances in the future, but there are indications that some writers will use the ratio expression.

The third, or gaseous phase, has received considerable attention during the last few years, and terms used to express the so-called air content of soils have varied somewhat and for this reason it seems advisable to consider these with the hope that greater uniformity will exist in the future.

Under the general heading “Porosity” as proposed by Shaw (2), is a subheading entitled “Soil Porosity” and defined as indicating the mass effect of the pores or voids between the individual particles and aggregates that make up the soil. It is clear in this definition that the term soil porosity, as used by Shaw, includes all the pore spaces, whether they are occupied by air or moisture.

Smith and Brown (4) have limited porosity to the pore spaces occupied by soil air and expressed it as a decimal, for instance 0.121, meaning thereby that of the total volume of soil particles, moisture and air, there was 12.1 per cent of air, or taking the total volume of the three phases as 1,000, that of the soil air was 0.121. The authors used porosity in the same manner as did Buckingham (1), and expressed the figure as a decimal fraction rather than as a percentage to avoid confusion with soil porosity as defined by Shaw.

The total pore space or per cent pore space has long been used to express the volume occupied by the soil moisture and soil air, and is usually calculated from the volume weight and specific gravity of the soil with the latter two factors calculated on the basis of the oven-dry weight of the soil.

The term porosity conveys to many the same thought as the term permeability, and expressions such as capillary porosity indicate a certain fraction of the pore space determined under artificial conditions. The length of the soil column, or its diameter, and the time which has elapsed since the base of the column was placed in contact with water, will greatly affect the final results.

A similar condition exists when reference is made to the moisture-holding capacity of a soil under laboratory conditions or to the field water-holding capacity, and with the latter it is becoming more generally recognized that the time factor is very important for the amount of moisture retained one day after a soil is irrigated is not the same as when it is determined at a later date. The knowledge of the amount of water present after a rainfall or an irrigation really only becomes of importance when the time between wetting and sampling is reported.

The total pore space in any one soil, under either field conditions or when artificially packed in some container as in the laboratory, will vary with the size and number of the individual pores, or as might be expressed with the texture and structure of the soil. The structure of the surface soil under field conditions varies during the year from that fairly loose condition usually existing after the field is plowed, to a more compact condition at a later date. In the subsoil, the structure or total pore space does not have a marked seasonal variation, and in fact one might say that it varies but slightly over a period of years.

As the pore space is filled either with moisture or soil air, the proportional amounts of either moisture or air varies markedly, for when the soil moisture is withdrawn from the soil by plant absorption, evaporated from the soil surface, or when it moves either as a liquid or a vapor from one part of the soil to another, the soil air content increases, and conversely it decreases in amount during periods of rainfall and irrigation.

The total pore-space of the soil is therefore not such a variable as the soil air-space, and although many soil scientists, with whom the author has consulted, agree in these interpretations of conditions, they do not all agree on the best usage of terms to designate the total pore-space and soil air-space. The majority, however, have stated that they are in accord with the recommendations which the writer now proposes.

In order to obtain a more universally accepted usage, it is suggested that the term soil pore-space be used to express the total pore space of the soil mass, regardless of the proportions of air or water that may occupy these pores; that soil air-space be used to express that portion of the soil pore space occupied by air, and soil moisture-space be used to express that portion of the soil pore space occupied by water. It is further recommended that these all be expressed as percentage of the total volume occupied by the entire soil mass, which method of expression is most used at the present time in soil physics, whether reference is made to soils in their natural state in the field or to any described artificial condition in the laboratory.

References

(3) Smith, Alfred. 1918. Moisture ratio. SCIENCE. N. S. No. 1728, pp. 48-49.