A RAPID APPROXIMATE METHOD FOR DETERMINING SOIL ORGANIC MATTER

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In soil survey and extension work it is often desirable to have a more precise idea of the organic matter content of a soil than a mere guess based upon color and texture, although the importance of the knowledge or the care taken in securing a sample may not warrant a determination by the standard methods. The following approximate method may be carried out in 10 minutes and appears capable of furnishing useful results. It is based upon the well known wet combustion method for total carbon in soil, and upon the commonly accepted average of about 50 per cent carbon and 5 per cent nitrogen in the organic matter of the usual soil types.

SOLUTIONS REQUIRED

The solutions required are prepared as follows:

*Saturated potassium dichromate in concentrated sulfuric acid.* Pulverize 20 gm. of the pure salt, add slowly with constant stirring to 1 liter concentrated sulfuric acid. Let stand for a week or more, closely stoppered, until the insoluble matter has settled out, and decant the clear solution into a glass stoppered bottle for preservation. If needed at once, the solution may be filtered through asbestos on a Buchner funnel, but it may deposit chromic acid after filtration. The solution is about 0.35 normal in oxidizing power. It is not perfectly stable on standing, however, and a blank should be run occasionally.

*Fifth-normal ferrous ammonium sulfate.* Dissolve 39.3 gm. of good quality crystals in water containing 10 cc. concentrated sulfuric acid and make to 500 cc. The solution keeps very well if protected from the air, but should not be used if the normal greenish tint has changed noticeably.

*Diphenylamine indicator.* Dissolve 0.5 gm. in 100 cc. concentrated sulfuric acid; pour carefully into 20 cc. cold water. This is the formula in general use as a qualitative test for nitrate.

PROCEDURE

Weigh 0.5 gm. air-dried and finely crushed soil, transfer to a large dry Pyrex test tube (the stock size 150 by 25 mm. is convenient). Add from a
pipette 10 cc. chromic acid solution, letting the acid run down the sides of the tube to wash down any particles of soil. Stir carefully with a thermometer and heat with constant turning and stirring over a low flame until the temperature reaches 175°C., which should require about 90 seconds. Cease heating at once. The heat in the glass will probably raise the temperature a little. Let the solution in the test tube cool 1 minute in the air, after which it is safe to cool Pyrex test tubes in water. Pour the cooled solution into 150 cc. tap water in a 400-cc. beaker, then fill the tube twice with tap water, emptying each tube full into the beaker. Add a few drops of the diphenylamine solution, which should produce a deep rich blue color, although the characteristic deep blue often appears only after the titration is started. Titrate with the iron solution until the pure blue fades to a muddy greenish blue, which is the proper end point. Deduct the reading from that secured in a blank experiment without soil: the difference is equivalent to the organic matter in the sample, which reduced a part of the chromic acid. With 0.5-gm. samples high in organic matter, the latter is not always completely oxidized, even though some chromic acid remains. If only a cubic centimeter or so of the iron solution is required in the titration, a repetition of the procedure with a smaller sample is advisable.

It is probably best for each operator to standardize his procedure and determine the value in organic matter of his solutions by a series of determinations

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\[ \text{Perce nt Carbon} \]

\[ \text{Percent.. Nitrogen} \]

\[ \text{Organic Matter} \]

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on soils of known carbon content, of the same character as those with which he expects to work. The results secured may be plotted as in figure 1, and most of the calculations for subsequent determinations avoided, as the content of organic matter in 0.5-gm. samples may be read direct from the graph. If the sample in a particular case is not 0.5 gm. the result as read must be multiplied by the proper factor.

RESULTS

As an illustration of the results obtainable from this procedure when used with soils of the same type but varying in organic matter content, a series of 10 samples of surface soils representative of the entire range of several hundred samples from plots at this Station were run and the results plotted as shown in figure 1. In this figure, cubic centimeters of fifth-normal iron solution equivalent to organic matter in the sample (i.e., blank titration minus titration with each 0.5 gm. sample) are represented by distances from the vertical axis and percentages of organic carbon by furnace combustion corrected for inorganic carbon and of nitrogen by the Kjeldahl method, and estimated tons of organic matter to the acre 7 inches of surface soil, are represented by distances from the vertical axis. As may be seen, a straight line can be drawn to fall near all the points representing carbon contents, indicating that the procedure is of reasonable accuracy throughout the entire range of carbon contents. The points representing nitrogen contents do not always fall so near this line, which of course indicates that the carbon-nitrogen ratio of the soil is not a constant. The correspondence is close enough, however, to justify a rough estimate of the nitrogen content of a soil from this titration. The number of tons of organic matter in the surface soil of an acre is included although it was not determined directly, and is not represented by points.

With soils of widely varied types, as good results could scarcely be expected, but even so, the indications should be better than guesses. Several determinations of the carbon contents of very different soil types were made, and the results calculated from the graph in figure 1, multiplying by the proper factor to allow for difference in weight of sample. The carbon and nitrogen contents

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>KNOWN CONTENT OF</th>
<th>INDICATED CONTENT OF CARBON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nitrogen</td>
<td>Carbon</td>
</tr>
<tr>
<td>Muck, 0.020 gm.</td>
<td>1.04</td>
<td>13.40</td>
</tr>
<tr>
<td>Fine sand, 0.300 gm.</td>
<td>0.11</td>
<td>1.33</td>
</tr>
<tr>
<td>Black clay, 0.100 gm.</td>
<td>0.31</td>
<td>3.53</td>
</tr>
</tbody>
</table>
of these samples were known, and are given in table 1 with the carbon contents indicated by this short method.

These data indicate that even for soils of widely varying nature the method may still be useful without a special standardization for each soil type.

Highly abnormal soils, such as those containing much oxidizable mineral matter, could not be examined by this method, but such soils are probably rare.