Laboratory Measurement of Available Soil Water

The three papers by G. W. Peterson, R. L. Cunningham, and R. P. Matelski on the "Moisture Characteristics of Pennsylvania Soils," Soil Sci. Soc. Amer. Proc. 32:271–275 (1968); 32:866–870 (1968); and 35:115–119 (1971) prompt a strong objection to the implications of this type of study. The authors should not be faulted too much for perpetuating concepts which have become so deeply ingrained in the folklore of soil science that editors and reviewers no longer require citations in their support. However, the almost universal adoption of an erroneous concept does not mitigate the error. I refer to the implication that there is a satisfactory laboratory measurement for available soil water and specifically that the difference between the water content at 15 bars and ½ bars water potential is such a measure.

The basic premise of the study, as stated by the authors in their first paper, is that the correlation between soil texture and soil moisture characteristics may be sufficiently good to provide information about the moisture characteristics of soils where moisture information itself is unavailable.

I would like to raise two objections to this approach. First, we know enough about factors influencing the moisture characteristics of soils to expect very limited success from such an approach. Second, the characteristics selected provide a poor estimate of the available water for plant growth.

There is little doubt that the soil water content at —15 bars water potential is highly correlated with texture since it is also highly correlated with surface area. However, the upper limit of available water, to the extent that such a limit is even definable, is related to the rate of drainage of a soil profile. This is a function of the permeability of both the soil and the subsoil. Structure is the important factor here and the correlation between permeability and texture can be no better than the correlation between texture and structure.

The authors acknowledge that: "The adequacy of the ½ atm moisture content as an estimate of field capacity in coarse textured soils may be debated and 1/10 atm tensions may be more appropriate. This problem was not pursued in this study and ½ tensions were used on all soils." It is most unfortunate that the authors did not pursue this problem in their study and make actual field measurements of available water which could then be correlated with soil texture to test their premise, rather than using a demonstrably inadequate measure of available water. Choice of the ½ atm value instead of 1/10 does insure a better correlation with texture, but provides a very poor estimate of field capacity even for fine textured soils. This choice leads to a virtual contradiction in terms in the third paper of the series in which the "available water" is correlated with drainage of poorly drained soils. The simple fact is that any soil which drains to ½ atm within 24 to 48 hours can hardly be considered poorly drained.

The difference between the ½ bar water content and the 15 bar water content does not give a good estimate of the available water in a soil profile. There may be some value in making such measurements for purposes of classification, but there should be no pretense that they measure available water. I would be reluctant to specify a range of available water, but if I had to select a single set of limits I would expect the —1/10 bar to —1 bar to give a more reliable estimate in A and B horizons. It is virtually impossible to define water availability in the C horizon without reference to rooting habit and water table depth, especially in poorly drained soils.

We are desperately in need of more quantitative information about the moisture characteristics of our soils if we are to use them effectively under even more demanding conditions. It is my strong belief that efforts spent on routine laboratory determinations such as those reported in this paper must be redirected towards more reliable, albeit more difficult, measurements of the soil profile hydrological properties.

Received March 11, 1971.

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This is a response to the comments on our papers on the "Moisture Characteristics of Pennsylvania Soils."

In general, the authors are in agreement with Dr. Gardner's concern for an adequate laboratory determination for plant available water. It was not the intent of this series of papers to quantitatively relate laboratory determined parameters to available water for plant growth, but rather to more clearly elucidate the soil factors related to retained soil-water.

The data used in these papers were obtained by The Pennsylvania State University Soil Characterization Laboratory over a 10-year period. The primary function of this laboratory is to obtain data on Pennsylvania's modal soils and few resources have been available for improvement of "standard" laboratory techniques. Because of the demand for moisture retention information on specific soil series and because of the problems involved in correlating soil series from state to state, it is necessary to use somewhat standard measurements of properties. Until soil physicists can propose (with some degree of unity) another system of measurement, we think that ½ and 15 bar will continue to be used. Therefore, although the authors were aware that the difference between the water content at ½ bars and 15 bars may not be the best estimate of plant-available water, it was deemed desirable to use them to study water retention of Pennsylvania's soils using available data to determine the soil factors involved.

Received June 14, 1971.

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Comments and Letters to the Editor