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DIVISION S-10 - WETLAND SOILS

A field method for determing percentage of coated sand grains

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ABSTRACT

TOP

TOP
ABSTRACT
INTRODUCTION
Materials and Methods
Results and Discussion
Conclusions
REFERENCES

Several USDA-NRCS hydric soil field indicators require estimation of the percentage of organic-coated sand grains (black grains). For example, to meet the Dark Surface field indicator the soil layer must contain at least 70% coated (black) grains. Field experience has shown that the estimation of the percentage of coated sand grains is often subjective and highly variable from one soil scientist to another. In order to overcome this variability a set of standards was created using a mixture of black and light gray (representing uncoated grains) sand grains. Weighing out each component for the desired ratio and mixing them in a 47-mm-diam. petri dish we made a set of three standards consisting of 50, 70, and 90% black grains. To test the effectiveness of these standards, soil scientists estimated the percentage of coated grains from similarly prepared samples first without the use of the standards and then with the use of the standards for comparison. Individuals improved the accuracy of their estimates by 10 to 60% and their hydric soil identification by 16%. The standards are easily prepared, easy to use, and portable.

Abbreviations: OM, organic matter

INTRODUCTION

TOP
ABSTRACT
INTRODUCTION
Materials and Methods
Results and Discussion
Conclusions
REFERENCES

THERE HAS BEEN CONSIDERABLE INTEREST in identifying and delineating wetlands in the last 15 yr. Jurisdictional wetlands are defined as having wetland hydrology, a predominance of hydrophytic vegetation, and hydric soils (Environmental Laboratory, 1987). Over the last decade soil scientists have developed a list of morphological features, called field indicators, to identify hydric soils. The *Field Indicators of Hydric Soils in the United States* has been published as a guide for identifying and delineating hydric soils (USDA-NRCS, 1998). The field indicators, as they are commonly referred to, are broken into three main categories: those applying to all soils, those applying to soils with sandy textures, and those applying to loamy and clayey textured soils. The field indicators rely on morphological features that are formed by reduction when soils are saturated. These include redoximorphic features formed by reduction, translocation, and oxidation of Fe and Mn; presence of hydrogen sulfide gas (rotten egg odor); and accumulation of C or organic matter.

The use of Fe and Mn based redoximorphic features to identify saturated and reduced conditions has long been established (Vepraskas, 1994; Evans and Franzmeier, 1988; Vepraskas and Wilding 1983; Veneman et al., 1976). Likewise, the accumulation of organic matter (OM) due to poor drainage has been documented (Reese and Moorehead, 1996; Daniels et al., 1987; Fanning et al., 1973). The studies investigating OM accumulation showed that the poorly drained soils have a thick, dark surface layer or the presence of organic horizons. Several technical publications dealing with hydric soils or wetland delineation make use of OM accumulations as well as several other C based morphological features (USDA-NRCS, 1998; Florida Soil Survey Staff, 1992; Environmental Laboratory, 1987). Five field indicators utilize the presence of a dark layer (value 3 or less, chroma 1 or less on the Munsell color notation) in which 70% or more of the grains are covered, coated, or similarly masked with organic matter for identification purposes (Table 1).

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[in this window] [in a new window]	Table 1. Hydric soil indicators that require the estimation of coated grains according the *Field Indicators of Hydric Soils in the United States* (USDA-NRCS, 1998)

The use of 70% coated grains for hydric soil identification in sandy soils is based largely on extensive field observation. Field estimation of the percentage of coated sand grains is often difficult, resulting in a wide range of coated grain estimates for the same sample. This disparity can result in misidentification of hydric or nonhydric soils. The figures in the *Munsell Soil Color Charts* (Kollmorgen Instruments Corporation, 1994) or the *Field Book for Describing and Sampling Soils* (Schoeneberger et al., 1998) do not adequately demonstrate the appearance of 70% black grains. Without a source of reference it is understandably difficult to estimate percentage of coated grains.

