

FIELD METHODS TO ESTIMATE SOIL ORGANIC MATTER

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THE FACT: Knowledge of soil organic matter (SOM) content is important in herbicide applications, pH maintenance, and general soil quality and productivity assessments

CRITERIA FOR FIELD METHOD

The need for knowledge on broad ranges of SOM content exists for proper application rates of certain residual herbicides, for potential N contributions to crops, and for general knowledge on changes in soil quality due to management practices that either favor soil erosion and accelerated SOM decomposition, or increase cover and crop residues. A quick field method to meet these objectives would be desirable.

Several factors are involved in evaluating a suitable field method for measuring SOM. A method would be based upon the appropriate weighing and prioritizing of all these factors. One such ordering is: 1) **Simplicity and ease of operation**, 2) **safety for the operators**, 3) **cost (number of samples and frequency of sampling)**, 4) **acceptable accuracy**.

Any field method requires basic steps that are easy to follow by operators from a field office. Thus, some accuracy is normally sacrificed for simplicity and ease of operation. Invariably, one would need to rely on visual observations or portable battery-operated field instruments which are not as reliable as in-house laboratory instruments and equipment. **The field method, though, still must distinguish and separate significant differences in SOM as required by its users.**

This field method could be used by the Natural Resources Conservation Service (NRCS), to estimate SOM for the revised wind erosion equation (RWEQ) so the soil erodible fraction (EF) can be calculated. For example, if the soil contains 1.7% SOM (1% organic carbon), the actual percentage of EF would be reduced by 4.66 percentage points. The formula, therefore, is important to estimate soil loss from erosion, and how this is attenuated by SOM.

POTENTIAL FIELD METHODS

There are two possible methods that could fall under the category of ease of operation:

- 1) Basic EDTA method
- 2) Modification of the Walkley-Black procedure

Method number 1 is less accurate than method no. 2, but is easier to perform in the field, and is relatively safe even though it utilizes a strong base (sodium hydroxide). The method is based upon the principle that basic EDTA releases SOM, and this release is directly proportional to the color intensity of the extract (1). Thus, the darker the extract, the higher the SOM content. Method number 2 poses a safety hazard since the procedure requires the use of dichromate, a heavy metal, and concentrated sulfuric acid (2). This method may be more useful for the lower range SOM samples (<2%). The method is routinely used in many laboratories, but could be modified for quick SOM assessment in the field. Because of the hazard and disposal problem, this method should be used sparingly.

Methods 1 and 2 require field standards of soils from the general area with varying but known SOM content. If these are not available, the color chart presented in Fig. 1 could be used as an approximation of the SOM, or previously extracted standard samples in clear vials could be used. These methods are based upon visual color comparison of the sample to color obtained from a series of standards (usually three: high, medium, low). Thus, estimation of SOM requires interpolation (between 1.0 and 1.5% SOM), or statements of less than (e.g., <0.5% SOM) or greater than (eg, >2.00% SOM). In the case of the basic EDTA, the sensitivity of the analyses could be increased by filtering the extract and reading the transmittance at 520 nanometers with a small field spectrophotometer (usually about \$800).

METHOD DEVELOPMENT

Four soils of varying SOM content (< 1%, 2%, 3%, and >4% SOM) were used to assess the basic EDTA method. Standard soils with less SOM content were used for the Walkley-Black procedure. Standards contained enough differences in SOM content so color was easily discernible by field operators.

Variables that were evaluated in this method development were: sample size (1 or 2 scoops), and shaking time (30 or 60 seconds). No advantage was gained with two scoops of soil or 60-second shake versus the one scoop and 30-second shake. The scoop generally delivered 0.63 ± 0.02 g for air-dried screened (2-mm) cultivated soils. The high (0.66 g) and low (0.58 g) weights did not visibly affect the color change. Although water content above air dryness will affect sample weight, the greatest error was from clods or uncrushed aggregates in the scoop which reduced weight and inhibited solvent contact within the clod during the 30-second shake. Other size scoops will require reevaluation of standards.

The two methods are briefly described below. One must realize that adequate sampling methodology and replications still apply even though the results may be less sensitive than those obtained from conventional soil testing. Since the test is applied to the top one inch of the soil, samples could be taken after the surface soil has dried out sufficiently. Dried samples should be mixed and ground with a mortar and pestle before filling scoop.

