The pF at the Wilting Point of Several Indiana Soils

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The wilting point, the wilting coefficient, or the permanent wilting percentage, as it has been variously called, is a useful soil moisture constant. The knowledge of the water content of the soil at the wilting point is of major importance in any study or field operation concerned with the water content of soils, such as irrigation, tillage, or mulching.

The direct determination of the wilting point by the original method of Briggs and Shantz (4) using plants is quite laborious and time consuming and requires many replications due to the inherent biologic variations. Indirect methods of determining the wilting point have therefore been suggested by Briggs and Shantz (4), Bouyoucos (1, 2, 3), and Schofield and Botelho da Costa (8).

The determination of the wilting point by multiplying the moisture equivalent, the hygroscopic coefficient, or the moisture-holding capacity with factors or by expressing the wilting point as a function of soil texture (4) must be carried out by rigorously approximate, as many other factors that affect the wilting point are not taken into consideration. Bouyoucos' (1) suggestion to determine the amount of soil water that does not freeze at \(-1^\circ C\) is valuable and may be useful. His method of estimating the wilting point from the cohesion of the soil (2, 3) is ingenious. Its accuracy has — as far as we know — not yet been verified by other workers.

Schofield's (7) introduction of the pF concept and Schofield and Botelho da Costa's (8) suggestion of indirect determination of the wilting point by the freezing point method have put an important tool into the hands of soil physicists. They found that a pF of 4.2 came nearest to express the wilting point of their soils. Russell (6) found that the pF at the wilting point of four Iowa soils varied with texture, being 4.4 for a fine sand and 4.0 for a silty clay high in organic matter. Richards (5) subjected soils to a pressure of 16 atmospheres (pF 4.2) with a pressure membrane extraction apparatus and found the resulting moisture content to be less than that at the wilting point as determined by the sunflower technique.

The present study was undertaken to determine what pF values represent the wilting points of Indiana soils and whether any variation in this relationship is a function of texture or organic matter content.

EXPERIMENTAL

SOIL SAMPLES

Samples were collected of soils of a wide range in texture and in organic matter content — the two factors that affect the pF corresponding to the freezing point t. The samples were air dried, passed through a 2-mm sieve, and their mechanical composition and organic matter content determined. Information on the soils used is given in Table 1.

DIRECT DETERMINATION OF THE WILTING POINT

The wax seal method to determine the wilting point was used, following essentially the technique described by Briggs and Shantz (4). Soybeans were used as indicator plants. The wilting points of the different soil samples varied from 1.32% to 18.61%. The figures given in Table 1 are the means of from 10 to 17 determinations. The pF of the mean of each wilting point is also given.

FREEZING POINT DETERMINATIONS

The freezing point technique. Six to nine subsamples of each soil sample were moistened with different amounts of water to obtain moisture contents that were both below and above the wilting point. The subsamples were placed in test tubes, supercooled in an air jacket within a freezing mixture, and then freezing was induced by light tapping. The freezing point was determined by means of a Beckman T500. Schofield's formula pF = 4.1 + \log t was used to determine the pF corresponding to the freezing point.

THE RESULTS

The data obtained are shown in Fig. 1. The freezing point is practically a straight line as it represents a short section of a slight curve. The pF values for the freezing point determinations are given in Table 1. Soils that have a high pF have a very steep pF curve for the range around the wilting point. The soils having less sand show flatter curves. The slopes of the curves vary with texture.

The wilting points by the direct method were plotted on the curves representing the data and the pF at the wilting point was determined graphically. The individual pF wilting points are presented for each soil. They vary from 4.00 to 4.28, with a mean of 4.11, which is the logarithm of the mean tension. The pF values obtained do not point to a relationship between organic matter content or the texture and the pF at the wilting point.

From a study of the data obtained it was decided to choose pF 4.1 as representative of the wilting point of soils of Indiana similar to those studied by Briggs and Shantz.