In order to overcome the potential problems of field estimation of percentage of coated sand grains and OM accumulation quantitative color analysis may be used. This analysis has been used to correlate A horizon color to cumulative saturation and to organic C content (Lindbo et al., 1998; Thompson and Bell, 1996; Schulze et al., 1993; Fernandez et al., 1988). Observation of sandy epipedons along an upland–wetland transect on the eastern shore of Maryland illustrated a darkening of the A horizon as duration of saturation increased (Condron, 1990; Rabenhorst and Lindbo, 1998). In order to quantify this relationship quantitative soil color measurements of A horizon material were made along the transect (Lindbo et al., 1998). Quantitative color measurements were obtained from a chromameter and were correlated to duration of saturation. It was noted that quantitative color also might be correlated to the percentage of coated sand grains, potentially providing a useful tool for identification of hydric soils.

This study had two objectives. The first objective was to evaluate the abilities of soil scientists to estimate percentage of coated sand grains. The second objective was to determine the degree to which estimates can be improved using a series of coated sand grain standards and quantitative color measurements.

Materials and Methods

- TOP
- ABSTRACT
- INTRODUCTION
- Materials and Methods
- Results and Discussion
- Conclusions
- REFERENCES

Preparation of Standards and Test Samples

Standards were developed using black and light gray colored sand since the majority of the indicators that use percentage coated grains are for sand textures. The sands are model railroad materials commonly available at many hobby shops. The black sand represents the organically coated grains and the gray sand represents the uncoated grains. Portions of black and light gray sand were weighed and mixed in a 47-mm diameter petri dish (Table 2), resulting in three standards: 50, 70, and 90% black. Ten samples with known ratios of black/gray sand were also made following the same procedure. These 10 samples were used as unknowns to test estimation abilities. It was possible to simply weigh out the sands because they had similar particle densities and size ranges estimation abilities. It was possible to simply weigh out the sands because they had similar particle densities and size ranges.

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Table 2. Sand grain weights for standard and test samples. Each sample prepared contained 5 g of sand

Evaluation Procedure

A total of 46 soil scientists and wetland specialists were given the set of 10 samples and asked to estimate and record the percentage of black grains in each. After evaluating the entire set of 10 samples, each person was given a set of labeled sand standards (50, 70, and 90% black) and asked to repeat the process. Statistical analysis of the results correlated the estimated percentage of black sand grains to the actual percentage of black sand grains for each person as well as for the overall group. Quantitative soil color was determined in triplicate for each sample with a Minolta CR 200 Chromameter (Minolta, Osaka, Japan). Statistical analysis of these data correlated the percentage of black sand grains to the Munsell value (wet and dry) and Munsell chroma (wet and dry) obtained from the chromameter.

Results and Discussion

- TOP
- ABSTRACT
- INTRODUCTION
- Materials and Methods
- Results and Discussion
- Conclusions
- REFERENCES

Overall high and low estimations of percentage of black sand grains without the use of the standards varied widely for most of the samples (Fig. 1) . The greatest variation was observed in the 50% black sample (Sample 1) and decreased with increasing percentage black. There were a few individuals that appeared unable to estimate percentage of black sand grains with any accuracy (r^2 = 0.01 for a single individual), as well as those adept at such estimations (r^2 = 0.95 for a single individual). In general, the percentage of black grains was underestimated without the use of the standards. The use of the standards decreased the overall range in variation and improved both individual and overall r^2 (Fig. 2 and Table 3). The lowest r^2 with the standards (0.63) illustrated a dramatic improvement of the lowest r^2 without the use of standards (0.01).

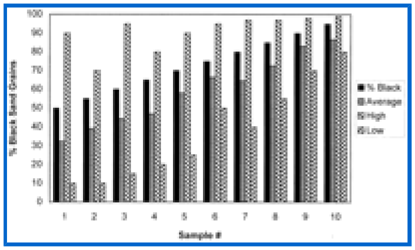

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Fig. 1. Average, high, and low values of percentage black sand grains of 46 soil scientists without using the standards

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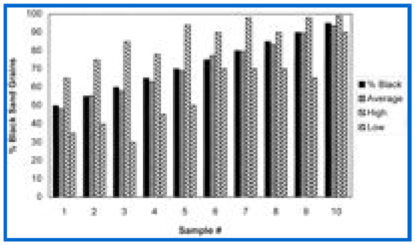