Basic EDTA

Equipment

1. Scoop (about 0.6 g)
2. Mortar and Pestle
2. Glass tubes or vials to hold 40-mL
3. 25-mL graduated cylinder
4. Rubber stoppers to fit tube, or caps for vials
5. Tube rack, or funnel rack
6. Filter paper (#2 Whatman), and funnels

Reagents

1. Sodium hydroxide (NaOH 0.25 M. 10 g/L).
2. EDTA disodium salt (Na_2EDTA 0.05 M. 18.6 g/L).
3. Basic EDTA: Mix 1 and 2 in equal proportions (v/v).

Procedure:

1. Place dry field sample (5 to 10 g) into mortar and pulverize. Mix thoroughly.

2. Place one level scoop of standard soils and unknown soil in respective vials or tubes.
3. Add 20 mL of basic EDTA to containers.
4. Stopper, and shake vigorously for 30 seconds.
5. Transfer to filter and funnels.
6. Catch clear filtrate in vials or tubes.
7. Compare color of unknown to color of standards.
8. Estimate SOM.

Note: Try to match textural classes of standards and unknown as much as possible.

Modified Walkley-Black

Equipment

1. Scoop (about 0.6 g)
2. Calibrated glass tubes with 25-mL mark
3. Tube rack.

Reagents

1. 1N potassium dichromate ($K_2Cr_2O_7$, 49.0 g/L). Place 2.5 mL in glass tubes
2. Conc. sulfuric acid (H_2SO_4 ; 5-mL delivery). CONDUCT WITH CAUTION!

Procedure:

1. Place one level scoop of standard soils and unknown soil in respective tubes.
2. Add 2.5 mL of $K_2Cr_2O_7$ if not previously added to tube.
3. Add 5 mL conc. H_2SO_4 to tube. Can be poured in from a graduated cylinder.
4. Mix (swirl) and let stand 15 minutes. CAUTION: HEAT GENERATED BY REACTION.
5. Make to 25 mL volume, and mix (glass rod or other tube).
6. Let stand and compare.
(Greener color represents more SOM).

Note: Method is better adopted to the lower SOM content soils (<2.5% SOM) since the volume of dichromate may not be enough to oxidize excess SOM, and method relies on keeping hazardous volumes to a minimum. Samples need to be brought back to a lab for proper neutralization and disposal.

CONCLUSIONS

The basic EDTA field method seems suited for SOM estimates where broad ranges are required. Given sufficient time, a farmer, directly, or through the assistance of a government agent, can compare differences among soils from his different cropping systems (wheat-fallow vs wheat-corn-millet-fallow) and to that from an adjacent native sod. Eroded sites on knolls versus non-eroded sites can be quickly compared. While it is recommended that a farmer assess his SOM content every 3 to 5 years through a certified laboratory, the quick field test can provide greater information and the impetus for a farmer to consider the necessary changes in management to produce and conserve more SOM.

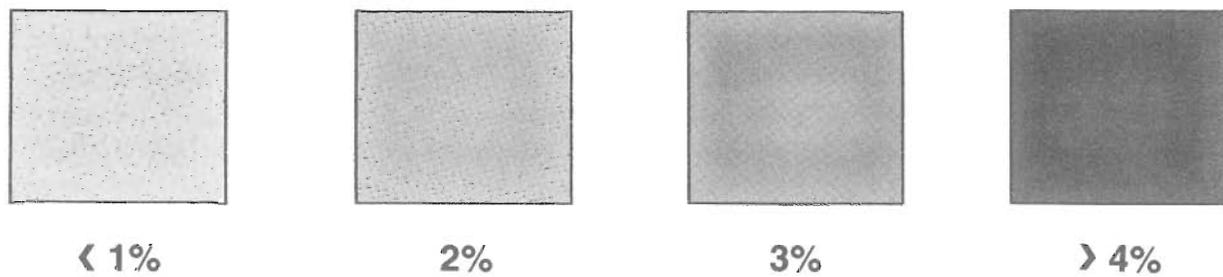


Fig. 1. SOM approximate concentration as a function of color

References.

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2. Walkley, A., and I. A. Black. 1934. An examination of the Degjareff method for determining SOM and a proposed modification of the chromic acid titration method. *Soil Sci.* 37: 29-38.