Fig. 2. Average, high, and low values of percentage black sand grains of 46 soil scientists using the standards

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Table 3. Statistical results summarizing correlation coefficients of estimated to actual percentage of black grains for all 46 individuals

In order to understand how the problems in estimating percentage of black sand grains might affect hydric soil determination, the number of times the estimates would have resulted in an incorrect determination of a hydric soil indicator was determined. For example, if an estimate of 75% black was made for a sample that was really 65% black that sample would have been incorrectly identified as meeting a hydric soil indicator. On the other hand, if an estimate of 75% black was made for a sample that was really 85% black that sample would have been correctly identified as meeting a hydric soil indicator even though the estimate was low. This breakdown resulted in three categories: correct identification of a hydric soil indicator (or lack of one), incorrect due to overestimation of black grains, and incorrect due to underestimation of black grains (Table 4). The use of the standards resulted in a correct determination 90% of the time. This represents a 16% improvement over the estimates made without the use of the standards.

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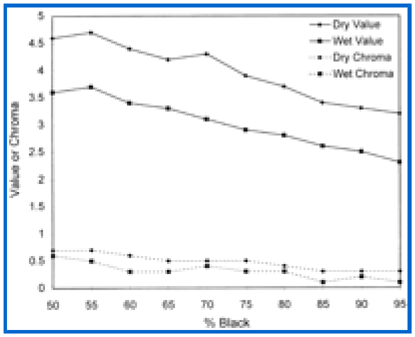
Table 4. Number of estimates that would have resulted in correct and incorrect use of a hydric soil indicator. Three categories are established: correct identification of a hydric soil indicator (or lack of one), incorrect due to overestimation of black grains, or incorrect due to underestimation of black grains

Quantitative color measurements also provide a tool in assessing the percentage of black sand grains (Fig. 3). The Munsell value

Quantitative color measurements also provide a tool in assessing the percentage of black sand grains (Fig. 3). The Munsell value and chroma of the samples decreased as the percentage of black sand grains increased. There was a high level of correlation with both chroma (r^2 = 0.94 dry and 0.78 wet) and value (r^2 = 0.94 dry and 0.97 wet), with the best correlation between the wet value (r^2 = 0.97) and percentage of black sand grains. Despite this high level of correlation, the change in both wet and dry chroma was small across a wide range of percentage of black sand grains. This small change suggests that it would be difficult to use chroma consistently to determine the percentage of black sand grains. Similarly, small changes in value correspond to relatively large changes in percentage of black sand grains. The small changes that are observed suggest that value must be read extremely accurately and should only be done so with the use of a chromameter.



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[in a new window]

Fig. 3. Results of quantitative color determination

Conclusions

TOP
ABSTRACT
INTRODUCTION
Materials and Methods
Results and Discussion
Conclusions
REFERENCES

The use of the standards improved the overall as well as individual estimation of percentage of black sand grains. Their use also improved the overall accuracy of correctly identifying a hydric soil indicator, from 74% without their use to 90% with their use. The standards are simple and inexpensive to make and can be used in the field.

It should be noted that the standards are designed to mimic the field observations but are not exact. Rabenhorst and Lindbo (1998) discussed how grains are often only partially coated or covered by organic matter or may actually be discrete black particles. Despite this observation the grains appear black or dark when viewed in the field. It is the field observation of percentage black that the standards discussed in this paper will assist.

Quantitative measurements of Munsell value and chroma are related to the percentage of black sand grains. The relationship established showed that small changes in both value and chroma correspond to relatively large changes in the percentage of black sand grains. In order to accurately assess these changes it is important that a chromameter be used. Unlike the sand grain standards, quantitative color measurements are generally made in the lab or office and require the use of an expensive piece of equipment. Nonetheless, the chromameter does show promise. Overall, it is recommended that those making routine hydric soil determination use the standards to assure the highest level of accuracy and reserve the use of a chromameter for select sites. Furthermore, the results for the chromameter need to be evaluated with known field samples, as results from actual soils may prove to be slightly different.

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REFERENCES

- TOP
- ABSTRACT
- INTRODUCTION
- Materials and Methods
- Results and Discussion
- Conclusions
- REFERENCES

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